



Fig. 1

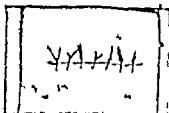


Fig. 2



Fig. 3



Fig. 4

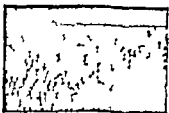


Fig. 5

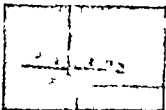


Fig. 6

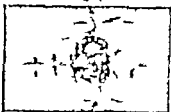


Fig. 7



Fig. 8

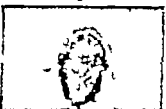


Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13

*An Experimental Study in Wound Healing in Vitamin C Depleted Human Subjects.*—  
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# SURGERY

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### AN EXPERIMENTAL STUDY IN WOUND HEALING IN VITAMIN C DEPLETED HUMAN SUBJECTS

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THE study of wound healing has been the subject of much thought through the ages but it is only in recent years that surgeons have become acquainted with tangible evidence concerning the value of certain systemically acting biochemical factors. Both clinical and laboratory observations have shown conclusively that the rate and efficiency of primary wound healing depend to a great extent upon the vitamin C (ascorbic acid) content and the protein concentration in the tissues while to a lesser degree upon carbohydrate and some mineral metabolism. Such conclusions have been drawn by eliminating the well known local deterrent factors of wound healing. There has been satisfactory laboratory evidence cited in the literature to prove the rôle played by vitamin C

through animal experimentation but the data obtained from clinical observations have been of necessity impure and incomplete. By this we mean that a condition in which there is a deficiency of a single vitamin as the only factor (pure mon avitaminosis) is a rarity whereas the usual instance is that of a patient presenting a poor nutritional status with multiple avitaminoses, a depletion in serum proteins and a distorted metabolism. Thus the early observations on impaired wound healing dealt with multiple deficiencies (2, 8, 16, 22, 25, 27, 28), and it was eventually necessary to use animal experimentation to differentiate the factors which were due to hypoproteinemia and those due to a vitamin C deficiency.

There has been some thought that the part played by vitamin C in human wound healing is overshadowed in importance by other mechanisms on the assumption that the human

The experimental work described here is part of an investigation conducted under a contract recommended by the Committee on Medical Research between the Office of Scientific Research and Development and Northwestern University.

Fig. 1. Skin and fascial incisions with silk sutures in latter.

Fig. 2. Skin incision closed with silk sutures.

Fig. 3. Biopsy of skin wound by elliptical excision.

Fig. 4. Biopsy of fascial wound by rectangular excision in site of healing suture line.

Fig. 5. Perifollicular petechial pigmentation in depleted subject following soap and water skin cleansing.

Fig. 6. Primary healing of cruciate skin closure in subject 5 (W. R.).

Fig. 7. Failure of wound healing after cruciate skin closure in depleted subject 1 (D. A.).

Fig. 8. Same in depleted subject 6 (L. M.).

Fig. 9. Same in depleted subject 8 (J. M.).

Fig. 10. Fascial suture line of depleted subject 8 (J) at 11 days. Photomicrograph reveals lack of blue-stain collagen immediately within the healing zone (Ziehl-Mallory stain).

Fig. 11. Fascial suture line of control subject 11 (I) at 7 days. Photomicrograph reveals abundant light staining collagen throughout the suture line.

Fig. 12. Skin suture line of depleted subject 8 (J) 11 days. Photomicrograph reveals again the lack of collagen throughout the healing zone except for the slight position just next to the epithelium.

Fig. 13. Skin suture line of control subject 13 (I) 10 days. Collagen is to be seen diffusely throughout the suture line.



factor is such that the tissue content not be sufficiently reduced. Concerning this, we must remember that the human skin cannot synthesize vitamin C. Thus, the healing of a wound is something of an emergency—it is logical to expect replacement of necessary substances in the body to be mobilized on the demand of a healing wound.

The work of Lauber and Rosenfeld indicated that in animals on a scorbutic diet any organs lost their vitamin C after the animal had been wounded while vitamin C could be demonstrated in the tissues about the healing wound. Despite this finding of a chemical balance, the same kind of experimentation has revealed a relationship between the tensile strength of the healing wound in those rendered scorbutic. Bartlett (1942) found the tensile strength to be proportionate to the vitamin C content of the scar tissue tested.

Work as just referred to should not lull us into a sense of false security because even the tissues in greatest need of vitamin C receive top priority in order to obtain satisfactory healing. It may be inferred that parts of the body suffer proportionately in the absence of vitamin C. Workers in this field have found that in the human subject some signs of scurvy can be obtained after 4 weeks of a strict deficiency diet, while 6 weeks of abstinence produces further changes. The total daily intake of vitamin C and the rate of inadequate intake are important in developing symptoms, and it has been found with the aid of guinea pig experiments that changes effected by a complete deficiency diet of short duration can be repeated in humans by administration of a standard dose over long periods of time. It is logical to conclude that the effect of deficiency in wound healing may be widespread in our population than was formerly suspected. To our knowledge, this study (9-10) on wound healing in an experimentally deficient in vitamin C for 3 months has not been duplicated in this report. In that instance the subject had been on a diet completely deficient in vitamin C for 3 months, and after the plasma vitamin C had been nil for 44 days, biopsy

material from a small wound showed satisfactory healing on the tenth postoperative day. The usual criteria of abundant intercellular substances and capillary formation were used as histological evidence of healing. In the same individual after 6 months on the deficient diet a similar wound showed no signs of healing as evidenced by a lack of intercellular substances and the presence under the skin of an unorganized blood clot. No study of tensile strength was carried out in this individual. While this experiment was of great value, the status of the wound never was fully established for according to Hunt there may be a good supply of intercellular fibers present in a healing wound, nevertheless if most of them are made up of immature collagen the tensile strength will be quite low.

An opportunity was afforded us to study the effect on wound healing of a prolonged vitamin C deficiency in 9 otherwise normal healthy young males. In addition 5 normal healthy young males were available as controls. Twelve of these men already have been referred to in a previous abstract (13). Each subject was a medical student who volunteered to submit to a diet deficient in vitamin C for a period of 7 months. The diet was selected from a hospital cafeteria, the foods chosen being free from vitamin C or subjected to processes destructive to vitamin C such as overcooking with or without soda, or by being held on the steam table. Chemical analysis of the whole meals, as well as individual articles of the diet showed vitamin C to be very low—occasionally 5 to 10 milligrams per day or entirely lacking. In this respect our dietetic approach differed from that of Crandon, Lund and Dill (9-10) since a civilian might conceivably select a diet similar to ours, but never as severe as that prescribed by the former investigators. Observations were made on the plasma and white-cell platelet vitamin C content, urinary vitamin C excretion, complete blood chemistry, hemoglobin determination and blood cell count, and metabolic urinary constituents. The deficiency status of the experimental subjects was established and maintained throughout the period of observation. At the

end of this time, an incision was made in the thigh through the skin and fascia and the course of the wound healing studied by removal of biopsy specimens at intervals of 4 to 14 days. This included a measurement of tensile strength of the healing incisions as well as histological examinations of skin and fascia wounds. Immediately after taking the biopsy specimen saturation tests were done to establish the fact that the tissues of the subjects on the deficiency diets were relatively highly depleted of vitamin C.

#### DEFICIENCY STATUS

As stated, no attempt was made to place our experimental subjects on as rigorous a dietary regimen as carried out by Crandon. We were interested in the effect of a diet grossly inadequate in ascorbic acid when administered over a prolonged period upon the severity of depletion of the body vitamin C and the degree of healing occurring following standardized surgical technique on depleted and undepleted control subjects. We wished to answer the question as to how severe vitamin C depletion must become before marked impairment of the healing process occurred.

All subjects were placed upon a basal diet, adequate in protein, fat, and carbohydrate but as low in vitamin C as selection and preparation could render it. This diet was also somewhat low in the members of the vitamin B complex, but not to such a degree as to be considered deficient. Subjects subsisting on this basal diet were designated for practical purposes as vitamin C deficient. A few of these subjects received daily supplements of the members of the B complex in amounts recommended as adequate by the Committee on Food and Nutrition of the National Research Council. The normal control group was placed upon the basal diet supplemented with adequate amounts of the vitamins of the B complex and 75 to 150 milligrams of ascorbic acid daily.

Several methods have been proposed for ascertaining the degree of depletion of vitamin C suffered by the body tissues. These tests frequently referred to as saturation tests, may be classified according to tech-



Fig. 14. Tensiometer used to test holding power of measured segment of suture line. Water falling into beaker on right side of balance causes clamp attached to left side to pull away from lower fixed clamp eventually rupturing suture line. Rupture producing force determined by weight of water used.

nique employed into the following four groups

- 1 Measurement of the 24 hour urinary excretion of vitamin C after the oral administration of a standard test dose (1)

- 2 Measurement of the plasma vitamin C rise and urinary excretion after oral administration of a test dose (12-24)

- 3 The measurement of the rate of plasma vitamin C drop and urinary excretion in 5 hours following the intravenous administration of a test dose (20-29)

- 4 The estimation of the vitamin C content of the white-cell platelet layer may also be used as an index of tissue depletion (6)

Of these tests the degree of tissue depletion may most readily be determined by the ad-

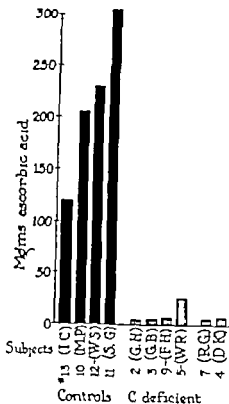


Fig. 15. Urinary excretion during 5 hour saturation

uation of a standard oral dose of 15 of vitamin C per kilogram of body and the determination of the blood and urinary vitamin C each hour for ours. The subject empties his bladder and first sample of blood is taken. The test e of vitamin C dissolved in 200 cubic centimeters of water and slightly sweetened if de-a is taken immediately. Blood samples, n either the finger or vein are taken hourly reafter for 5 hours. The bladder is com- pletely emptied at the time the blood samples taken. Both blood and urine samples are lyzed (11) and the data plotted as shown he accompanying charts (Figs. 15 16 17

t is desirable that the saturation test be on the subject in the fasting state. If not aient. It may be started 4 hours after a meal which contains no vitamin C. No l is taken during the test. The subject is a total of 400 cubic centimeters of s as desired to assure sufficient urine for specimens.

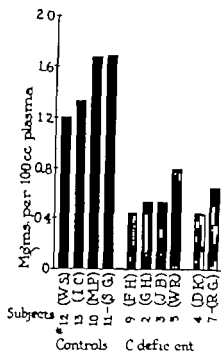


Fig. 6. Magnitude of plasma ascorbic acid rise following saturation test dose of 5 milligrams per kilogram body weight. Data plotted is peak plasma value minus fasting level.

White-cell platelet vitamin C was determined periodically during the investigation. The average values for subjects deprived of vitamin C at the time the surgical studies were done were 0.75 milligram per 100 grams white-cell platelet layer the normal controls averaged 31.85 milligrams per 100.

The plasma total protein levels of all subjects ranged between 6.80 and 7.57 grams per 100 cubic centimeters during the entire study.

#### SURGICAL PROCEDURE

The left thigh was used throughout. A 6 centimeter longitudinal incision was made over the region in which the fascia lata was suspected of being strongest. The incision first was made through the skin and superficial portion of the subcutaneous layer thus allowing uniform undermining of the skin 1 centimeter away from the incision in each direction. The incision was then continued to the level of the fascia lata, this being carefully exposed with a minimal of tissue damage. A corresponding 6 centimeter longitudinal incision was then made in the fascia, the edges being allowed to fall apart. Interrupted silk

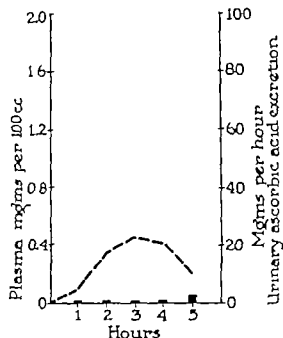


Fig. 17. Vitamin C saturation test. C deficient. November 8, 1942. Weight 63.6 kilograms, dose 954 milligrams, ascorbic acid.

sutures were used for closure of both fascia and skin and were placed about 1 centimeter apart so as to obtain perfect apposition. Simple dressings were then applied. During the course of healing alternate sutures were removed on the fourth day, and the remaining on the sixth or seventh day.

In obtaining the skin specimens for study, two different techniques were used. In 4 cases a 2 centimeter square block was removed so as to include the suture line in its middle. The closure of the defect was obtained by converting this square into a transverse ellipse undermining the borders and using interrupted silk sutures under some tension. This, with the former incision, resulted in a cruciate closure with a maximum of interference to the blood supply. In the remaining 10 cases the original incision was removed in its entirety by an elliptical excision the closure being accomplished with a minimum of undermining and with interrupted silk sutures under only moderate tension.

In all cases the specimens of fascia lata were obtained by simple excision of a corresponding 2 centimeter square section of tissue, which included the suture line. No attempt was made to close this defect.

As a routine, all the subjects were admitted to the hospital the evening before the

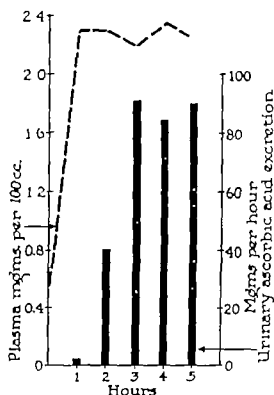


Fig. 18. Vitamin C saturation test—control. November 11, 1942. Weight, 89.8 kilograms. Dose 1350 milligrams ascorbic acid.

surgical procedure and remained in the hospital for at least 24 hours afterward. Hospitalization was continued much longer in those exceptional cases in which complications developed. All the surgery was carried out in the operating rooms under strict aseptic precautions the skin preparation being soap and water cleansing for 10 minutes. Exceptions to the latter were made in the secondary operations in those instances in which it was thought that the mechanical rubbing would be deleterious to the wound edges. Routine iodine and alcohol preparation was used in these cases. The anesthetic agent was 1 per cent procaine solution with adrenalin used as a circumferential field block.

*The rupture factor.* The tensiometer used for the tissue tensile strength determination is shown in Figure 14. The essential feature of this device was a perfectly balanced pair of clamps, which could be separated very slowly by an accurately measured weight of water. The biopsy specimen was held by the soft rubber-cushioned clamps so that the suture line was immediately between and parallel to the clamps. The weight of the clamps was first balanced out and then water was allowed

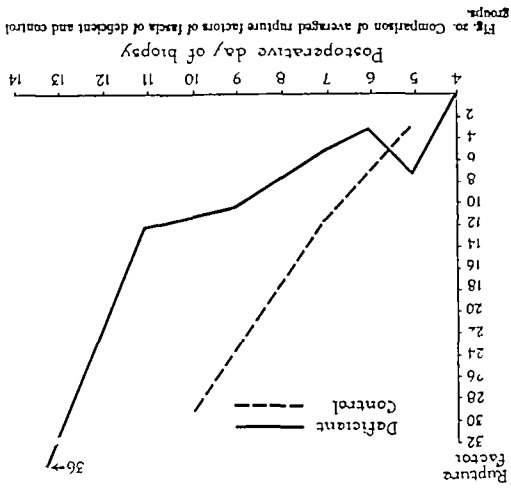


Fig. 20. Comparison of averaged rupture factors of fascia of deficient and control groups.

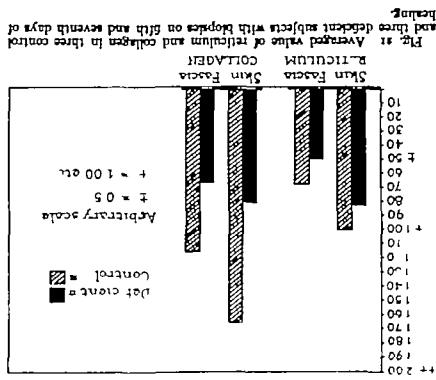


Fig. 21. Averaged value of reticulum and collagen in three control and three deficient subjects with biopsies on fifth and seventh days of healing.

strength of the suture line of the skin and of the fascia was reduced 19 per cent and 50 per cent, respectively. A study of the saturation tests for these subjects reveals that both con-

trols were adequately supplied with ascorbic acid while one of the two deficient subjects (No 5) previously referred to as having a rupture factor approaching the control aver-

stance. Subject No. 1 (D.A.) showed the presence of collagen after 4 days of healing with no evidence of reticulum. This discrepancy may be the result of taking the section stained for collagen and the section stained for reticulum from separate blocks of tissue. In general, the amount of reticulum paralleled the amount of collagen, slightly more reticulum being evident in the earlier stages of healing and slightly less in the later stages (Fig. 21).

**Tensile strength.** In comparing the tensile strength with the degree of ascorbic acid deficiency as measured by the saturation tests and tissue depletion determinations, three clear-cut time intervals are available for study. The first is that of the fifth day and is represented by the deficient subject No. 2 (G.H.) and the control subject No. 10 (M.P.). The fifth day was the earliest time period permitting a measurement of tissue strength and is an interval in which the peritoneal or inherent tissue differences of tumor thickness, and healing properties may cause variations in results. In addition, the normal momentum of healing is quite slow at this time, and difference in healing strength has not had time to develop. Thus it is that these 2 cases present quite similar numerical results and are important only as basic lines for comparison and as starting points of the healing curve.

The second interval is that of the seventh day and is represented in the deficiency group by subjects No. 4 (D.K.) and No. 5 (W.R.) and in the control group by subjects No. 11 (D.G.) and No. 12 (W.S.). When an average value of the rupture factors of each group is compared, it is found that there is a definite difference in favor of the control group (Fig. 19 and 20). If one considers that the groups are too small for averaging then the simple summeation of these factors may be an adequate measure for comparison. Thus, the sum of the skin rupture factors for the two deficient subjects is 17.6 as compared with 21.7 for the controls. The sum of the factors for the deficient subjects is 10.6 as compared with 21.7 for the controls. Assuming the normal controls to represent a base line of 100 per cent, calculations reveal that in these deficient subjects the tensile

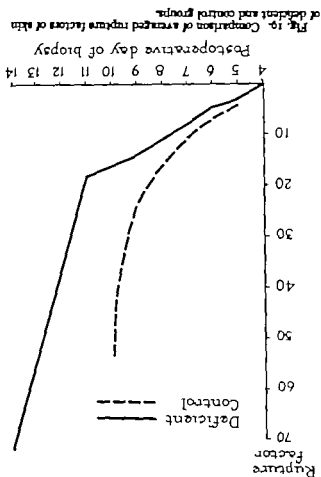


Fig. 19. Comparison of averaged rupture factors of skin Postoperative day of biopsy.

used on the Zetzer fixed material. In all, 180 slides were studied from 0 to +++ for each component studied, 0 being considered a negative amount, † the minimal amount, and +++ the maximum amount in the series. (Number of this method of grading it offers a means of comparing the slides of the biopsy specimens in relation to each other. This is recorded in Table II.)

In all cases, healing in the skin was first evidenced by a proliferation of fibroblasts just beneath the epithelium while in the fascium, healing generally occurred by a growth of granulation tissue into the wound from the inner and outer surfaces of the fascium. The reticulum stain was expected to be a more sensitive indicator of incipient sub-stance in the earlier stages of healing however this did not prove to be true in all in-

TABLE III

Date	Subject N Initials	Tissue depletion* milligrams ascorbic acid	Saturation test ascorbic acid		Rupture factor		% normal	
			Dose milligrams	Saturated tissue urine in 3 hours milligrams	Skin	Fascia	Skin	Fascia
C deficient	D K	100.4	954	6.23	6.03	47	80.9	70
C deficient	W K	37.3	06	1.80	66	8.44		
Normal control	D G	(None)	13,501	960.00		0	100.0	100.0
Normal control	W S	(None)	10,601	30	7.3	00		

\*Tissue depletion. This is arbitrarily chosen as the total number of milligrams of ascorbic acid administered (including the saturation test dose) before blood plasma level of ascorbic acid was attained. The rate of administration following the test dose was usually 500 mgm. per day.

†The plasma ascorbic acid levels rose above 500 mgm. per cent upon administration of the saturation test dose of 5 mgm. ascorbic acid per kilogram of body weight. ‡Tissue deficit exists in these control subjects.

§For purpose of comparison, the control subjects are taken to represent 100 per cent of normal.

age proved to be less depleted than was suspected. This relative lack of depletion was reflected in a tensile strength higher than a corresponding deficient partner especially in the fascia, but was not up to the level of the control average. The amount of ascorbic acid spilled into the urine during this subject's saturation test was significantly more than that which was found in the other deficient subjects but yet it was not enough to be compared with any of the control subjects. Thus, it appears that while this subject was quite deficient, he still possessed a minimal amount of vitamin C in his tissues sufficient to obtain adequate healing (Table III).

The third interval is that which approximates the tenth day. The deficient group here consists of subjects No. 6 (L.M.) No. 7 (R.G.) and No. 8 (J.M.) two of these representing the ninth day of healing while the third represents the eleventh day. These can be compared with the ten day control subjects No. 13 (L.C.) and No. 14 (W.M.). The skin wound only was studied in subject No. 13 while only a fascial wound was studied in subject No. 14. The average of the rupture factors for the skin wound of the deficient subjects is 15.3 as compared with 53 for the control subject. The average of the rupture factors for the fascial wound of the deficient subjects is 10.5 as compared with 28.1 for the other control subject. Barring error due to use of a single control subject for skin and a single control subject for fascia (though both

were consistently comparable) and again assuming the normal controls to represent a base line of 100 per cent, it was found that in these deficient subjects the tensile strength of the suture line of the skin and of the fascia was reduced 71 per cent and 70 per cent, respectively. In other words the depleted subjects had by this time developed only 30 per cent as much wound holding power as was found in their corresponding normal controls. The tissue depletion studies and the saturation tests on these subjects revealed that enormous amounts of ascorbic acid were needed by the deficient group to attain a fasting plasma level of 1 milligram per cent as compared with that required by the control subjects. These differences are quite evident even when the factor of inflammation in subjects No. 6 and No. 8 is taken into account. This correlation is shown in Table IV.

#### DISCUSSION

A review of the literature reveals only one instance of clinical scorbutic investigation related to the tensile strength determination of healing human wounds. In 1942 Bartlett, Jones and Ryan (4) studied the ascorbic acid content of small healing human thigh wounds of 6 supposedly healthy individuals with normal serum proteins who were convalescing from hernioplasties. By using the principle of a direct pull such as we have done, they also measured the tensile strength of the wounds. Five of the 6 subjects showed an adequate

TABLE IV

Diet	Subject No. initials	Tissue depletion*	Saturation test ascorbic acid		Rupture factor		% normal	
			Dose milligram	Secreted into urine in 5 hours milligram	Skin	Fascia	Skin	Fascia
C deficient	8 J.M.	4300	H	II	8	6.3	70	
C deficient	7 R.G.	957	1057	4.44	4	3.33		30.1
C deficient	6 L.H.	5300	II	H	4	80		
Normal control	1 C.	(none)	900		53		100	
Normal Control	14 W.M.	(none)	†	†		85		100

\*Tissue depletion. This is arbitrarily chosen as the total number of milligrams of ascorbic acid administered, including the saturation test dose before a blood plasma level of 100 mgm. ascorbic acid per 100 ml. was attained. The rate of administration, following the test dose was usually 500 mgm. per day.

†I. Subjects marked "II" were hospitalized because of failure of biopsy wound to heal and could not come to laboratory for test.

†Proven normal control subject but no saturation test done † time of experiment

holding power even though their vitamin C blood levels ranged as low as 0.20 milligram per cent. The sixth individual had a blood level of 0.09 per cent, a tissue ascorbic acid content of 0.0, and a tensile strength determination only one-fifth the average of the other 5 supposed normals. In this depleted subject, a second similar procedure was carried out on the opposite thigh (while the patient was convalescing from the second hernioplasty) an adequate amount of vitamin C then being administered for the next 10 days. The resulting specimen yielded a healing scar whose tensile strength was slightly above the group average while its ascorbic acid content was slightly below average. This isolated instance in the human subject was highly corroborative of the already known guinea pig experimentation correlating the strength of a healing wound with the ascorbic acid content of the tissues.

Our studies on the other hand have been on experimentally produced scorbutics, 9 in all, the other 5 subjects acting as controls. The results as shown graphically reveal the presence of a diminution in healing tensile strength which is more evident before the tenth day than after. In the case of the fascia, this difference approximates 50 per cent but after 11 days there is a development of parallelism such as to suggest development of satisfactory strength by the thirteenth or fourteenth day.

The same is true of the skin except that this difference approximates only 30 per cent diminution in strength through the first 8 days and because of the time lag in the deficient subjects, the percentage increases to 60 per cent during the tenth and eleventh days only to show the same tendency to parallelism nearing the thirteenth day. In other words early in wound healing it was noted that the fascia of the controls had the same wound strength on the seventh day as the deficient subjects on the eleventh while in the skin the comparable days were eighth and eleventh. In the later period the fascia of the controls achieved on the ninth day the same level of tensile strength as was found in the fascial wound of the deficient subjects on the twelfth day while in the skin the comparable days were tenth and thirteenth. The curves developed by Hartzell and Stone in guinea pigs (using a tensiometer principle for estimation of wound strength) reveal the same differences early in the course of healing, but their parallelism began around the eighth day and was such as to show a marked diminution in wound strength as late as the fourteenth day in the scorbutic animals. Their estimate was about one-quarter normal from the eighth through the fourteenth day, the latter being the termination point of their experiment.

In 1943 Jones Bartlett Ryan and Drum may reverted to guinea pig experiments and



found while working with ascorbic acid and sulfanilamide that certain of their results suggested that maximal saturation of the tissues with ascorbic acid aided in providing optimal tissue resistance to infection. Their lowest tensile strength determinations were obtained in animals with scurvy and wound infection. Their mortality figures were highly suggestive that more than a moderate tissue saturation was needed if ascorbic acid was to be of value in increasing tissue resistance. They concluded that complete saturation aided greatly in diminishing infection. This was interesting in the light of Hunt's fine work on the histological aspects of scorbutus. In 1941 he stated that not only is growth and migration of fibroblasts affected in healing wounds in vitamin C deficiency but phagocytosis is also inhibited."

With this in mind it is fitting to mention the complications encountered in the deficient subjects while convalescing from the biopsy surgery. As mentioned before the majority of the subjects underwent an elliptical excision of the suture line followed by a primary closure of the skin edges under a mild degree of tension. This could be considered as wound healing under slightly difficult circumstances. These subjects healed without complication according to the usual gross standards of external evidences of wound healing. Four subjects underwent an excision of the central portion of the wound this excision being made at right angles in the form of an ellipse. This was followed by a primary closure of the wound. Such a maneuver resulted in a cruciate incision with a moderately severe degree of tension exerted on the healing surfaces. The necessary amount of undermining resulted in some diminution of blood supply to the apex of each skin flap. Circumstances as these could be construed as poor for healing under normal conditions. All four of the subjects chosen for this latter type of closure were from the deficient group. Three out of the 4 failed to heal by primary intention as evidenced by their accompanying photographs and case histories. All but 2 subjects received ascorbic acid on the third day following biopsy during the performance of the saturation test followed by 500 milli-

grams of ascorbic acid daily until the plasma level attained 1 milligram per cent. The two exceptions were hospitalized because of wound infection appearing on the second day following biopsy at which time administration of ascorbic acid began. Massive doses of 1000 milligrams daily were administered in some cases after the plasma reached 1 milligram per cent when necrosis was severe, and continued until healing was complete. Final wound healing therefore, occurred under the influence of administered ascorbic acid.

*Subject No. 1 (D.A.)* A white male aged 24 years, C deficient underwent his first skin and fascial incisions on October 17, 1942. The bleeding was so slight that no ligatures were needed in the subcutaneous tissues. Four sutures were placed in the fascia and seven in the skin. He returned to the hospital on the fourth postoperative day for his biopsy. The wound edges were fully intact and sealed throughout. There was no edema, no evidence of subcutaneous bleeding nor reaction around the sutures. The biopsy was carried out with the procedure which resulted in a cruciate closure. There was a moderate amount of tension on the transverse suture line. His subsequent course was marked on the fifth day following the biopsy by the appearance of a slight amount of skin necrosis in the point of each flap. Occasional sutures were removed and by the seventh day all sutures were out. By the ninth day the central necrosis had included an area 1.5 centimeters wide and 2.1 centimeters long (Fig. 7). The subject was now placed on large amounts of ascorbic acid for it was felt that the experimental phase of this process was now passed. Eventual secondary healing was completed on the forty fifth day.

In regard to the biopsy tissue, both the skin and fascial specimens obtained presented excellent apposition of wound edges, but the slightest amount of handling resulted in dissolution at the suture line. The tensile strength of this tissue was too low to permit measurement, but adequate specimens were obtained for histological study.

*Subject No. 6 (L.M.)* A white male, aged 33 years, C deficient underwent his first skin and fascial incisions on October 17, 1942. There was minimal bleeding experienced so that no ligatures were needed. Four silk sutures were placed in the fascia and seven in the skin. Subsequent healing appeared to be satisfactory so that every other suture was removed on the fifth day and the remaining on the seventh day. There was a slight amount of redness about the sutures, but the wound was sealed. The edges were entirely intact, and there was no separation. There was no edema or sign of subcutaneous bleeding. The biopsy was performed on the ninth postoperative day at which time the wound appeared quite dry. The procedure used was the type that resulted in a cruciate skin closure. There

was slightly more tension in this instance than in subjects No. 1 and No. 8. The subject left the hospital 24 hours later but returned in another 24 hours with a temperature of 102.2 degrees F., a white count of 14,000 and a diffuse scarletina like rash over the trunk of the body. He had experienced chills and fever for the preceding 15 hours. It was recalled that he had a definite chill while on the operating table at the time of his recent biopsy. There was a small amount of serosanguineous drainage from the central portion of the wound, but very little, if any induration in the periphery. A few sutures were removed, a culture taken and hot wet dressings were applied. The throat cultures revealed a mixed growth of *Staphylococcus albus* and non-hemolytic streptococci while that from the wound showed a heavy growth of hemolytic *Staphylococcus albus*. The temperature peak was 100.8 degrees F. on the following day and reached normal by the fifth day. The subject received a total of 200 cubic centimeters of scarlet fever convalescent serum during the first 2 days of the febrile course as well as an adequate amount of sulfadiazine. One of the clinicians believed that the subject presented a mild form of strawberry tongue and later while in the hospital, a slight scaling of his face and hands was noted. He was placed on a high ascorbic acid supplement to his diet, but wound healing was quite slow. The last sutures were removed on the seventh postoperative day. The central defect measured about 3 centimeters in diameter on the fourth day, but had increased to an area 5 centimeters wide and 6 centimeters long by the eleventh day (Fig. 8).

*Subject No. 8 (J M)* A white male aged 24 years, C deficient, underwent his first skin and fascial incisions on October 17, 1942. No ligatures were needed in the subcutaneous tissues. Four silk sutures were used for the fascia and seven for the skin. The progress of healing was satisfactory so that occasional sutures were removed on the fifth day and the remaining on the seventh. There was no evidence of inflammatory changes about the sutures. The biopsy was performed on the eleventh postoperative day at which time the wound edges were found to be excellently apposed, tightly sealed with no separation. There was no edema or sign of ecchymosis. The procedure used resulted in a cruciate closure with a moderate amount of tension on the transverse incision.

The subsequent course was unusual in that he developed a temperature of 102 degrees F. exactly 24 hours following the closure of the wound. This was also accompanied by some swelling and tenderness about the wound. His white blood cell count was 17,000. Because of the type of culture previously obtained from subject No. 6 it was deemed advisable to remove a few of the central sutures and apply heat to the wound. The temperature peak 24 hours later was 100.6 degrees F. reaching normal the following day. A culture from bloody fluid obtained from the wound at the height of the febrile reaction revealed the presence of a mixed growth of hemolytic strep-

tococcus. A few more sutures were removed on the fourth postoperative day which resulted in more separation of the wound in the transverse axis. At this time, there was no sign of any spreading infection. This subject was fed a diet with ascorbic acid supplement on the second day after the biopsy but his wound continued to break down so that the granulating surface measured 4 centimeters wide and 7 centimeters long on the ninth postoperative day (Fig. 9). The progress in healing was quite slow but gradually the granulations appeared healthy enough to accept a split thickness graft on the twenty-seventh day. He left the hospital 11 days later with the graft sufficiently healed to allow walking.

*Subject No. 5 (W R)* A white male aged 25 years, C deficient, underwent his first skin and fascial incisions on October 17, 1942. No ligatures were needed in the subcutaneous tissue. Four silk sutures were placed in the fascia and 7 in the skin. Subsequent healing appeared to be satisfactory so that every other suture was removed on the fourth postoperative day. The biopsy was performed on the seventh day preceding which the remaining sutures were removed. The wound edges were found nicely approximated and well sealed with no separation. There was no edema but a slight amount of subcutaneous ecchymosis was noted. There was a slight redness about three of the last sutures removed. The skin biopsy was obtained by using the procedure which resulted in a cruciate closure. There was moderate amount of tension on this second suture line but the subsequent healing was very good. Every other suture was removed on the fifth postoperative day and the remaining on the seventh day. Photograph in Figure 6 was taken on the thirteenth day following the biopsy.

It is interesting to note that while all of these subjects came from the deficient group the lone subject who did heal primarily was not as deficient as the others. As a matter of fact, his response to the saturation test was intermediary between the control and deficient group (same subject previously given special mention under discussion of saturation test). Two of the three subjects who failed to heal primarily could be listed as complicated cases because of the obvious infection which developed but in the light of the above-mentioned work of Bartlett and his associates it would seem logical to assume that the end results of this poor wound healing and infection might be due to the deficiency status. If this is so it would seem that the vitamin C deficiency state exerts its greatest deterrent influence on tissue healing when circumstances for the latter are poorest i.e. in the more severe types of wound.

As early as 1923, Højer reported on the histology of experimental scurvy stating that the most constant change was an atrophy of the connective tissue fibers in all parts of the body. This study was confirmed by Wolbach and Howe in 1926 and climaxed in 1937 by Mazoué when the latter demonstrated the direct relationship of vitamin C to the production of collagen fibers. This relationship was confirmed by Querido and Gaillard in 1939 while in 1941 Hunt revealed that there might well be found many reticular fibers formed in scorbutic animals, but that these were low in collagen and thus suspected of being poor in strength. Such fibers have been referred to as precollagen fibers which do not mature without vitamin C. Hunt also noted that the proliferating mesodermal cells failed to mature under the same set of circumstances. Animal experimentation concomitant with this extended study further substantiated these microscopic observations and led to the conclusion that the absence of collagen or mature intercellular cement, results in a wound of poor holding power.

There is no doubt that the guinea pig presents a much more delicate mechanism for presenting the picture of experimental scurvy. It develops severe scurvy in 2 to 3 weeks, whereas many months are necessary to elicit a similar response in man. In the guinea pig there even is a gross difference in the appearance of scorbutic wounds due to the presence of edema along the suture lines with some evidence of mild inflammation plus heavy bloody crusts as late as the eighth and tenth postoperative days. As late as the fourteenth day these wounds are hard and thick as compared to those in the normal guinea pig. Under such circumstances, it is not difficult to diagnose the presence of scurvy with or without the microscope; the essential findings being the edema, pools of unorganized bloody exudate, the presence of some reticular fibers, and the absence of collagen. In the human subjects our findings in most instances are entirely the same save for the frank edema, but while the deficiency can be noted in the histological section in some instances it has been difficult to estimate the tensile strength of a particular wound from its microscopic

appearance. This is particularly true if the healing time is not considered in evaluating the lack of intercellular cement. Thus, if a suture line presents a total absence of collagen after 10 days of healing, one might forecast a marked diminution in tensile strength, but a comparable situation would not be present after 5 days of healing since the holding power at that time is not so dependent upon the same mechanism. This difficulty is more pronounced where only partial microscopic evidence of the deficiency exists. The explanation for this may vary all the way from the technical difficulties of a two dimensional tissue study to the specificity of ascorbic acid utilization on the part of the individual. Since the completion of our study this matter has been brought up by Bourne who found that 'wounds in scorbutic animals which are receiving different doses of vitamin C may be very similar in general histological appearance but may have very different tensile strength. Despite this relatively minor problem, the overall microscopic picture in this series is entirely in keeping with the findings of other investigators. The slides, for example of subject No. 8 (J. M.) are outstanding in the series of deficient subjects, showing almost no collagen or reticulum in the fascia (Fig. 10) and a minimal amount next to the epithelium in the skin (Fig. 12) 11 days after the initial incision was made. Fibrocytes were fairly plentiful at the borders of the incision but none was seen in the central portion of the wound which was filled with a fibrin clot.

#### CONCLUSIONS

1. Human subjects on prolonged ascorbic acid depletion exhibit an approximate 50 per cent diminution in tensile strength of healing wounds.
2. Such depletion delays the development of tensile strength in an uncomplicated healing wound from 3 to 5 days up to the fourteenth postoperative day.
3. When circumstances for healing are poor such as the presence of undue wound tension or diminution in blood supply this depletion in ascorbic acid is made more evident through gross failure of primary wound healing.

4 The incidence of wound infection under such circumstances suggests the need for ascorbic acid in the tissues for maximum resistance to infection by favoring primary wound healing

5 Human subjects on prolonged ascorbic acid depletion exhibit a recognizable lack of collagen and reticulum in their healing wounds.

# REFERENCES

- 1 ABBASY M. A., HARRIS, L. J. RAY S. N. and MER RACK, J. R. *Lancet, Lond.* 1935 2 1399.
- 2 ARCHER, H. E., and GRAHAM, G. *Lancet, Lond.* 1936 2 364.
- 3 BARTLETT, M. K. JONES, F. M., and RYAN A. E. *N England J M.*, 1942 226 469-473.
- 4 *Ibid.*, pp. 474-481.
- 5 BOURNE, G. H. *Lancet, Lond.*, 1944, 1 688-699.
- 6 BUTLER, A. M. and CUSHMAN M. J. *Clin. Invest.*, 1940, 19 459.
- 7 CLARK, A. H. *Bull Johns Hopkins Hosp.* 1919, 30 117.
- 8 COLP R. *Ann Surg.*, 1934, 99 14.
- 9 CRANDON, J. H. LUND C. C., and DELL, O. B. N. *England J M* 1940, 222 748-752.
- 10 *Ibid.*, 1940, 223 353-369.
- 11 FARMER, C. J. and ABT A. F. *Proc. Soc. Exp. Biol* N Y., 1936, 34 146.
- 12 FARMER, C. J. *Q. Bull. Northwest. Univ M School*, 1940, 14 220.
- 13 *Idem.* *Federation Proceedings*, 1944, 3 179.
- 14 HARTZELL, J. B. and STONE, W. E. *Surg Gyn. Obst.* 1942, 75 1-7.
- 15 HÖJER, J. A. *Acta paediat., Stockh.* 1924, suppl 3 8-278.
- 16 HOLMAN E. *Surg. Gyn. Obs.*, 1940, 70 261-269.
- 17 HUNT A. H. *Brit. J Surg.*, 1941 28 436.
- 18 JONES, C. M., BARTLETT M. K. RYAN A. E., and DRUMMAY G. D. *N England J M* 1943, 229 642-646.
- 19 LAUBER, H. J. and ROSENFELD W. *Klin. Wochr* 1938, 17 1587-1588.
- 20 LUDDEN J. B., and WRIGHT I. *Arch. Int. M* 1940, 65 151.
- 21 MAZOUZ, H. *Arch. anat. micr. Par* 1937 33 1929.
- 22 MELLENEY F. L. and HOWE, E. L. *Ann. Surg* 1934 99 5.
- 23 QUERIDO A., and GAILLARD P. J. *Acta brev. neerl* 1939 9 70.
- 24 RINEHART J. F. and GREENBERG, L. *Ann. Int. M* 1942 17 672.
- 25 SINGLETON A. O. and BLOEKER T. G. *J. Am. M. Ass.*, 1939, 112 122.
- 26 WOLBACH, S. B., and HOWE, P. R. *Arch. Path. Lab M* 1926 1 1-24.
- 27 WOLFER, J. A. *Surg Gyn. Obs.* 1936 63 607.
- 28 WOLFER, J. A. and HOEHL, F. C. *Surg Gyn. Obst* 1939, 69 745.
- 29 WRIGHT I. S. LILIENTHAL A. and MACLEATHEN E. *Arch. Int. M* 1937 60 264.

# THE EXCRETION AND CONCENTRATION OF PENICILLIN AND STREPTOMYCIN IN THE ABNORMAL HUMAN BILIARY TRACT I GALL BLADDER

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IN recent years penicillin and streptomycin have been subjected to rather extensive clinical and experimental investigation. The excretion of these substances into the normal biliary tract of man has been reported in a few papers (4, 8, 14). Although hope that the antibiotics may prove useful in diseases of the biliary tract has often been expressed, no one has reported any studies on the excretion and concentration of these substances in the abnormal biliary tract of human beings. The present study was undertaken with the specific purpose of determining the rôle that these antibiotics might play in diseases of gall bladders and bile ducts of human beings.

While it must be admitted that it is easier to control observations on the lower animals than on man, it was decided in this study to approach the problem directly by observations on human beings for even after animal experiments are concluded, the actual status of the matter in man is still in question. Differences in physiologic processes, both normal and abnormal, in different species of animals are known to exist. Although definite limitations were encountered in an investigation of the type conducted here, the results have given some definite impressions as to the use of penicillin and streptomycin.

## REVIEW OF THE LITERATURE

*Penicillin in bile* In 1941 Abraham and his associates first reported that penicillin was excreted in the bile of rabbits. It was not until 1943, however, that Rammelkamp and

Helm studied excretion of penicillin in bile in man. By introducing a nasal tube into the duodenum of each of 5 normal persons and removing specimens every 15 minutes after intravenous injection of 20,000 units of penicillin, they found that penicillin was present in bile from both the liver and gall bladder. They were able to demonstrate penicillin in bile as early as 15 minutes after injection and it was present for as long as 2 hours. In 1 case, after a single intravenous injection of 20,000 units, levels in the blood and in bile removed from the common duct by means of an indwelling T tube were determined. They observed, first that the concentration in the bile exceeded that in the blood indicating that the liver concentrated the drug; second, whereas no penicillin was demonstrated in the blood after 2 hours, it was still present in hepatic bile up to 2½ hours. Struble and Bellows, while investigating the distribution of penicillin in the eye of the dog after a single massive dose, also noted that the drug was present in bile in high concentration for a long period.

*Streptomycin in bile* The reports concerning the activity of streptomycin in bile are limited to 3. Stebbins, Graessle, and Robinson (10) reported that rabbits excreted 8 to 10 per cent of the drug in the bile after 5000 units per kilogram of weight had been given intravenously. Following a single intravenous injection of 600,000 units in 2 patients, Zintel and his associates found the maximal concentration in bile was attained in 2 hours. In 1 case the level reached 75 units per cubic centimeter and in the other 3 units per cubic centimeter. In each case the concentration in the blood reached more than 30 units per cubic centimeter in 15 minutes, and fell to 18 units in 2 hours. It was interesting to see a lag

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in the appearance of streptomycin in the bile of 1 patient. No activity was present for the first 30 minutes, even though the level in the blood was high at that time. In addition, in neither case did the concentration in the bile exceed that in the blood. Heilman and her associates (4) found 12.5 units per cubic centimeter of the bile and 6 units per cubic centimeter of blood 2 hours after a single subcutaneous injection of 100,000 units of streptomycin indicating that streptomycin was concentrated in the bile of human beings. When 100,000 units were given subcutaneously every 3 hours for several days, the concentration in the bile on the second and third days was between 3 and 6 units per cubic centimeter.

#### STUDY OF PENICILLIN AND STREPTOMYCIN IN BILE FROM THE GALL BLADDER

**Method.** Twenty-five patients who were to undergo cholecystectomy were selected for the study of each antibiotic agent. At periods varying from 12 minutes to 14 hours before operation, each patient was given a single intramuscular injection of either 15,000 units of penicillin or 100,000 units of streptomycin, doses commonly used clinically. No food was given to the patient after the antibiotic agent was administered. The time interval between injection of the antibiotic agent and clamping of the cystic duct at operation was noted. The levels of penicillin or streptomycin in the bile obtained from the gall bladders of these patients were determined in all cases. The level of penicillin was determined by Fleming's modification of the Wright slide cell technique as described by Heilman and Herrell (5). The organism used for the test was a strain of hemolytic streptococcus. The level of streptomycin was determined by a method similar to the cup-plate method of assay employed by Stebbins and Robinson (11). The organism was a sensitive strain of *Staphylococcus aureus*. The test plates were placed in the icebox for 20 hours to allow the streptomycin to diffuse from cups then in an incubator overnight, and the zones of inhibition were read.

A note was made of the report by the roentgenologist of the function of the gall bladder

and of the presence and position of stones in the gall bladder and of the condition of the liver and its excretory apparatus at operation.

**Results.** Penicillin.—In the 25 cases in which penicillin was used three conditions were noted: nonfunctioning gall bladders with stones, functioning gall bladders with stones and gall bladders without stones. The motor activity of the gall bladder had been determined by the roentgenologist by means of the Graham-Cole test. In the 3 cases in which cholecystectomy was performed and no stones were found, the roentgenogram showed nonfunctioning gall bladders in 2 cases and a functioning gall bladder with stones in the other case.

The results of this study are given in Table I. No penicillin was found in the bile from 5 of the 10 nonfunctioning gall bladders with stones. The time intervals after injection of penicillin in these 5 cases varied from 12 minutes to 12 hours. In these 5 cases a stone was found impacted in the cystic duct at the time of operation and the gall bladders in 4 of these were reported by the pathologist to be hydropic. The levels of penicillin in the other 5 cases in this group varied from 0.25 unit to 1 unit per cubic centimeter. The cystic ducts in these cases were patent.

In only 3 of the 12 cases of functioning gall bladder with stones was no penicillin recovered. In 2 of these the cystic duct was found to be obstructed at operation. In 1 case the duct was patent, but subsequent study showed that penicillin was not excreted into the hepatic bile in this case. In all of the other 9 cases in this group the cystic duct was patent, the levels varied from 0.06 to 1.9 units per cubic centimeter, and the time intervals after injection of penicillin varied from 45 minutes to 14 hours.

In 3 gall bladders no stones were found. In these the levels of penicillin were 0.24 unit, 1.0 unit and 0.12 unit per cubic centimeter of bile at 45 minutes, 1 hour and 15 minutes and 10 hours and 45 minutes after injection of penicillin respectively.

In the entire group in cases in which levels were obtained at long intervals after injection (9 to 14 hours) penicillin was still present in all those in which the cystic duct was patent.

TABLE I.—LEVELS OF PENICILLIN IN BILE FROM GALL BLADDERS FOLLOWING INTRA MUSCULAR INJECTION OF 15 000 UNITS

Condition of gall bladder	Penicillin level, units per c.c.	Time after injection	Obstruction cystic duct
Nonfunctioning with stones		man	Yes <sup>a</sup>
		30 min	Yes
		h 45 mi	N
		3 hrs	Yes <sup>b</sup>
		3 hrs	Yes <sup>c</sup>
	5	3 hrs	N
	5	hrs	N
	5	hrs	N
		hrs	Yes
	5	12 hrs	N
Functioning with stones		man	Yes
		30 min	Yes <sup>d</sup>
	5	5 min	N
	00	h	N
	2	hrs 30 min	N
		hrs 3 mi	N
	5	hrs 30 min	N
		hrs 10 min	N
		hrs	N
	00	hrs	N
Without stones		hrs	N
		hrs 5 min	N
		hrs, 4 min.	N

<sup>a</sup>Gall bladder reported by the pathologist to be hydropic.

<sup>b</sup>Reported by the pathologist that acute cholecystitis as superimposed on chronic cholecystitis.

<sup>c</sup>In this case penicillin was not present in bile from the gall bladder, although the cystic duct was patent.

varying from 0.06 to 1.0 unit per cubic centimeter

Comment.—Analysis of these results reveals several important facts. In any case in which the cystic duct was obstructed by a stone no penicillin was demonstrated in the contents of the gall bladder. When the cystic duct was patent, penicillin was usually found in rather high concentration. When these results are compared with those obtained from a subsequent study of excretion of penicillin in hepatic bile (13) it is obvious that in general the level of penicillin in bile of gall bladders removed soon after parenteral administration

TABLE II.—LEVELS OF STREPTOMYCIN IN BILE FROM GALL BLADDERS FOLLOWING INTRA MUSCULAR INJECTION OF 100 000 UNITS

Condition of gall bladder	Streptomycin c.c. level, units per	Time after injection	Obstruction cystic duct
Nonfunctioning with stones		hr	Yes
	5	hr	N
	0	hr 30 min.	No
		3 hrs	Yes
		4 hrs.	Yes <sup>a</sup>
		4 hrs 5 min.	Yes <sup>b</sup>
		4 hrs 30 min.	Yes <sup>c</sup>
		6 hrs	No
	05	hrs.	N
	5	hrs	N
Functioning with stones		30 min	No
		5 min	No
		40 min	No
	5	hr	No
		hr 45 min.	Yes <sup>d</sup>
		hrs	Yes
	5	hrs 35 min.	N
	0	5 hrs min.	No
	05	4 hrs 30 min.	No
	08	hrs	No
Without stones	3	hrs	No
	5	hrs	No
	03	hrs	No
	3	hr	N

<sup>a</sup>Chronic empyema with hydrops.

<sup>b</sup>Reported by the pathologist that acute cholecystitis as superimposed on chronic cholecystitis.

<sup>c</sup>In these cases streptomycin as not present in bile from the gall bladder although the cystic duct was patent.

<sup>d</sup>Gall bladder reported by the pathologist to be hydropic.

is equal to or slightly lower than the highest level which might be expected in the hepatic bile up to that time and is either equal to or somewhat higher than that in the blood. In those cases in which many hours elapsed between administration of penicillin and cholecystectomy the levels obtained indicated that neither marked concentration, rapid absorption nor ejection of the antibiotic agent from the gall bladder had occurred. In no such case did the level of penicillin exceed 2 units per cubic centimeter. This was true even in cases in which concentration function was excellent as shown by the Graham-Cole test.

In addition, the darkness of the bile, an index of the ability of the gall bladder to concentrate, did not seem to affect the level of penicillin.

**Streptomycin**—Results are given in Table II. There were 10 nonfunctioning gall bladders with stones. Of these, no streptomycin was found in the bile from the gall bladder in 6 cases. In 5 of the 6, the cystic ducts were obstructed completely, and 1 of the 5 gall bladders contained thick creamy pus. In the sixth case, although the cystic duct was patent, no streptomycin was found in the contents of the gall bladder after 12 hours. This patient had active obstructive jaundice with high levels of serum bilirubin, and it is likely that no antibiotic agent was excreted from the liver (this phenomenon is described more fully in a subsequent report, 13). Streptomycin was recovered from the gall bladders in 4 cases, the levels varying from 1.5 to 2 units per cubic centimeter. The time intervals after injection were from 1 hour to 12 hours. The cystic ducts in these 4 cases were patent.

In the 14 cases of functioning gall bladders with stones, no streptomycin activity was found in 5. However, the time intervals after injection in 3 were less than 1 hour, and subsequent study showed that there often was a lag of a half hour or more in the appearance of streptomycin in hepatic bile (13). In the other 2 cases in which no streptomycin was found in the bile from the gall bladder, the cystic duct was obstructed, and in 1 of these the gall bladder was hydropic. In the remaining 9 cases the level of streptomycin varied from 0.8 to 3.9 units per cubic centimeter of bile and the time intervals after injection varied from 1 hour to 12 hours. The cystic ducts in these 9 cases were patent.

One gall bladder contained no stones. However, no streptomycin was demonstrated 2 hours and 10 minutes after injection. Further study revealed that this patient had marked impairment of hepatic function, as shown by the hippuric acid excretion test, and also an elevated level of serum bilirubin.

In all cases of gall bladders in which levels were obtained after long intervals (10 to 12 hours) streptomycin was still present in all those in which the cystic duct was patent,

the highest level being 1.5 units, the lowest, 0.98 unit per cubic centimeter of bile.

Analysis of these results leads to the same conclusions as were reached when penicillin was used.

#### COMMENT

Any substance given parenterally may reach the lumen of the gall bladder by one of two routes either through the bile or by way of the blood vessels in the wall of the gall bladder. It is known that the gall bladder fills passively when the pressure in the common duct reaches a critical level of 50 to 70 millimeters of water. Therefore, if the antibiotic agent reaches the bile in the gall bladder through the biliary tree, when the cystic duct is patent the level of the antibiotic agent obtained in the bile of the gall bladder should be either equal to the highest level in the hepatic bile up to that time or somewhat lower than this highest level as a result of dilution in the gall bladder which may already have contained bile before the excretion of antibiotic agent from the liver started.

If on the other hand the agent does not reach the lumen of the gall bladder through the biliary tree, it may be supposed that it does so through vessels in the wall of the gall bladder. That this does not occur is proved by the results of the present study.

From this investigation it appears that the major factor concerned in the presence of penicillin or streptomycin in the bile of the gall bladder is the patency of the cystic duct. Lynn and his co-workers came to a similar conclusion while studying excretion of sulfonamides in dogs in which the cystic ducts were experimentally obstructed. In all of the cases in the present study in which the duct was obstructed completely by a stone, the antibiotic agent was not recovered from the contents of the gall bladder.

This is a significant observation since in most cases of acute cholecystitis and empyema obstruction of the cystic duct is also present (2, 3, 6, 9). When these conditions coexist penicillin or streptomycin is almost certain not to get into the lumen of the infected gall bladder. Although antibiotic agents do reach the tissues of the gall bladder through the



blood stream, and conceivably may help control infection in the wall, it is unlikely that these agents will overcome the infection present in the bile in the lumen. While it is true that, in the main, the cases in this study were examples of chronic disease of the gall bladder the fact that in 4 cases reported by the pathologist to be acute cholecystitis superimposed on chronic cholecystitis the antibiotic agent was not found in the bile at least suggests that acute inflammation does not alter the mode of entrance.

In chronic cholecystitis with stones, the effectiveness of penicillin or streptomycin in sterilization of the contents of the gall bladder in any given case cannot be predetermined, because in only some of the cases of this type does the drug reach the bile of the gall bladder. The cystic duct of a gall bladder with stones may become obstructed at any time. However once the antibiotic agent has entered the lumen it remains there for many hours in fairly high concentration, since it is neither rapidly absorbed nor ejected from the gall bladder.

#### SUMMARY AND CONCLUSIONS

After intramuscular injection of 15,000 units of penicillin or 100,000 units of streptomycin, no antibiotic agent was found in the bile of gall bladders in cases in which the cystic duct was obstructed. Antibiotic agent was found in large amounts in gall bladders in which the cystic duct was patent, provided that the antibiotic agent was excreted normally from the liver.

The roentgenologic report was of little value in indicating from which gall bladders the antibiotic agent would be recovered.

The antibiotic agent was neither highly concentrated nor rapidly absorbed nor ejected from the lumen of the gall bladder.

Penicillin and streptomycin may prove of no value in acute obstructive cholecystitis.

The usefulness of penicillin or streptomycin in any given case of chronic cholecystitis with stones is uncertain.

#### REFERENCES

1. ABRAHAM, E. P., CHAIR, E., FLETCHER, C. M., GARDNER, A. D., HEATLEY, N. G., JENNISON, M. A., and FLOREY, H. W. *Lancet*, Lond., 1941, 8: 77-83, 89.
2. BLOMBERG, NATAN, and ZIEGLERMAN, LOUIS. *Am. J. Surg.*, 1943, 70: 38-42.
3. COWLEY, L. L., and HARRIS, H. N. *Surg. Gyn. Obst.*, 1943, 77: 66-668.
4. HEILMAN, DOROTHY H., HEILMAN, F. R., HINSHAW, H. C., NICHOLS, D. R., and HERRELL, W. E. *Am. J. M. Sc.*, 1945, 2: 576-584.
5. HEILMAN, DOROTHY H., and HERRELL, W. E. *Am. J. Clin. Path.* 1945, 15: 7-9.
6. JUDS, E. S., and PHILLIPS, J. R. *Ann. Surg.* 1933, 98: 359-36.
7. LYNN, DAVID, BERRY, G. S., and SPIEGEL, W. W. *Surgery*, 1943, 3: 447-449.
8. RANDELKAMP, C. H., and HELM, J. D. Jr. *Proc. Soc. Exp. Biol., N. Y.* 1943, 34: 34.
9. SCHAEFFER, R. L. *Pennsylvania M. J.* 1943, 45: 566-568.
10. STELLINGSMA, R. B., GRANNELL, O. E., and RODRIGUEZ, H. J. *Proc. Soc. Exp. Biol., N. Y.* 1943, 60: 68-72.
11. STELLINGSMA, R. B., and RODRIGUEZ, H. J. *Proc. Soc. Exp. Biol., N. Y.* 1945, 59: 253-257.
12. STROBLE, G. C., and BELLON, J. Q. *J. Am. M. Ass.*, 1944, 3: 685-690.
13. ZARLOW, JERRY, COURCHER, V. S., and HEILMAN, F. R. Unpublished data.
14. ZIVTEL, H. A., FLIPPIN, H. F., NICHOLS, ANDREA C., WILEY, M. JUDITH, M., and RUCAD, J. E. *Am. J. M. Sc.*, 1945, 2: 42-430.

# TOTAL GASTRECTOMY FOR CARCINOMA OF THE STOMACH

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IN the period from July 1, 1944, to December 1, 1945, a series of 25 patients with carcinoma of the stomach were operated upon. In 20 of these cases, total gastrectomy was performed with 2 immediate deaths and an operability rate of 80 per cent, and an operative mortality rate of 10 per cent.<sup>1</sup> Seven patients have now survived for over a year, have resumed a part of their previous occupations, and with a special dietary and medical regimen show little clinical evidence of digestive or metabolic disturbance.

In the present series all the neoplasms were at least moderately extensive, and some had invaded the entire stomach. These results, however, together with the recent successful reports of Horsley, Farris, Ransom, and Collier, Jones and Kehm, and others, have led to the belief that the operability rate and the percentage of 5 year cures following the surgical treatment of malignant gastric neoplasms would be increased if total gastrectomy were more frequently employed even in the treatment of the smaller early lesions of the pylorus and fundus. All of the neoplasms encountered in the present series originated in the pyloric or fundic portion of the stomach. Tumors of the cardia, although sometimes successfully treated by total gastrectomy, have characteristic metastatic pathways which present special surgical problems. Treatment of lesions of the cardia of the stomach is not included in the present discussion.

## DISCUSSION

The careful study of the regional lymphatic metastases of carcinoma of the stomach made

by Collier, Kay, and MacIntyre lends strong support to the more frequent use of total gastrectomy. These authors found it impossible to tell without microscopic section whether lymph nodes were invaded by metastases unless they were definitely replaced by carcinoma. There were metastases to regional lymph nodes in 75.5 per cent of the cases they studied. The upper margin of the neoplasm in the wall of the stomach could not be determined by palpation alone at the time of operation in 24.5 per cent of the cases. There was no relation between the duration of symptoms or the size of the neoplasm and lymphatic metastasis. The authors conclude that whether palpable lymph nodes are or are not present, the regional lymph nodes should be included within the resection to increase the likelihood of cure.

The chances of complete eradication of a malignant tumor would certainly be greater with block excision of the entire stomach and regional lymph nodes than with local excision of the growth or subtotal resection of the stomach. Just as radical mastectomy and abdominoperineal resection of the rectum are preferred in the treatment of malignant lesions of the breast and the rectum respectively, so total gastrectomy I believe should be the procedure of choice in many cases of malignant gastric tumor which at the present time are routinely treated by subtotal resection. The more widespread use of such a procedure is dependent upon the development of a technique which lowers the operative mortality and postoperative complications to compare more favorably with those of other types of gastric resection, and upon evidence that the human body can adapt itself to the absence of a stomach and maintain a satisfactory nutritional state.

Reports from various clinics indicate that the operative mortality following total gastrectomy is declining. Jones and Kehm have

<sup>1</sup>From the Department of Surgery of the Johns Hopkins Medical School and the Johns Hopkins Hospital.

<sup>2</sup>One other successful total gastrectomy not included in this series was performed on a patient with a large benign gastric ulcer. At operation the lesion was thought to be a neoplasm. Since that time the diagnosis of malignancy has been established by routine microscopic section before continuing the operation. Thus the operative mortality for all 2 total gastrectomies is just under 10 per cent.

recently reported 8 consecutive cases without a death. Farns, Ransom, and Collier in 1943 had only 2 deaths in 19 cases, one of a patient 79 years old. In 1943 Horsley reported 3 total gastrectomies without a death. These series, although small, indicate that the mortality rate of total gastrectomy is being lowered to compare more favorably with that following other types of gastric resection for malignancy.

As regards the adaptation of the gastrointestinal system to the absence of a stomach over a period of years our knowledge is limited for in the past, total gastrectomy has been reserved for such advanced malignant disease that most of the patients have died within a few months. In all, 16 patients (10) are known to have survived for over 3 years, and all of these patients were able to lead an active life with few dietary restrictions. Farns, Ransom, and Collier studied the digestive function of 4 patients who had survived total gastrectomy for over 4 years. They found no evidence of disturbance in the digestion of fats and proteins. The absorption of glucose was more rapid than normal. The chief disturbance noted was in the metabolism of iron. In the absence of hydrochloric acid from the stomach the ferric and organic iron in the diet were not absorbed and hypochromic microcytic anemia developed unless the patients were given ferrous iron regularly. On the other hand, Rekers, Pack, and Rhoads found in 3 patients 6 months after the performance of total gastrectomy impaired ability to digest or absorb the fat of the diet and 1 patient had impaired ability to digest or absorb the protein of the diet. Their patients had normochromic normocytic anemia. According to Pack and McNeer of 80 patients who have survived total gastrectomy 82.5 per cent subsequently died of metastasis. In the remainder of the group there were 4 cases which suggested that the interference with nutrition following total gastrectomy had been severe enough to cause death. Two of these patients died of anemia, 1 of general weakness and 1 of acute enteritis.

In summarizing this point there are three important considerations (1) Sixteen patients are known to have led a fairly normal

life for more than 3 years after total gastrectomy (2) A few patients have apparently been unable to adjust the digestive apparatus to the absence of a stomach and in some instances death has ensued as a direct result. It is possible that these patients might have survived if more detailed and prolonged post-operative care had been instituted. (3) The majority of the patients have died of metastasis before follow up studies could be made. The final answer must await further clinical experience and study. The present series gives some additional information regarding this phase of the problem.

#### CASE MATERIAL

All of the patients in this series were seen in consultation with Dr Alfred Blalock, Professor of Surgery and Director of the Department of Surgery in the Johns Hopkins Hospital. In using the term "total gastrectomy" the criterion of Finney and Rienhoff has been followed, that is, removal of the entire stomach including the pyloric and cardiac sphincters.

In this series there were 15 male patients and 5 female patients. The ages ranged from 37 to 76 years, all but 4 were over 55. Although in some instances it was very difficult to tell exactly when the symptoms due to the carcinoma began, the duration of symptoms ranged from 1½ months to 11 months. Four patients had had similar symptoms for many years which had been attributed to peptic ulcer. In 2 patients a scarred duodenal ulcer was found in addition to the gastric carcinoma. In 2 instances it was definitely established that the neoplasm originated in a large chronic gastric ulcer. With the exception of one whose weight had remained unchanged, all of the patients had lost from 15 to 20 pounds in weight.

On admission to the hospital the hemoglobin content of the blood of these patients ranged from 5.0 to 15.6 grams, with an average value of 11 grams. In 14 patients determinations of the blood chemistry were made. The total serum protein was below normal in only 2 patients. There was a slight decrease in the blood chlorides in 4 patients. Seven patients had no free acid in a fasting specimen.

TABLE I.—PORTION OF STOMACH WALL INVADED

Name	Portion of stomach invaded	Metastasis to regional lymph nodes	Distant metastasis	Direct extension
F.B.	Distal one-half			Anterior abdominal wall. Transverse mesocolon. Pancreas.
J.S.	Distal one-half	+		Mesocolon
D.B.	Distal one-third	+		
J.W.	Entire lesser curvature	o		
J.P.	About periphery of chronic gastric ulcer	+		
G.B.	Pyloric antrum and posterior wall			Pancreas
W.T.	Pyloric antrum	+		Transverse mesocolon
S.T.	Entire lesser curvature and two-thirds of stomach wall	+		Esophagus
N.M.	Distal one-half	+		
E.W.	Entire lesser curvature	+		Duodenum
J.N.	Pyloric antrum	+		Duodenum
J.B.	Pyloric antrum	+		
C.H.	Distal one-half	+		Duodenum. Anterior abdominal wall
E.G.	Entire stomach wall	+	Celiac lymph nodes (?)	Pancreas
T.H.	Pyloric antrum	+	Celiac lymph nodes (?)	
G.P.	Entire lesser curvature and posterior wall	+		Pancreas
J.L.	Entire lesser curvature and one half of stomach wall	+		
F.C.	Entire stomach	+		Mesocolon
A.H.	Distal one-third	+		
J.B.	Distal one-half	+		

of gastric juice, in the others the free acidity ranged from 8 to 48 degrees. Roentgen and fluoroscopic examinations were made of the stomach after the ingestion of barium in 16 patients. The presence of a neoplasm was correctly diagnosed in all but 1. In this patient the presence of an ulcerative lesion was noted in the report, but it was not stated that this was due to neoplasm. The changes in the contour of the stomach noted upon roentgen examination agreed closely with the extent of the gross lesion of the stomach found at operation.

As regards the general medical condition of the patients before operation, it was found that 1 patient had rheumatic heart disease with mitral and aortic insufficiency, hypertension and cardiac hypertrophy. Six other patients had advanced arteriosclerosis, one with a history of angina pectoris and another with hypertension. The serologic test for syphilis was positive in 4 patients although there were no clinical signs of the disease. One

patient had an extensive fibroid infiltration throughout both lungs which was thought to be due to inactive tuberculosis. One patient had mild diabetes mellitus with a blood sugar determination of 131 milligrams per cent.

The following classification groups the cases according to the approximate portion of the stomach wall invaded by the tumor (Table I). The entire stomach wall was invaded in 3 instances. In 5 patients the growth extended throughout the length of the lesser curvature. The distal half of the stomach wall was infiltrated in 5 patients and the distal one-third in 2. The lesion was restricted to the pyloric antrum in 4 instances. One patient had a large chronic gastric ulcer with malignant changes about the periphery. Three patients showed no evidence of extension to the regional lymph nodes. There was 1 patient with involvement of the lymph nodes of the lesser curvature, 1 with involvement of the lymph nodes of the greater curvature, and 1 with involvement of the lymph



Fig. 1. G.B. Operative specimen. Entire stomach, omentum, spleen, and distal three-fourths of pancreas.

nodes along both curvatures. In 9 patients there was extension to the lymph nodes about the pylorus along the lesser curvature and about the left gastric artery. Lymph nodes about the pylorus, along both curvatures, and about the left gastric artery were invaded in 5 cases.

The spleen was removed with the stomach in 7 patients. In 4 patients there was direct extension of the growth into the body of the pancreas and in 2 of these patients it was necessary to remove three-fourths of the pancreas and the spleen together with the stomach<sup>1</sup> (Fig 1). A portion of the peritoneum overlying the middle colic vessels in the transverse mesocolon was removed in one case in which there was direct extension of the carcinoma into this area. The growth had extended into the duodenum in 3 patients and into the esophagus in one.

During this same period an exploratory operation was performed upon 5 other patients who had carcinoma of the stomach with generalized carcinomatosis. In 2 a posterior

gastroenterostomy was performed. Thus of 25 patients with carcinoma of the stomach operated upon during this period, total gastrectomy was performed in 20 or 80 per cent.

#### OPERATIVE TECHNIQUE

The operative technique is as follows. The abdomen is entered through an upper midline incision which extends from the apex of the left xiphocostal notch to the umbilicus. A specimen for examination by frozen section is taken of the original lesion or of a grossly involved regional lymph node. The extent of the lesion is determined. The liver the cul-de-sac, and the regional, mesenteric, and aortic lymph nodes are palpated. If resection is decided upon the omentum is freed from the transverse colon and removed with the stomach. The right gastric and gastroepiploic arteries are divided as close to their origins as possible and the duodenum is freed down to the head of the pancreas and divided. The stomach is freed posteriorly. If there is evidence of peritoneal implants or extension of the tumor the peritoneum of the posterior wall of the lesser peritoneal sac is removed. When difficulty is encountered in visualizing the vasa brevia, the spleen is mobilized laterally by freeing its peritoneal attachments. If bleeding is troublesome in this region or if extension to the splenic lymph nodes is suspected the main splenic vessels are divided and the spleen is removed with the stomach. With the greater curvature mobilized, the stomach is reflected upward and to the left a maneuver which brings the left gastric vessels clearly into view. The left gastric vein is traced down to the splenic vein and divided. The left gastric artery is ligated at the celiac axis and all lymph nodes in the region are removed.

At this point a peritoneal flap is raised which starts from the gastrohepatic omentum and extends across the esophagogastric junction to the left side of the diaphragm. This flap is elevated and the vagus nerve on each side of the esophagus is divided. This procedure allows the abdominal esophagus to stretch and the cardia of the stomach to drop down several centimeters. Only enough of the areolar tissue is divided to allow clear

<sup>1</sup>In one of these patients surgical diabetes developed after operation, the blood sugar rising to 400 milligrams per cent on the 15th postoperative day. At that time 3 units of protodinsulin each morning were required for regulation. During the next week the blood sugar slowly declined to normal and remained so. At the time of discharge on the 31st postoperative day there was no sugar in the urine. The blood sugar was 100 milligrams per cent, and the patient was taking no units of protodinsulin each morning. Although the extent of the pancreatic excision was the same in the second patient, the disturbances of his blood sugar were normal throughout his postoperative course.



Fig. 2 a. Stomach freed and retracted over upper angle of incision. Posterior row of interrupted silk sutures placed between jejunal loop and posterior wall of esophagus. b. Opening made into lumen of esophagus and jejunum. Second posterior row consists of interrupted catgut sutures which pass through the entire thickness of the wall of esophagus and jejunum.

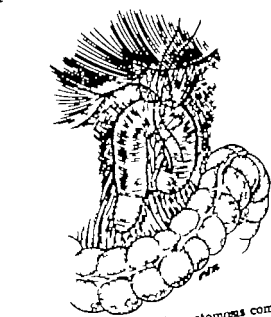


Fig. 3 Esophagojejunal anastomosis completed. Peritoneal flap sutured to jejunum. Transverse mesocolon sutured obliquely across jejunal loop.

identification of the wall of the esophagus. No attempt is made to free the esophagus up through the diaphragm.

Both an antecolic and a retrocolic esophagojejunostomy have been performed now, however the retrocolic type is generally employed. The chief advantage of this type is that at times the jejunal mesentery is short and difficulty is encountered in getting the jejunum up to the esophagus. Placing of the jejunum anterior to the colon causes further shortening of the mesentery. When the retrocolic method is followed the transverse mesocolon is sutured across the intestine obliquely as recommended by Morton. In 3 of the cases in this series it has been necessary to divide one of the primary mesenteric arteries to the jejunal loop to afford sufficient length for the anastomosis. One row of interrupted silk sutures is placed between the posterior wall of the esophagus and the jejunum and the sutures are tied (Fig. 2a). The posterior wall of the esophagus is divided and a correspond-

ing opening is made in the jejunum. The second row of sutures is formed of interrupted catgut sutures which pass through the entire wall of the esophagus and jejunum and carefully approximate the mucosal edges (Fig. 2b). The anterior wall of the esophagus is divided and the two rows of sutures unite the anterior edges in similar fashion. The peritoneal flap previously formed is now sutured over the anastomosis to the jejunum (Fig. 3). This step helps to support the jejunal loop as well as to reinforce the suture line.

The procedure as outlined is a combination of certain features of several different methods previously described by others. There are however points which should be emphasized as being particularly important. In an attempt to reduce the magnitude of the operation all of the steps that are not essential have been eliminated. Enterointerostomy recommended by most operators, is usually unnecessary and has not been used. An enterostomy for feeding the patient after operation is unnecessary if the patient is properly prepared before operation and modern intravenous therapy is used after operation. Numerous other steps such as duodenojejunostomy and complicated esophagojejunal anastomoses have been omitted. A simple upper midline incision gives ample exposure and is quickly opened and closed with mini-

mal loss of blood. The duodenum should be divided as close to the head of the pancreas as possible. This permits complete removal of all pyloric lymph nodes and is an additional safeguard in those cases in which there is extension of the gastric carcinoma into the duodenum. Three such cases were encountered in the present series.

With the stomach well mobilized and elevated out of the wound, the left gastric vessels are clearly visualized. They are divided at the celiac axis and all surrounding lymph nodes removed. As this region is a pathway of early dissemination by the lymph nodes, this step is important. The esophagus is mobilized and exposed just enough so that its walls are clearly defined. Every effort is made to preserve its blood supply. The diaphragmatic and mediastinal esophagus are not disturbed unless extension of the growth into the abdominal esophagus necessitates this step. The abdominal esophagus is surrounded by fibrous areolar tissue which if left intact holds sutures better than the bare muscle of the mediastinal esophagus.

There have been no signs of structure formation at the site of anastomosis in any of these cases. The use of interrupted sutures throughout the anastomosis is important in preventing this complication. Great care is used in placing all of these sutures although this care is tedious at times, the rewards are great. Forty per cent of the reported operative deaths following total gastrectomy have been due to leakage from the line of anastomosis (10).

#### POSTOPERATIVE COURSE

In this series of 20 cases there were 2 immediate deaths. In 1 patient who died an attempt was made to form a food reservoir from the loop of jejunum that was anastomosed to the esophagus. The blood supply of a portion of the jejunum adjacent to the esophagus was impaired by the procedure. Gangrene developed in this area with perforation on the 10th postoperative day and the patient died of generalized peritonitis.<sup>1</sup> The second operative death occurred in a 43 year old colored female who had a mild diabetes mellitus.

Total gastrectomy was performed on October 23, 1943, for an extensive carcinoma which involved the distal third of the stomach with metastasis to the regional lymph nodes. Twenty four hours after operation the patient's temperature rose to 103 degrees and signs of pneumonia appeared in the left lung. In spite of the administration of penicillin and sulfamerazine her condition grew steadily worse. Forty-eight hours after operation pulmonary edema developed and she died a short time later. Of the other immediate complications only one has been serious. In this patient acute pancreatitis developed on the second postoperative day which slowly subsided with conservative treatment, however as soon as oral feedings were started he showed signs of partial high intestinal obstruction and a second exploration was performed on the 18th postoperative day. It was found that a loop of upper jejunum was bound to the lateral peritoneal wall by adhesions in the left upper quadrant, causing intestinal obstruction. The adhesions were released. The remainder of the patient's postoperative course was uneventful. In 2 patients venous thrombosis developed in a lower extremity which was treated by ligation of the femoral vein. There was 1 case of postoperative atelectasis which responded quickly to intratracheal aspiration and the administration of penicillin. There have been no difficulties with the line of anastomosis there have been no fistulas, intra abdominal abscesses or strictures. The average postoperative stay in the hospital for these patients has been 25 days.

The adjustment of the alimentary tract to the absence of the stomach has been remarkable. The patients have been given water in small amounts by mouth on the 4th postoperative day. The amount has been increased gradually and other liquids have been added. By the 10th postoperative day almost all of the patients have been able to take a soft diet divided into 6 small feedings. After starting to eat solid food 5 of the patients complained of heartburn and 9 of a feeling of abdominal fullness after eating. The heartburn responded quickly to small doses of amphetol. The feeling of fullness was more troublesome. This symptom has been at

<sup>1</sup>Two cases in which this method was successful, by word were later reported by Engel.

tributed to the limited capacity of the jejunum, and the patients were given frequent small feedings. In some of these patients this discomfort has continued for months after operation. Two patients have had transient diarrhea during the second postoperative week which subsided spontaneously. One to 3 soft formed stools a day is the usual bowel habit for these patients.

Röntgenograms taken at the time of discharge showed 2 instances in which there was slight delay in the passage of barium from the esophagus into the jejunum. Both of these patients were asymptomatic, however. In another patient the barium passed into the proximal loop which was dilated. In none of the patients was there any retention of the barium in the proximal loop after 5 hours. De Amesti has reported an instance of great dilatation and retention in the proximal loop in a patient without an enteroenterostomy between the afferent and efferent loops, and he stresses the importance of performing such an anastomosis. It is my opinion however that if the esophagojejunal anastomosis heals without undue scarring or stricture formation there is no delay in the emptying of the proximal loop. Four of these patients have complained of occasional regurgitation of small amounts of bile stained fluid as long as 2 months after operation. Thus far however this regurgitation has not been sufficiently frequent or severe to warrant the performance of an enteroenterostomy as a routine part of the operative procedure. The barium passed through the small intestine more slowly than normal in 2 patients, and in another there was delay in the ileum suggestive of partial obstruction. This patient's progress while in the hospital was rather slow and he vomited small amounts on a number of occasions. Since discharge however he has improved. He has gained weight and has returned to work.

With the exception of a slight decrease in blood chlorides in 6 patients, all blood chemistry values were within normal limits at the time of discharge. These included nonprotein nitrogen, carbon dioxide combining power, chlorides, total proteins, albumin and globulin. The hemoglobin content of the blood at the time of discharge ranged from 10.8 to 14.9

TABLE II.—CAUSE OF DEATH

Name	Survival period	Cause of death
E.W.	2 weeks	Slough 1 site of gastric pouch
A.H.	2 days	Pneumonia cardiac failure
J.B.	3 months	Recurrence
J.N.	3 weeks	Inanition
C.H.	3 months	Recurrence
T.H.	months	Recurrence
P.L.	months	Recurrence
E.G.	months	Recurrence
F.B.	5 months	Inanition
G.P.	7½ months	Recurrence

grams with an average of 12.4 grams for the group.

#### FOLLOW UP STUDIES

Tables II and III summarize the condition of these patients at the time of this report. It has been 1 year and 7 months since the first operation. The last gastrectomy in this series was performed 4 months ago. Ten of the patients who were submitted to total gastrectomy have died. In addition to the 2 operative deaths described, 6 patients have died of recurrence of the carcinoma. It is not surprising if we bear in mind the extent of their lesions, that 5 of the patients have died of recurrence within 3 months after operation. On the other hand, some of the patients with the longest survival periods have had even greater involvement of both stomach and regional lymph nodes than those who have died so soon of recurrence.

In this limited series with the relatively short time that has elapsed since operation, no correlation can be made between the size and type of the lesion or of the regional lymph node invasion and the survival time. In none of the cases was total resection attempted if distant metastasis was thought to be present at the time of operation. Two of the patients with rapid recurrence of the carcinoma showed extensive metastatic implants over the visceral and parietal peritoneum at the time of death and it might be suspected that operative trauma was directly responsible for this extensive 'seeding' of the peritoneal cavity. In 2 other patients with recurrence



TABLE III.—PRESENT CONDITION OF SURVIVORS

Name	Postoperative survival	Weight	Appetite	Food capacity	Gastrointestinal symptoms	Stools	Work
J.W.	10 months	Gained slowly to the under best weight	Good	Most eat small meals	Occasional burning and fullness after meals	Normal rxD	Regular
N.M.	9 months	Gained 1 lb. after operation. No change in last 4 months	Good	Slightly less than regular meals	None	rxD Normal	Light housework
J.F.	14 months	Gained 1 lb. since operation	Good	Eats 6 small meals daily	Occasional epigastric pain. Fullness if he eats too much	Normal rxD	Regular
H.T.	3 months	Gained 1 lb. after operation. No change in last 4 months	Good	Eats 1 to 6 meals da	Occasional fullness after meals	rxD Normal	Regular
E.T.	months	Gained 5 lbs. since operation	Good	Normal	Occasional difficulty swallowing liquids	Constipated at times rxD	Housework
G.B.	3 months	Gained 5 lbs. since operation	Good	Normal	None	rxD Normal	Regular light work
D.B.	months	Gained 12 lbs. since operation	Fair	Most eat small meals	Burning, fullness and eructation after eating	Normal rxD	Irregular light work
J.S.	8 months	Gained 5 lbs. since operation	Fair	Most eat small meals	Fullness and burning after meals	Normal D	Unable to work
J.B.	months	Slight gain	Fair	Eats 6 meals a day	Fullness after meals	rxD Normal	3 hours daily light work
F.C.	4 months	Gained 1 lb.	Fair	Eats 6 meals da	Occasional regurgitation	rxD Normal	Unable to work

one of whom survived 7½ months, large retroperitoneal masses developed along the aorta suggesting that the malignant condition had spread to unsuspected lymph nodes beyond the limits of the resection at the time of operation.

The remaining 2 patients who have succumbed apparently died of inanition. They illustrate one of the problems in the postoperative management of gastrectomized patients. J.N., a 55 year old colored male, underwent total gastrectomy on December 16 1944, for an extensive carcinoma of the lesser curvature of the stomach with invasion of regional lymph nodes. No distant metastases were found. Two days after operation, atelectasis of the left lower lung field developed, but he recovered quickly in the next 24 hours. Thereafter his course was uneventful. He was started on liquids by mouth on the 4th postoperative day. He tolerated his feedings well and his diet was steadily increased. At the time of discharge from the hospital on the 16th day after operation he was eating a full soft diet taken in 6 small feedings a day. He had been up and walking about the ward for 5 days and had no complaints. Roentgenography after the ingestion of barium showed the esophagojejunal anastomosis to function satisfactorily. He was discharged in the care of friends who apparently had no regard for his dietary requirements. Eight days later he was returned to the hospital in a comatose condition and died within a few hours. He was said to have taken nothing by mouth after discharge but small sips of water. At autopsy the anastomosis was found to be widely

patent. Scattered microscopic metastases were found in other organs but there was nothing to explain his early death but starvation and dehydration.

F.B. a 60 year old colored man, was operated upon on August 17 1945. Total gastrectomy was performed for an extensive carcinoma which involved the distal one third of the stomach with metastasis to regional lymph nodes and extension into the posterior surface of the anterior abdominal wall. His postoperative course was complicated by an attack of acute pancreatitis during which the serum analysis showed 9.9 milligrams per cent reducing substance per milliliter or 540 per cent of average normal (9). He recovered from this attack spontaneously but later partial intestinal obstruction developed. Exploratory laparotomy was performed on the 23d postoperative day when adhesions about a partially obstructed loop of jejunum were freed. Following the second operation his course was uneventful, and at the time of discharge on September 30, 1945, he was taking a full soft diet divided into 6 small feedings a day. His weight was increasing. He was followed thereafter at weekly intervals by Dr. Moses Paulson in the medical out-patient department. His weight increased, his appetite was good, and he followed instructions fairly well. His only complaint was of intermittent edema of the ankles. The total serum protein on November 1 1945 was 6.63 grams per cent. The nonprotein nitrogen was 30 milligrams per cent and serum bilirubin was less than 0.8 milligram per cent. Jejunoscopes on December 12 was essentially negative. He was last seen in the outpatient department on January 11 1946. Six days later he was brought to the accident room to be pronounced dead how

ever a faint cardiac pulsation was heard and intensive supportive therapy was instituted. He improved for a time but died in 24 hours. Permission for autopsy was not granted.

The patient had no relatives and a reliable history of events leading up to this final episode could not be obtained. He had apparently been feeling weak for several days. About 3 days before admission he had fallen without suffering any particular injury but following this accident he stayed in bed. As there was no one to care for him he had eaten practically nothing. His condition grew steadily worse up until the time he was admitted to the hospital. Before therapy was instituted his blood sugar was 20 milligrams and the nonprotein nitrogen 58 milligrams per cent. Five minutes after receiving 50 cubic centimeters of 50 per cent glucose intravenously he responded to verbal stimuli for the first time. It was our belief that the patient died of starvation and dehydration.

The terminal events in these 2 cases were very similar. It was felt that both of these patients would have survived had they been provided with ordinary dietary requirements. During a period of a very few days they had declined from a relatively good general state of health into a moribund condition that failed to respond to intensive therapy. The nutritional reserve of these patients is apparently so small that the absence of an adequate food intake for a short time cannot be tolerated. It is imperative that these patients be seen frequently after operation and any disturbance in nutritional intake be reported immediately. We have recently adopted the rule that unless we can be certain that the care of these patients after returning home will be entirely satisfactory they must remain in the hospital for an extra week beyond the usual discharge date to allow them to gain additional strength. The management of these patients after discharge from the hospital has been supervised by Dr Moses Paulson. The details of the medical and dietary regimen which he has developed, together with the observations made by jejunoscopy, will appear in a subsequent publication.

The survival period of the 10 patients alive at the time of this report ranges from 19 months to 4 months. All of these patients have gained weight although the increase has usually not been great. The weight of none of these patients has equalled his normal weight before the onset of gastric symptoms. The

lack of adequate gain in weight has been rather puzzling for all of the patients have a good appetite and apparently eat well. Careful questioning, however, has disclosed the fact that even after a year and a half, the usual meal is smaller than normal. Too large a meal brings on an uncomfortable feeling of epigastric fullness and hence they limit their intake. 'Between meal' nourishment which is advised, has frequently been omitted particularly after the patients return to work. New diets are being tried at present. Another important factor is the large amount of unabsorbed fat which is excreted in the stool. Recent preliminary metabolic studies in 3 of these cases, 7 months or more after operation conducted by Dr John E. Howard and Mr Lay Fox, confirm the results of Rekers, Pack, and Rhoads of an impaired ability to absorb the fat of the diet. The percentage of fat in the dry stool ranged between 22.5 and 49.0 per cent. As the number and character of the stools have been normal it has been assumed that the dietary fat has been digested but absorption has been inadequate.

In addition to epigastric fullness, 4 patients complain of epigastric and substernal burning usually experienced 15 to 30 minutes after meals. This symptom frequently follows the ingestion of fruit juices. It is temporarily relieved by taking alkalis.

All of the patients operated upon over a year ago have resumed a major portion of their normal occupations. Four of them all men have returned to their regular jobs. The 2 women do housework. One patient 12 months after operation, is able to do only light work at irregular intervals. One patient, 4 months after operation does a limited amount of light work. Two patients have been unable to return to work, one 8 months after operation and the other 4 months after operation.

Ferrous iron has been given at regular intervals to all of these patients. Hemoglobin values and red cell counts of the blood of all of them have remained within normal limits. Normal blood prothrombin and bilirubin values have also been found consistently in all of these patients. These studies will be reported in greater detail.

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE III.—PRESENT CONDITION OF SURVIVORS

Name	Postoperative interval	Weight	Appetite	Food capacity	Gastrointestinal symptoms	Stools	Work
J W	9 months	Gained slowly to the under last weight					
N M	9 months	Gained to the after operation. N change in last 3 months	Good	Must eat small meals	Occasional burning and fullness after meals	Normal rxD	Regular
J P	14 months	Gained the same operation	Good	Slightly less than regular meals	None	rxD Normal	Light housework
W T	3 months	Gained to the after operation N change in last 3 months	Good	Eats 6 small meals daily	Occasional epigastric pain. Fullness if he eats too much	Normal rxD	Regular
E T	3 months	Gained 5 lbs since operation	Good	Eats 6 small meals daily	Occasional fullness after meals	rxD Normal	Regular
G B	13 months	Gained 5 lbs since operation	Good	Normal	Occasional difficulty swallowing liquids	Constipated times rxD	Housework
D B	13 months	Gained the same operation	Good	Normal	None	rxD Normal	Regular light work
J S	8 months	Gained 5 lbs since operation	Fair	Must eat small meals	Nausea, fullness and eructation after eating	Normal rxD	Irregular light work
J B	months	Slight gain	Fair	Must eat small meals	Fullness and burning after meals	Normal rxD	Unable to work
P C	4 months	Gained to the	Fair	Eats 6 meals daily	Fullness after meals	Normal rxD	3 hours daily light work
				Eats 6 meals daily	Occasional regurgitation	rxD Normal	Unable to work

one of whom survived  $7\frac{1}{2}$  months large retroperitoneal masses developed along the aorta, suggesting that the malignant condition had spread to unsuspected lymph nodes beyond the limits of the resection at the time of operation.

The remaining 3 patients who have succumbed apparently died of inanition. They illustrate one of the problems in the postoperative management of gastrectomized patients. J N., a 55 year old colored male, underwent total gastrectomy on December 16 1944, for an extensive carcinoma of the lesser curve of the stomach with invasion of regional lymph nodes. No distant metastases were found. Two days after operation, atelectasis of the left lower lung field developed but he recovered quickly in the next 24 hours. Thereafter his course was uneventful. He was started on liquids by mouth on the 4th postoperative day. He tolerated his feedings well and his diet was steadily increased. At the time of discharge, he was eating a full soft diet taken in 6 small feedings a day and had no complaints. Roentgen esophagojejunal anastomosis to function satisfactorily. He was discharged in the care of friends who apparently had no regard for his dietary requirements. Eight days later he was returned to the hospital in a comatose condition and died within a few hours. He was said to have taken nothing by mouth after discharge but small sips of water. At autopsy the anastomosis was found to be widely

patent. Scattered microscopic metastases were found in other organs but there was nothing to explain his early death but starvation and dehydration.

F B a 60 year old colored man, was operated upon on August 17 1945. Total gastrectomy was performed for an extensive carcinoma which involved the distal one-third of the stomach with metastasis to regional lymph nodes and extension into the posterior surface of the anterior abdominal wall. His postoperative course was complicated by an attack of acute pancreatitis during which the serum analysis showed 9.9 milligrams per cent reducing substance per milliliter or 540 per cent of average normal (9). He recovered from this attack spontaneously but later partial intestinal obstruction developed. Exploratory laparotomy was performed on the 33d postoperative day when adhesions about a partially obstructed loop of jejunum were freed. Following the second operation his course was uneventful, and at the time of discharge on September 30, 1945 he was taking a full soft diet divided into 6 small feedings a day. His weight was increasing. He was followed thereafter at weekly intervals by Dr. Moses Paulson in the medical outpatient department. His weight increased, his appetite was good, and he followed instructions fairly well. His only complaint was of intermittent edema of the ankles. The total serum protein on November 1 1945 was 6.63 grams per cent. The nonprotein nitrogen was 30 milligrams per cent and serum bilirubin was less than 0.8 milligram per cent. Jejunostomy on December 12 was essentially negative. He was last seen in the outpatient department on January 21 1946. Six days later he was brought to the accident room to be pronounced dead, bow

ever a faint cardiac pulsation was heard and intense supportive therapy was instituted. He improved for a time but died in 24 hours. Permission for autopsy was not granted.

The patient had no relatives and a reliable history of events leading up to this final episode could not be obtained. He had apparently been feeling weak for several days. About 3 days before admission he had fallen without suffering any particular injury but following this accident he stayed in bed. As there was no one to care for him he had eaten practically nothing. His condition grew steadily worse up until the time he was admitted to the hospital. Before therapy was instituted his blood sugar was 20 milligrams and the nonprotein nitrogen 58 milligrams per cent. Five minutes after receiving 50 cubic centimeters of 50 per cent glucose intravenously he responded to verbal stimuli for the first time. It was our belief that the patient died of starvation and dehydration.

The terminal events in these 2 cases were very similar. It was felt that both of these patients would have survived had they been provided with ordinary dietary requirements. During a period of a very few days they had declined from a relatively good general state of health into a moribund condition that failed to respond to intensive therapy. The nutritional reserve of these patients is apparently so small that the absence of an adequate food intake for a short time cannot be tolerated. It is imperative that these patients be seen frequently after operation and any disturbance in nutritional intake be reported immediately. We have recently adopted the rule that unless we can be certain that the care of these patients after returning home will be entirely satisfactory they must remain in the hospital for an extra week beyond the usual discharge date to allow them to gain additional strength. The management of these patients after discharge from the hospital has been supervised by Dr Moses Paulson. The details of the medical and dietary regimen which he has developed together with the observations made by jejunoscopy, will appear in a subsequent publication.

The survival period of the 10 patients alive at the time of this report ranges from 19 months to 4 months. All of these patients have gained weight although the increase has usually not been great. The weight of none of these patients has equalled his normal weight before the onset of gastric symptoms. The

lack of adequate gain in weight has been rather puzzling for all of the patients have a good appetite and apparently eat well. Careful questioning, however, has disclosed the fact that even after a year and a half the usual meal is smaller than normal. Too large a meal brings on an uncomfortable feeling of epigastric fullness and hence they limit their intake. 'Between meal nourishment, which is advised, has frequently been omitted particularly after the patients return to work. New diets are being tried at present. Another important factor is the large amount of unabsorbed fat which is excreted in the stool. Recent preliminary metabolic studies in 3 of these cases 7 months or more after operation conducted by Dr John L. Howard and Mr Lay Fox confirm the results of Rekers, Pack and Rhoads of an impaired ability to absorb the fat of the diet. The percentage of fat in the dry stool ranged between 22.5 and 49.0 per cent. As the number and character of the stools have been normal it has been assumed that the dietary fat has been digested but absorption has been inadequate.

In addition to epigastric fullness 4 patients complain of epigastric and substernal burning usually experienced 15 to 30 minutes after meals. This symptom frequently follows the ingestion of fruit juices. It is temporarily relieved by taking alkalis.

All of the patients operated upon over a year ago have resumed a major portion of their normal occupations. Four of them, all men, have returned to their regular jobs. The 2 women do housework. One patient, 12 months after operation, is able to do only light work at irregular intervals. One patient, 4 months after operation does a limited amount of light work. Two patients have been unable to return to work one 8 months after operation and the other 4 months after operation.

Ferrous iron has been given at regular intervals to all of these patients. Hemoglobin values and red cell counts of the blood of all of them have remained within normal limits. Normal blood prothrombin and bilirubin values have also been found consistently in all of these patients. These studies will be reported in greater detail.

## SUMMARY

In the past, total gastrectomy has usually been reserved for the treatment of those malignant lesions of the stomach without distant metastases which could not be locally removed by subtotal resection. The high mortality rate of the procedure and the incidence of serious postoperative complications together with the uncertainties of digestion and metabolism in the absence of the stomach, have restricted the use of total gastrectomy. If these objections can be obviated undoubtedly block excision of the stomach and regional lymph nodes should be the most effective means of treating neoplasms of the pyloric and fundic regions of the stomach. The present series of 20 total gastrectomies with 2 operative deaths, together with the recent reports of other writers, indicates that the operative mortality of total gastrectomy is no longer prohibitive.

The available information concerning the digestion and metabolism of gastrectomized patients has been limited and uncertain. The postoperative study of these patients 7 of whom have now survived for a year furnishes additional evidence that such patients can maintain a fairly satisfactory nutritional state with special medical and dietary supervision. Six of these patients have returned to their former occupations. All of the patients now surviving have gained weight. The gains in weight have not been large however ranging from 2 to 12 pounds. The hemoglobin value in all cases is within the normal range. All of the patients are having from 1 to 3 normal bowel movements a day although preliminary metabolic studies in 3 patients indicate an impairment of absorption of the dietary fat. They uniformly have a good appetite and are now taking a full diet divided into 4 to 6 meals a day. Recent roentgenograms, in all cases but 1 show a normal passage of barium through the anastomosis and remaining intestinal tract. One patient has a slight delay in the passage of barium through the anastomosis.

The lack of adequate gain in weight, the excretion of abnormal amounts of fat in the

stools the slow return of normal muscular strength and the persistence of occasional attacks of abdominal fullness and epigastric burning are still problems to be solved, possibly by new surgical procedures or by improved postoperative medical management.

## CONCLUSIONS

Total gastrectomy offers the most effective means of eradicating gastric carcinoma of the pyloric antrum and fundus. Since it is possible to perform total gastrectomy with a mortality rate of less than 10 per cent, and since the evidence at present indicates that gastrectomized patients maintain a fairly satisfactory nutritional state, the more frequent use of the procedure is recommended. Certain lesions that would be considered inoperable if only subtotal gastric resection were employed may be adequately treated by total gastrectomy. Malignant lesions of a less extensive nature should be removed by total gastrectomy if adequate excision of the involved stomach and regional lymph nodes by subtotal resection is considered a doubtful undertaking.

Gastrectomized patients present problems associated with adequate intake and absorption of food sometimes persisting for months after operation, which at present prevent the recommendation of the procedure as the operation of choice for all malignant tumors of the stomach which are amenable to surgical treatment.

## REFERENCES

1. COLLIER, F. A., KAY, E. B. and MacLESTER, R. S. Arch. Surg. 94: 43, 743.
2. DE ADESTE, F. Ann. Surg. 94: 117, 85.
3. EXCEL, G. C. Surgery 94: 7, 52.
4. FARRIS, J. M., RANKIN, H. K., and COLLIER, F. A. Surgery 94: 3, 823.
5. FINLEY, J. M. T. and RANKIN, W. F. Jr. Arch. Surg. 92: 18, 140.
6. HOSLEY, J. S. Virginia M. Month. 94: 70, 540.
7. JONES, T. E., and KERR, R. W. Surg. Gyn. Obst. 1945, 80, 534.
8. MORTON, C. B. Surg. Gyn. Obst. 94: 75, 560.
9. MYERS, V. C., FREE, A. H., and ROSENTHAL, E. E. J. Biol. Chem. 94: 154, 39.
10. PACK, G. T. and McNEER, G. Surg. Gyn. Obst. (Internal Abstr. Surg.), 94: 77, 705.
11. REEDER, P. E., PACK, G. T. and RHOADS, C. F. Surgery 94: 14, 97.

# COMPLICATIONS FOLLOWING THE USE OF COTTON AS SUTURE MATERIAL

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THE use of spool cotton as suture material in surgery is now well established and has been employed routinely in many outstanding surgical clinics in this country for several years. Ever since the appearance of the results of the experimental work of Meade and Ochsner (7) the reports in the literature have been uniformly enthusiastic in their support of cotton. Complications following its use have been so rare as to warrant their publication as individual case reports (1). Cotton as suture material was first used routinely in all my cases early in 1943 and it seemed entirely satisfactory, as I had anticipated. However after a few months, complications which were considered directly attributable to the suture material began to be encountered with sufficient frequency to prompt me to investigate the cases with a view to determining the incidence and causes of these complications. In the cases in which the wounds healed without complications I as well as others had noted that the healing and scars were so far superior to those in which catgut had been used, that it was considered undesirable to discontinue the employment of cotton without investigation.

After the study had been begun more and more surgeons were found who objected to the use of cotton for various reasons. Most of them however had had little personal experience in its use and were not sufficiently familiar with specific cases in which it had proved unsatisfactory to warrant publication of their results. A notable exception to this group was Key who stated that he had given cotton a trial only to abandon it and return to the use of catgut. He particularly objected to its use in orthopedic operations where it was buried over a gliding surface such as a joint. Although certain writers have mentioned instances in which it has been extruded from

wounds, this complication is not considered serious because it has not been accompanied by the chronic draining sinuses so commonly encountered when other types of nonabsorbable sutures have been employed.

The main advantages that have been claimed for cotton are its pliability decreased tissue reaction adequate tensile strength high coefficient of friction and stability on exposure to heat and moisture (2, 3, 5, 6, 8, 9). Another distinct advantage is the fact that it encourages the surgeon to be gentle in the handling of tissues. All of these claims are perfectly logical and just. However extravagant claims have been made and it is thought that one writer was slightly overenthusiastic when he attributed the lower postoperative febrile reaction in a group of patients who had undergone herniorrhaphies to the fact that they had been repaired with cotton (10).

It has been repeatedly pointed out by Ochsner and others that the successful use of cotton depends upon strict observance of the tenets of Halsted which are as follows:

- 1 Use interrupted sutures only
- 2 Never use coarse suture material.
- 3 Never bridge over a dead space as a cord subtends an arc.
- 4 Use transfixion sutures in ligation as finer material can be used in this way
- 5 Use a greater number of fine stitches rather than a few coarse ones.
- 6 Avoid the combined use of absorbable and nonabsorbable sutures.

## METHODS AND MATERIAL

The present report is based upon 372 operations of various types performed in three different hospitals in which cotton was used as suture material either alone or in conjunction with catgut. The only cases in which the two materials were used together were in laparotomies in which the peritoneum was sutured

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TABLE I.—IMMEDIATE POSTOPERATIVE COMPLICATIONS

Case No.	Operation	Type of complication
2	Thyroidectomy	Severe infection
7	Herniorrhaphy	Superficial infection
10	Appendectomy	Severe infection
20	Herniorrhaphy	Hematoma
41	Leg amputation	Superficial slough
51	Kistectomy	Deep abscess
70	Closure of colostomy	Deep abscess
87	Appendectomy	Slight infection
9	Herniorrhaphy	Maceration of skin
95	Appendectomy	Severe infection
	Cholecystectomy	Superficial infection
14	Right colectomy	Wound disruption
5	Cholecystectomy	Wound disruption
11	Tumorhaphy	Superficial infection
15	Leg amputation	Superficial infection
17	Open reduction of compound fracture	Superficial infection
19	Tumorhaphy	Superficial infection
7	Ramstedt	Small stitch abscess
112	Thyroidectomy	Severe wound infection
122	Open reduction	Severe wound infection
9	Appendectomy	Deep wound infection with extensive slough
57	Herniorrhaphy	Small hematoma
180	Herniorrhaphy	Superficial infection
175	Herniorrhaphy	Superficial infection
104	Closure of perforated ulcer	Deep abscess
113	Gastrectomy	Deep abscess
147	Subtarsal oophorectomy	Intestinal obstruction, severe infection
141	Appendectomy	Deep abscess
179	Herniorrhaphy	Superficial infection

with continuous chromicized catgut, the remainder of the structures with interrupted cotton. Ordinary long fiber spool cotton sterilized by autoclaving was employed in every case. Only three sizes were used: No. 60 for ligature of small vessels, No. 30 for suture of the deep fascia and ligature of larger vessels and occasionally heavy crochet cotton for ligature of still larger vessels. In the type of operations performed it was seldom necessary to use the heavy cotton. The tenets of Halsted were followed except for the combined use of

absorbable and nonabsorbable sutures as mentioned.

The series included 34 different types of operations, of which 158 were laparotomies, 74 orthopedic procedures of various types, and the remainder herniorrhaphies, thyroidectomies, repair of deep traumatic wounds, kidney operations, mastectomies, and excision of subcutaneous tumors. Cotton was used indiscriminately whether or not the wounds were infected or contaminated.

The patients were carefully observed for from 4 to 18 months. The original wounds were classified as either clean or contaminated. A contaminated wound is defined as one in which there was previous soiling from outside sources or in which an obviously infected organ such as a perforated appendix was removed. Postoperative wound complications were carefully watched for and the most trivial ones reported (Table I). There were 311 (83.6 per cent) clean and 61 (16.4 per cent) contaminated wounds. The complications ranged in severity from complete disruption and deep abscesses to small hematomas and maceration of the skin edges.

There were 29 cases (7.7 per cent) with early postoperative complications, 15 of which were severe, 14 trivial. The most serious early complication, wound disruption occurred in 2 cases. These are interesting in that this complication is seldom encountered when wounds have been sutured with cotton. Both of these instances occurred in gravely ill patients, one having undergone a one stage resection of the right colon for carcinoma, the other a cholecystectomy for a ruptured gall bladder with generalized bile peritonitis. Secondary suture with through-and-through silk sutures was carried out in each case with uneventful healing. The appearance of the wounds at the time of secondary closure was interesting in that very little cotton could be seen and the small amount present was fragmented. It is thought that this complication cannot be solely attributed to the suture material as there were obviously several other factors responsible which are usually found in all cases of wound disruption regardless of the type of suture material employed. Further reference to Table I will reveal that the remainder of

the early postoperative complications were in no respect unusual and the same that might be seen in any similar series of operations.

Table II shows the late complications encountered. In this class were also included all of the complications no matter how trivial. It was considered of particular importance to note whether or not any cotton knots were extruded from the depths of the wounds. The occasional extrusion of a cotton knot, if it did not interfere with wound healing, was not considered serious. However, the patient frequently attaches undue significance to this and in 2 cases which were not considered serious or complicated from the standpoint of healing there were threats of litigation. It may seem strange to some readers that there were such threats even though the eventual wound healing was retarded little if any. However in this region for many years non-absorbable sutures have never before been used on a large scale and the patients are educated to believe that all deep sutures should be absorbed.

The cases showing late complications naturally fall into two groups, the mild and the serious. The former has been explained. If a large number of knots are extruded or if the suture material was considered definitely to interfere with the healing of the wound the complication must be regarded as serious. All of those cases in which it was thought that the suture material alone was not responsible for the difficulty were excluded from this group. According to this criterion it is seen that of the 17 cases with late complications (4.5 per cent) 9 (2.4 per cent) were considered serious. Further reference to Table II reveals that the complications often did not appear until several weeks or months after the wound had healed. At the present time all of the wounds are healed, even though exploration was necessary in 3 cases which will be considered in some detail below.

An attempt was made to discover whether or not any common denominator could be applied to the cases with late complications. It was discovered early in the study that the cases did not follow any definite pattern in regard to infection. For example there were several perfectly clean wounds from which

TABLE II —LATE COMPLICATIONS

Case No.	Operation	Type of complication	Time of appearance
3	Thyroidectomy	Extrusion of 1 knot	4 months
4	Thyroidectomy	Extrusion of 2 knots	months
10	Mastectomy	Extrusion of knot	6 weeks
74	Closure of colostomy	Extrusion of many knots, healed after 3 months	weeks
83	Appendectomy	Sinus for 4 months; exploration necessary	Immediately
86	Ureterolithotomy	Sinus for 3 months	Immediately
9	Herniorrhaphy	5 knots extruded	5 weeks
95	Appendectomy	Drained for 4 months; many knots extruded	Immediately
9	Appendectomy	5 knots extruded	4 weeks
33	Open reduction	Many knots extruded	6 weeks
123	Tenorrhaphy	knots extruded	3 weeks
137	Open reduction	Drained 4 months; many knots extruded	3 weeks
150	Tenorrhaphy	knots extruded	weeks
173	Thyroidectomy	Draining sinus 5 months, exploration necessary	week
83	Hysterectomy	Drainage for 6 months, exploration necessary	months
9	Appendectomy	knots extruded	month
250	Thyroidectomy	knot extruded	3 months

cotton was extruded or had to be removed at a later date after healing had progressed uneventfully. On the other hand there were several patients with perforated appendices and considerable peritonitis which healed uneventfully. One of the most striking of these was in a patient with a perforated appendix with massive fecal leakage into the peritoneal cavity. His general condition was complicated by rather severe diabetes. Cotton has also been used to close colostomies without causing difficulty.

Of the 17 cases with late complications 9 were originally classified as clean wounds. Of these, 2 developed severe infections post-operatively. If these are added to the cases which were originally contaminated or infected, it is seen that there is a total of 10 cases in which infection was a conspicuous feature.

The 9 cases with serious late complications are naturally of the greatest interest and will



be considered in some detail. In all of these draining sinuses appeared at various times following operation and they all had one factor in common they did not heal until all of the cotton had been removed, either by being extruded spontaneously or by surgical intervention. In 3 cases it was necessary to explore the wounds, remove many cotton sutures from the deep fascia and resuture them with catgut. This was followed by prompt healing in each instance. Two of the wounds had been grossly infected, one operation having been performed for a perforated appendix with considerable peritonitis, the other a thyroidectomy which was followed by a deep abscess. The third case, a total hysterectomy was perfectly clean, healed by first intention with a minimum of reaction remaining healed for 2 months, at the end of which time two sinuses appeared. Many knots were extruded or were removed with forceps but drainage continued. Consequently at the end of 5 months, it was necessary to explore the sinuses and remove the remaining sutures in the deep fascia. This was followed by prompt healing.

During the latter part of the period comprising the study it was thought that infection was the commonest cause of difficulty and the use of cotton was discontinued in cases in which infection or contamination were present.

The patients were also examined with a view to discovering whether or not cotton was unsuitable for any particular type of wound. In the 4 most common types of operation—laparotomies of all types, orthopedic procedures, thyroidectomies, and herniorrhaphies the incidence of late complications was noted. Out of 158 laparotomies there were 6 complications (3.8 per cent). In 74 orthopedic procedures there were 2 complications (2.7 per cent). In 46 herniorrhaphies there was 1 (2.2 per cent). In 32 thyroidectomies there were 3 (9.3 per cent). When broken down in such a manner it is acknowledged that the series of operations is entirely too small from which to draw any definite conclusions. But here again, with the exception of the thyroidectomies, infection seems to be the only factor that appears with any degree of consistency whatever. The question as to whether or not the quantity of cotton buried in any one

wound will have any effect upon the healing also arose. If this were true, one would expect to find more difficulty with the thyroidectomies than with any of the other types of operations, as much more cotton is used in them. This was not found to be the case.

The series was arbitrarily divided into three parts on a chronological basis. In the first one third there were 9 complications in the second, 7 while in the last one third there was only 1. One possible explanation for this is that the writer became more and more adept in the use of cotton and more meticulous in his technique with the passage of time. Even though he had had previous experience in the use of nonabsorbable suture material in the form of silk, he had become thoroughly accustomed to the use of catgut, which had been employed for several years. Although every effort was made to carry out each procedure as meticulously as possible early in the series it was found that there was a natural tendency to use cotton in a fashion similar to that in which silk had been used. It was frequently found that too much tissue had been included in a ligature, for example. However the better results in the last group may be partly due to the fact that no contaminated cases were included. The decreasing incidence of complications might also be due to the fact that in the last group insufficient time had elapsed for all of them to appear. But in the vast majority of cases the complications occurred within the first 4 months and all of the cases were observed for at least that length of time.

#### DISCUSSION

While it is not considered that all of the causes of complications have been found, from the analysis presented, it seems that the most conspicuous single factor in the complicated wounds is infection. Although it was a factor in only a slight majority it is regarded as sufficiently important to cause the writer to feel that cotton is not the suture material of choice in such cases, in spite of many opinions to the contrary. Emphasis must also be placed upon surgical technique in the use of this material and it is considered that the results, at least in the clean cases, should show further

improvement. It is thought that an incidence of serious postoperative complications due to suture material of 2.4 per cent is entirely too high, and the 3 cases in which the deep sutures had to be removed would be sufficient to cause many surgeons to abandon cotton entirely. A word of warning is believed in order to the surgeon who has been accustomed to the use of catgut and considers adopting cotton.

#### CONCLUSIONS

1. A series of 372 operations in which cotton suture material was employed is presented.
2. There were 17 cases (4.5 per cent) with late complications attributable to the suture material which is considerably higher than the incidence encountered in the literature. Of these, 9 were considered serious and 8 mild.
3. Two early complications in the form of wound disruption were encountered which is very rare according to the literature.
4. Infection did not seem to be present frequently enough to attribute all of the bad results to it.

5. Complications were present more frequently in the earlier than in the later cases in the series, and it is suggested that this may be due to improvement in technique in the later cases as well as to the fact that the use of cotton was finally given up in obviously infected or contaminated cases.

6. While cotton is still considered an excellent suture material contrary to general opinion it is not entirely without hazards and has definite limitations.

#### REFERENCES

1. DINGIANKI V. *Am. J. Surg.* n. s., 1945 69:137.
2. FLOYD J. R., and BROCKBANK, M. *Am. J. Surg.* 1944, 16:403.
3. HYDE, T. L. *Surgery* 1944, 16:407.
4. KEY J. A. Personal communication.
5. LOCALIO A. S. and HINTON J. W. *Surg. Gyn. Obst.* 1941 72:615.
6. MEADE, W. H. and LONO C. H. *J. Am. M. Ass.* 1941 117:2140.
7. MEADE, W. H. and OCHSENER, A. *J. Am. M. Ass.* 1939, 113:2230.
8. *Idem.* *Surgery* 1940 7:485.
9. THORKE P., GRADMAN R. and GLATTS, A. *Am. J. Surg.* 1943, 59:68.
10. ZOLLINGER, R. W. and FLYNN W. J. *Surg. Gyn. Obst.* 1945 81:201.

# THE EVOLUTION OF ADENOMAS OF THE LARGE INTESTINE AND THEIR RELATION TO CARCINOMA

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THE present day active search for the smallest tumors which may be recognized as malignant has added a new importance to many lesions previously considered insignificant. During the last few years there has been an increasing effort on the part of pathologists to recognize carcinoma in its preinvasive stage. By repeated biopsies Schiller was able to show that certain lesions of the cervix were followed eventually by an invasive carcinoma. Broders applied the phrase carcinoma in situ to describe this noninvasive stage of carcinomas of glandular and of squamous cell origin. Both Verge and Dukes observed the presence of carcinoma in polypoid adenomas of the large intestine a picture which would appear to correspond to the carcinoma in situ of Broders. Moreover the literature attests that this picture has been noted by many workers. Nevertheless the exact relation of adenomas to carcinomas of the large intestine has remained controversial.

Adenomas constitute the great majority of polyps occurring in the large intestine (10). Confusion in the literature has resulted from the different interpretation of the term polyp. By some authors, the term polyp is used to designate any sessile or pedunculated benign tumor arising in the mucosa or wall and projecting into the lumen of the intestine. While this interpretation indicates the gross appearance of the tumor it does not signify the exact pathologic type. On the basis of histologic examination the generic classification of polyps may be divided into several different specific types of tumors such as adenomas, lipomas, leiomyomas, and carcinoids. By other authors the term polyp has been considered synonymous with adenoma. In order

to avoid this confusion of terminology it would seem best to designate these tumors according to their specific structure. In this paper the term adenoma is used to designate either a sessile or pedunculated benign tumor of glandular origin. In accord with this restricted interpretation of the term adenoma, I have excluded from this study all other types of tumors, hemorrhoids, fibrous tags, and lesions obviously the result of infection.

The problem of the relation of adenomas to carcinomas of the large intestine has usually been investigated by one of two different methods. First, information about adenomas has come from observations made on patients at frequent intervals. While this method of study is advantageous, it is also inconvenient. Furthermore, it is not an ideal therapeutic procedure to follow the course of an adenoma over a period of time and determine whether a transition from benignancy to malignancy occurs. The second method by which information has been gained has come from the observation in adenomas of histologic changes commonly recognized as diagnostic of carcinoma. Many of the investigations in which adenomas have been examined for histologic foci of carcinoma have been undertaken on small segments of the colon removed at surgical operation. Other investigations, in which there has been no concerted effort to determine the exact occurrence of adenomas or to examine all of them carefully, have been carried out on colons removed at autopsy. It seemed that a more definite understanding of the relation of adenomas to carcinomas of the large intestine could be gained by a careful determination of the incidence of adenomas at autopsy and the analysis of each adenoma for the presence or absence of histologic changes commonly recognized as diagnostic of carcinoma.

# MATERIALS AND METHODS

The present report is based upon a study of 1460 consecutive autopsies in which the entire large intestine was available for examination. Each large intestine was carefully examined in the fresh state. All sessile and pedunculated mucosal elevations together with the contiguous wall of the colon were removed and fixed in 4 per cent formaldehyde. The site of each lesion was noted and its distance from a specific landmark was recorded. After fixation notes and drawings were made of each lesion. If a lesion was large it was divided one or more times along a plane perpendicular to the mucosa. Specimens were then embedded in paraffin in such a manner that the plane of the section was at a right angle to the plane of the mucosa. At intervals throughout each block, step and serial paraffin sections stained with hematoxylin and eosin were prepared. Unstained sections contiguous with the stained sections were saved until after the stained sections were observed. Additional sections were prepared when deemed necessary. The microscopic findings were then noted and compared with the gross appearance.

## CLASSIFICATION OF ADENOMAS

A great deal has been written about the classification of adenomas of the large intestine (2, 5, 7, 8, 13, 16, 17, 21). Most of the proposed classifications have been based upon (1) apparent etiologic factors such as ulcerative colitis, (2) clinical features such as the singularity or multiplicity of the tumors and the age of the patient, and (3) the character of the morphologic and histologic structure of the tumor.

The adenomas studied in the present series of cases have not yielded evidence to support the concept of an associated inflammation as the inciting agent of the adenomas. Although most of the more common types of adenomas were encountered in the present series of autopsies only one example of the association of colitis and adenomas was observed. In the colon of a 67 year old man, a single adenoma and amebic ulcers were present. It would appear from this series that any relation between the presence of some form of colitis and adenomas is purely coincidental.

The clinical picture of familial adenomatosis or multiple polyposis of the large intestine is well established. However, it is impossible to determine any fundamental differences in the adenomas occurring in familial adenomatosis and those occurring singly. The gross and microscopic features of adenomas noted in the one example of familial adenomatosis in this series could be duplicated in any number of colons containing one or only a few adenomas.

The literature contains many references to classifications based upon either or both the macroscopic and microscopic appearance of adenomas. It is claimed that the contour of the tumor and the regularity or irregularity of the surface are useful criteria regarding classification. Much importance has been attached to the microscopic appearance of the epithelium and to the connective tissue framework. It seems doubtful that any significance such as was suggested by Hauser can be attributed to the amount of degenerated epithelium. In the present series degenerated epithelium occurred in adenomas in an indiscriminate manner. Likewise the separation of adenomas into three groups as proposed by Fitzgibbon and Rankin (8) and others (9) seems to be of questionable usefulness. These authors, on the basis of the histologic picture, felt able to determine that certain adenomas were destined for a long and benign course. Such a degree of faith in the interpretation of a histologic section does not seem warranted. In the present series many of the adenomas when studied by step and serial sections did not show a uniform cytologic and histologic picture. No evidence could be adduced that any particular group of adenomas would maintain a constant benign course. It does not seem justifiable to predict that a selected group of adenomas will not contain a focus of carcinoma at some future date. These same authors also were presumably able to determine the age of an adenoma by the microscopic appearance. The observations in the present study did not give any clue as to the age of an adenoma. It seems doubtful that the age of an adenoma can be determined except by observation of the tumor in a patient over a period of time.

On the basis of the present study no distinguishing morphologic and histologic characteristics which would seem to warrant a complex classification of adenomas were noted. In all instances the adenomas appeared basically similar and no practicable significance could be attached to minor variations of structure and cells.

#### MORPHOLOGY AND EVOLUTION OF ADENOMAS

The gross appearance of adenomas has been described many times. In the present series the tumors varied in size from 1 millimeter to 9 centimeters in diameter. The smaller tumors in some instances occurred on the summits of mucosal folds and at other times arose from the flat mucosa. There did not appear to be any definite pattern for this phenomenon since intestines with multiple adenomas were likely to show involvement of both sites. Moreover a comparison of those adenomas of similar size which were situated on the summits of folds with those arising from the flat surface frequently showed a longer pedicle on the former. This picture suggests that the site of the adenoma may influence the development of the pedicle. Those adenomas situated on a mucosal fold would be more exposed to peristaltic action of the intestine.

It is common practice to describe adenomas as pedunculated or sessile. Many of the tumors present an obvious pedicle and may be correctly termed pedunculated. The group of tumors referred to as sessile do not present such an obvious picture. These tumors are commonly hemispherical in shape and on the basis of the external configuration appear sessile. However in most instances, a midsagittal section through the tumor reveals a short central stalk with tumor overhanging the margins like an umbrella. In reality many adenomas with the appearance of sessile tumors are actually pedunculated and only a few tumors are truly sessile. Even when an adenoma covers a large surface and appears sessile there may be numerous individual stalks supporting closely approximated polypoid projections.

The contour of the adenomas may be regular lobulated or villous. Both the pedicle and the tumor frequently are flattened in one

dimension. Not only may different adenomas in one colon exhibit various configurations, but occasionally a single adenoma may show diverse forms of contour. In general the smaller tumors are more likely to show a regular outline and the larger adenomas a definitely lobulated or villous form. Likewise the smaller tumors tend to be gray in color and the larger tumors grayish red or red. However these tinctorial qualities are not constant and a fair proportion of the tumors will exhibit both red and gray foci. The color is determined by the richness of the vascular supply by the degree of congestion and by foci of hemorrhage, inflammation, and ulceration.

Because of the protean histologic structure of adenomas it is difficult to describe any particular picture as typical. The small tumors are disposed to have a more simple framework than are the larger ones. Usually this consists of a single connective tissue core with or without an extension of the muscularis mucosae into the stalk. When the adenomas are minute, a definite connective tissue stalk may be absent. In such instances the histologic picture is primarily one of epithelial hyperplasia. The epithelial hyperplasia brings about either an increase in the size of the glands or in the number of glands or both. Usually there is no appreciable disposition to stratification of the cells or to papillary infolding. The epithelial cells may or may not be distended with mucus but otherwise are not particularly abnormal. An essentially similar picture has been described by Dukes, who observed patches of epithelial hyperplasia in the vicinity of carcinomas of the colon. Dukes considered these patches of epithelial hyperplasia to be the first step in the formation of adenomas. The location of the epithelial hyperplasia has been thought by Bargen, Cromar and Dixon (1) to be determined by the site of the lymphoid follicles in the intestine. According to these authors a subclinical inflammatory process produces a rupture of the lymphoid follicles, and the subsequent repair results in an isolation of a portion of epithelium by a ring of lymphoid tissue. This process may result in the formation of an adenoma or because of a change in the envi-

ronment of the cells give way to malignant neoplasia. This theory is hardly tenable in the light of the observations in the present study. Microscopic examination of the smallest adenomas disclosed some with lymphoid follicles situated in the stroma beneath the epithelial hyperplasia and others without lymphoid nodules. If the lymphoid nodules are an essential factor in the evolution of the adenoma then they should be found in all examples. Moreover, lymphoid nodules undergo hyperplasia in other organs such as the appendix, small intestine, and thyroid and are not associated with the development of adenomas. As will be brought out subsequently, adenomas of the large intestine are less common in the negro than in the white race although there is no evidence that negroes have fewer lymphoid nodules or less clinical or subclinical inflammation of the large intestine. The lymphoid nodules normally are located internal or external to the muscularis mucosae and in some instances partially obscure it. There is no constant location of the nodules, when present, relative to the epithelial hyperplasia. They may appear either directly beneath the epithelial hyperplasia or at the margin. This suggests that there is no direct relation between the site of the lymphoid nodule and the development of the adenoma. It is not surprising that some adenomas show one or more lymphoid nodules in the immediate vicinity and frequently show infiltration of inflammatory cells, hemorrhage and deposits of hemosiderin. Lymphoid nodules are normally present in the large intestine and large lymphoid follicles with secondary nodules commonly occur in inflammation. Thus a subjacent prominent lymphoid nodule might be expected to occur as a result of inflammation within the tumor. The lymphoid nodules occasionally observed at the margin of lipomas and carcinoids of the colon probably occur for the same reason. On the basis of this evidence it seems more logical to conclude that the lymphoid nodules are not an important factor in the mechanism of development of adenomas but are coincidental and undergo hyperplasia as the result of the presence of the tumor.

As the adenomas increase in size the supporting connective tissue structure tends to become more complex. In the largest tumors it is common to observe not only a central stalk but also a number of branches which support the polypoid or villous processes. The central stalk and branches are comprised of connective tissue and in some tumors contain strands of smooth muscle. The smooth muscle may or may not be continuous with the muscularis mucosae. The connective tissue frequently shows a variation in the degree of cellularity, not only among all adenomas but in different fields of a single tumor. The stroma is sometimes dense and hyalinized and at other times tenuous and cellular. The extent of the vascularity of the stalk is also variable. In most adenomas the larger tumors, in particular one or more large blood vessels is present. Occasionally the walls of the arteries are thickened and are the seat of hyalinization. Some adenomas contain arteries and veins occluded by thrombi. All stages of organization are represented among the thrombi. In some instances the thrombi appear to be secondary to the inflammatory process. This is especially evident when the involved area is limited to the superficial or exposed segment of the tumor. In other examples the thrombi are not accompanied by an appreciable inflammatory reaction. It is conceivable that the thrombi in these adenomas are the result of trauma or twisting of the pedicle of the tumor.

The architectural pattern of the glands forming the larger adenomas may appear essentially similar to that of the small tumors previously described. More frequently, the glands in the larger tumors exhibit abnormalities such as elongation, dilatation, branching and papillary infolding. The character of the epithelial cells lining the glands shows little change from normal. The cells are usually tall and columnar sometimes have an elongated and compressed appearance and may or may not be predominately of the mucous type. The nuclei are moderately chromatic and usually do not show large nucleoli. There is a distinct tendency for the nuclei which are sometimes elongated to occupy the basal portion of the cells. Mitotic figures may be

TABLE I.—INCIDENCE OF ADENOMAS  
IN WHITE PATIENTS

Age groups years	Males	With adenomas	Per Cent	Females	With adenomas	Per Cent	Total Patients	With adenomas	Total per cent
0-1	38								
1-10	1			100					
10-20	43		10.0	8					
20-30	53			30					
30-40	64	7	10.0	29					
40-50	83	8	9.4	45					
50-60	58	16	27.4	1	3	3.6	59	19	32.0
60-70	39	30	76.9	14	8	57.1	53	38	71.7
70-80	25			20			45		
80-90	6			8			14		
90-100	3			1			4		
									6.6

frequently encountered. Stratification of the epithelial cells is uncommon, and there is a definite line of demarcation of the epithelial cells from the contiguous stroma. If the tumor is pedunculated normal appearing mucosa commonly covers the pedicle or base of the stalk.

Swinton and Warren have stated that adenomas usually show no evidence of inflammatory reaction other than slight lymphocytic infiltration at the base. This observation is contrary to the observations made in the present study. I have found that adenomas, the larger ones in particular contain inflammatory cells, including lymphocytes, plasma cells, monocytes, and neutrophils and eosinophilic polymorphonuclear leucocytes. Several tumors contained foci of acute inflammation, small abscesses and ulceration. Serial and step sections of a single adenoma may disclose acute inflammation in some sections and not in others. It is possible that some of the dense connective tissue within adenomas represents the former sites of inflammation. That the adenomas are subjected to severe trauma is verified by the frequent observation of hemorrhage and intracellular and extracellular deposits of hemosiderin within the stroma of the tumors.

Many authors have attributed the development of adenomas in the large intestine to some form of antecedent inflammation. In

TABLE II.—INCIDENCE OF ADENOMAS  
IN NEGRO PATIENTS

Age groups years	Males	With adenomas	Per Cent	Females	With adenomas	Per Cent	Total Patients	With adenomas	Total per cent
0-1	33								
1-10	1								
10-20	5			1			6		
20-30	14								
30-40				100			100		
40-50	14								
50-60				21			21		
60-70				9			9		
70-80				9	7	77.8	16	7	43.8
80-90									
90-100									

the present study it was rarely possible to demonstrate gross or histologic changes of a previous inflammation in the mucosa or wall of the intestine. This observation does not deny that small or minor foci of inflammation had not previously occurred followed by complete repair or the evolution of an adenoma—neither does it support such a concept. However it does seem unlikely that an inflammatory process such as ulcerative colitis could regress without leaving evidence of chronic inflammation, atrophy or fibrosis. Since one person in five who reaches the age of 60 has an adenoma of the large intestine it is reasonable to expect some people with adenomas to reveal a past history of colitis. A previous history of colitis should not then necessarily implicate the colitis as the etiologic agent of adenomas. The observations in the present study coincide with the opinion of Swinton and Warren that adenomas of the large intestine are true tumors and are not the result of diffuse inflammatory processes.

#### THE INCIDENCE OF ADENOMAS

The large intestine in each of 1,460 consecutive autopsies was examined. Of this number 139 or 9.5 per cent contained adenomas. After 1 case of familial adenomas was excluded the remaining 138 specimens contained 372 tumors. Four of the tumors were unsatisfactory or unavailable for detailed mi-



Fig 1

Fig 2

Fig 3.

Fig 1. Gross specimen of an adenoma of the pedunculated type.  $\times 1.7$

Fig 2. Photomicrograph of the adenoma shown in Figure 1. The stalk is covered with normal mucosa. There is a large cystic space partially lined by epithelium at the base of the adenoma.  $\times 1.9$ .

Fig 3. High power photomicrograph showing histologic carcinoma in the base of the adenoma pictured in Figure 2. The irregular glands show intraglandular budding and invasion of the stalk. The nuclei are hyperchromatic and there is a variation of the nuclear polarity.  $\times 70$ .

oscopic study and were considered as benign adenomas.

In Table I the incidence of adenomas of the large intestine of 1 279 white patients is given and in Table II similar figures are presented for 181 negro patients.

The incidence of adenomas in the 1 279 white patients was 10.4 per cent. When the incidence is studied by age groups a fairly constant progressive increase is noted above the age of 30 in both sexes. The peak incidence was reached in the eighth decade when 25.8 per cent of the men and 20.5 per cent of the women showed adenomas. In all decades above the third slightly more men than women had adenomas. This observation although not so pronounced is in agreement with the results of Lawrence who noted that more white males over 40 years of age had adenomas of the colon than did white females by the proportion of 1.6:1.

The number of negro patients examined 181 is admittedly small. The overall incidence of adenomas in this group was 2.7 per cent compared with 10.5 per cent in the white patients. If only those patients over 30 years of age are included the incidence in the negro

race was 3 per cent compared with 16 per cent in the white race. From these figures it is evident that at least in the older age groups there is a greater disposition to the development of adenomas among the white race than among the negro race. Lawrence also noted a higher incidence in the white race but not such an appreciable difference.

In 80 of the 139 cases there were single adenomas and in the remaining cases two or more tumors were noted. Saint noted that multiple tumors were slightly more common than were single tumors but Lawrence observed a predominance of single tumors.

From Table III it is apparent that an individual 35 years of age with adenomas has about the same chance of having multiple tumors as does the person 75 years old. However multiple adenomas are more common in older people because the incidence of adenomas is greater in older people. This observation would indicate that in many instances the factors initiating the development of adenomas act on multiple sites at about the same time.

The number of female patients—24—with single adenomas (63 per cent) is slightly greater than the number of male patients—





Fig. 4.

Fig. 4. Photomicrograph of an adenoma of the pedunculated type.



Fig. 5.

Fig. 5. High power photomicrograph showing histologic carcinoma near the tip of the adenoma pictured in Figure 4. An abrupt transition in the character of the glands is apparent. There is marked stratification of cells and intraglandular budding. The cells vary in size and shape. The nuclei show variable polarity and have prominent nucleoli.

56—with single tumors (55 per cent) Conversely more men—45 (45 per cent)—than women—14 (37 per cent)—have multiple tumors.

The sites of adenomas are shown in Table IV. In 80 of the 139 large intestines the adenomas occurred singly. However 20 of the 59 intestines with multiple tumors showed localization of the tumors to one segment and in 10 more instances the distribution of the tumors was confined to two contiguous segments such as the sigmoid colon and rectum

or cecum and ascending colon. Thus in 100 of the 139 intestines the tumors were localized to one segment and in an additional 10 examples the tumors were localized to two contiguous segments. In the other 29 intestines the adenomas were scattered indiscriminately throughout though at times more tumors were concentrated in one segment than in another. Thus in the group of tumors without localization 9 of 12 tumors in the transverse colon came from only two intestines.

In a previous paper (10) I have shown that adenomas of the colon are more frequent than adenomas of the rectum and that the sigmoid colon is the most common site of adenomas in the large intestine. As noted in Table IV this latter observation holds true whether there are single tumors, multiple tumors localized to one site or multiple tumors with a wide spread distribution. After taking into consideration that many of the groups in Table IV are small and that the ratio of men to women examined in this series is 17:1 there is a general indication that the incidence of adenomas in men is greater than that in women in all sites of the large intestine regardless of singularity or multiplicity of tumors.

#### RELATION OF ADENOMAS TO CARCINOMA

In order to acquire further knowledge on the relation of adenomas to carcinoma of the

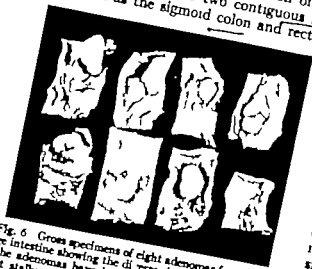


Fig. 6. Gross specimens of eight adenomas from a single large intestine showing the diverse sizes and shapes. Some of the adenomas have long pedicles whereas others have short stalks. The smallest adenoma measures 1.5 millimeters and the largest 30 millimeters in the greatest diameter.



Fig 7

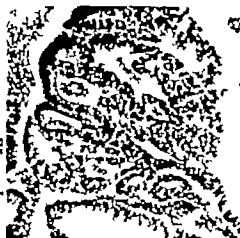


Fig 8.

Fig. 7. Photomicrograph of the third adenoma from the left in the bottom row shown in Figure 6. There is a short stalk over which the normal mucosa extends for a short distance.  $\times 27$

Fig. 8. High power photomicrograph showing histologic carcinoma at the margin of the shallow cleft in the superior surface of the adenoma pictured in Figure 7. The irregular atypical glands are not separated by a limiting membrane. The cells are pleomorphic. The nuclei are hyperchromatic and have large nucleoli.  $\times 100$ .



Fig 9.



Fig 10.

Fig 9. Photomicrograph of an adenoma. There is a broad short stalk covered with normal mucosa.  $\times 3$

Fig 10. High power photomicrograph showing histologic carcinoma in the base of the adenoma pictured in Figure 9. There is little tendency to gland formation and the cells are pleomorphic. The nuclei vary in size and shape and have prominent nucleoli. The cell masses extensively invade the base of the adenoma.  $\times 100$ .

large intestine, step and serial histologic sections of each tumor and the contiguous wall were analyzed. From these histologic observations it was clear that many adenomas exhibited minor variations in structure in different parts rather than a homogeneous picture. Furthermore a few adenomas contained a focus or foci which resembled the structure of carcinoma. These adenomas with foci of carcinoma were considered to represent the

transition stage from benignancy to malignancy.

The establishment of the transition from simple adenoma to carcinoma is relatively difficult. In the manifest or unquestioned carcinoma the diagnosis is readily established by the invasion of the wall of the intestine. In addition to the invasion of the wall the carcinoma is usually characterized by the formation of irregular glands a certain de-



Fig. 11  
Photomicrograph of a small carcinoma not arising in an adenoma.

Fig. 12. High power photomicrograph of the base of the small carcinoma pictured in Figure 11. The glandlike structures have invaded the muscularis mucosae. The lining cells show stratification and a variable nuclear polarity. The cells are hyperchromatic and the nucleoli are large.  $\times 300$



Fig. 13. Photomicrograph of small carcinoma not arising in an adenoma. Note the tumor within a crypt extending through the muscularis into the adjacent fat.  $\times 30$ .  
Fig. 14. High power photomicrograph of small carcinoma shown in Figure 13. The atypical glands show stratification and pleomorphism of the lining cells. The nuclei show variation of polarity. They are hyperchromatic and have prominent nucleoli.  $\times 300$ .

degree of anaplasia of the cells and in some instances invasion of lymphatic and blood vessels. In the diagnosis of carcinoma arising in an adenoma the irregularity of the glands and the anaplasia are of paramount importance since whatever invasion is present is likely to be limited to the stalk. It is well known that some carcinomas of the large intestine simulate the cell arrangement of an adenoma so closely that the diagnosis of a malignant tumor depends entirely on the invasion of the wall of the intestine. Obviously a carcinoma of this type cannot be identified in an adenoma unless there is evident invasion.

In determining the presence of a carcinoma arising in an adenoma in this series, the general criteria suggested by Swinton and Warren have been used. These criteria are the presence of at least two of the following three conditions: (1) anaplasia, (2) irregularity of architecture, and (3) invasion. The anaplasia is characterized by a variation in the size of the cells and nuclei, deep-staining nuclei with prominent nucleoli and the presence of mitotic figures. The irregularity of architecture is characterized by either extensive stratification of cells or by intraglandular budding or by both. In all instances there is marked

# HELWIG EVOLUTION OF ADENOMAS OF LARGE INTESTINE

TABLE III — AGE AND NUMBER OF ADENOMAS

Age group—years	Sex	One	Two	Three	Four	More than four
1-10	M		1			
	F					
11-20	M					
	F	2				
21-30	M					
	F					
31-40	M	4	1	1		
	F		1			
41-50	M	6				
	F	2		6		
51-60	M	14	4			1
	F	7		4		
61-70	M	6				
	F	6	4			
71-80	M	13	4			
	F	5				
81-90	M			1		
	F					

TABLE IV — SITE AND NUMBER OF ADENOMAS

Site	Sex	Intestines with single adenomas	Intestines with multiple adenomas confined one site	Intestines with multiple adenomas confined two contiguous sites	Intestines with multiple adenomas without localities
Cecum	M	7			7
	F	3			8
Ascending colon	M	3			3
	F	4			7
Hepatic flexure	M				0
	F				
Transverse colon	M	7			
	F				8
Splenic flexure	M				7
	F				
Descending colon	M	3			
	F				
Sigmoid colon	M	4		5	6
	F	9			3
Rectum	M			4	5
	F				
Throughout	M				1
	F				

variation in the polarity of the nuclei. The intraglandular proliferation of cells produces glandlike structures and cell masses which are not separated by a limiting membrane. Invasion is recognized when no definite border is apparent between the epithelial cells and the surrounding stroma. Using these criteria as the basis for the determination of the presence of malignancy, all gradations from adenoma with foci of carcinoma to unquestionable carcinoma could be demonstrated (Figs 1 2 3 4 5, 6, 7 8, 9 10).

A factor of primary importance in the histologic diagnosis is the site involved in the transition from adenoma to carcinoma. Some authors believe that the site of transition from adenoma to carcinoma appears first at the tip of the adenoma and others believe it occurs first at the base. In the present study no definite pattern could be established for the occurrence of the foci of carcinoma. In several instances the malignant change occurred at the periphery of the adenoma either at the tip or at the margins. In other specimens the transition occurred deep within the tumor near the stalk and at the base. With this fact established, it is obvious that an accurate

histologic diagnosis demands that an adequate number of sections be observed. The precision of the diagnosis will be proportionate to the care taken in the selection of representative sections. In a few adenomas the gross appearance of a firm solid gray focus was later confirmed histologically as a focus of carcinoma. Otherwise, there were no macroscopic identifying features of the malignant foci.

The smallest adenoma showing malignant change in this series measured 7 by 6 by 3 millimeters, and the largest, 9 centimeters in the greatest diameter. The median of the largest diameter of the tumors was 1.8 centimeters. Saint did not observe malignant change in any adenoma which was smaller than a walnut. In the present series several of the benign adenomas were larger than some of the adenomas with malignant foci. However, the adenomas with malignant foci as a group were larger than the class of benign adenomas.

When the incidence of adenomas and carcinomas in the negro race is contrasted with



Fig. 11.

Photomicrograph of a small carcinoma not arising in an adenoma.

Fig. 12. High power photomicrograph of the base of the small carcinoma pictured in Figure 11. The glandlike structures have invaded the muscularis mucosa. The lining cells show stratification and a variable nuclear polarity. The cells are hyperchromatic and the nucleoli are large.  $\times 60$ .

Fig. 12.

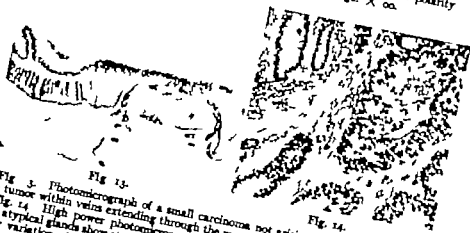


Fig. 13.

Fig. 13. Photomicrograph of a small carcinoma not arising in an adenoma. Note the tumor within veins extending through the muscularis into the adjacent fat.  $\times 3$ .

Fig. 14. High power photomicrograph of small carcinoma shown in Figure 13. The atypical glands show stratification and pleomorphism of the lining cells. The nuclei show variation of polarity are hyperchromatic and have prominent nucleoli.  $\times 60$ .

Fig. 14.

gree of anaplasia of the cells, and in some instances invasion of lymphatic and blood vessels. In the diagnosis of carcinoma arising in an adenoma the irregularity of the glands and the anaplasia are of paramount importance since whatever invasion is present is likely to be limited to the stalk. It is well known that some carcinomas of the large intestine simulate the cell arrangement of an adenoma so closely that the diagnosis of a malignant tumor depends entirely on the invasion of the wall of the intestine. Obviously a carcinoma of this type cannot be identified in an adenoma unless there is evident invasion

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	F				1	
31-40	M		4	1		
	F	1	1			
41-50	M	6				
	F	2				1
51-60	M	14	4			
	F	7				1
61-70	M	6	7		4	
	F	6	4		3	
71-80	M	13	4		3	
	F	5				
81-90	M			1		
	F			1		

variation in the polarity of the nuclei. The intraglandular proliferation of cells produces glandlike structures and cell masses which are not separated by a limiting membrane. Invasion is recognized when no definite border is apparent between the epithelial cells and the surrounding stroma. Using these criteria as the basis for the determination of the presence of malignancy, all gradations from adenoma with foci of carcinoma to unquestionable carcinoma could be demonstrated (Figs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10).

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	F	4			7
Hepatic flexure	M				
	F				
Transverse colon	M	7			
	F				8
Splenic flexure	M				
	F				7
Descending colon	M	3			
	F				
Sigmoid colon	M	14		5	6
	F	9			3
Rectum	M		4		
	F				1
Throughout	M				
	F				

histologic diagnosis demands that an adequate number of sections be observed. The precision of the diagnosis will be proportionate to the care taken in the selection of representative sections. In a few adenomas the gross appearance of a firm solid gray focus was later confirmed histologically as a focus of carcinoma. Otherwise, there were no macroscopic identifying features of the malignant foci.

The smallest adenoma showing malignant change in this series measured 7 by 6 by 3 millimeters, and the largest, 9 centimeters in the greatest diameter. The median of the largest diameter of the tumors was 1.8 centimeters. Saint did not observe malignant change in any adenoma which was smaller than a walnut. In the present series several of the benign adenomas were larger than some of the adenomas with malignant foci. However the adenomas with malignant foci as a group were larger than the class of benign adenomas.

When the incidence of adenomas and carcinomas in the negro race is contrasted with

the incidence in the white race a distinct difference is noted. As previously mentioned only 2.7 per cent of 181 negro patients showed adenomas of the large intestine in contrast with an incidence of 10.5 per cent in the white race. If only those patients over 30 years of age are considered then the contrast of the 3 per cent incidence in the negro race with the 16 per cent incidence in the white race is even greater. Furthermore, in this series of 181 negroes there was not a single instance of carcinoma of the large intestine. Karsner and Clark have analyzed the racial incidence in Cleveland of carcinoma of the large intestine. These authors state that Cleveland is a city with a large negro population, but in only 2 of 100 of their cases in which a note as to color was made was the patient a negro. Thus the data on racial incidence would indicate that both adenomas and carcinomas of the large intestine are uncommon in negroes.

Table V gives by age the incidence of (1) adenomas, (2) adenomas with foci of carcinoma, and (3) manifest carcinomas in the 1,279 white patients in the series covered by the present report. There were 134 patients with adenoma, 10 with adenoma with foci of carcinoma, and 25 with manifest or obvious carcinoma. From the figures in the table it is evident that in each of the three groups there is a greater incidence in the latter decades of the life span.

Among the entire group of 1,460 patients, both white and negro there were 139 large intestines containing adenomas. Of these 139 intestines having adenomas, 10 or 7.2 per cent contained one or more adenomas with malignant transition. In 8 of the 10 intestines the transition to carcinoma occurred in only a single adenoma. In the other 2 intestines, carcinomatous change was present in 2 and 3 adenomas, respectively. Furthermore, 2 of the 10 intestines containing a single adenoma with carcinomatous transition and the one intestine with triple tumors of this type also contained an obvious or manifest carcinoma. When the adenomas with malignant transition and the obvious carcinomas are classed together 4 of the 10 intestines each contained 2 or more malignant tumors. The occurrence of multiple primary malignant tumors has

TABLE V — AGE AND INCIDENCE OF CARCINOMA

Age group	White patients examined	With adenomas		With manifest carcinomas		With carcinoma arising in adenomas		With carcinoma arising direct from mucosa	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
0—	138								
10	79		3						
20	75		1.3						
30	52				5				
41—50	10	0	0		2		4		
51—60	38		7.9	3					
61—70	3	27	6	1					
71—80	68	40	59	6	8.8	6	8.8	1	1
81—90	121	30	24	3			3		2
91—100	81		16.6						
91—100									1

been reported by Warren and Gates and by Brindley. The findings in the present study agree with the concept that the presence of one malignant tumor does not protect against the occurrence of a second malignant tumor and that a patient with a carcinoma is more likely to have a second carcinoma develop than the patient who is free from malignancy.

No informative data are gained from a morphologic study of the 25 examples of manifest carcinoma. In most instances the widespread growth of the tumor had destroyed the initial architecture making it impossible to identify pre-existing adenomas. Swinton and Warren were able to demonstrate that 14 per cent of the carcinomas of the colon arose in benign mucosal polyps and believed the percentage to be much higher.

In the 25 large intestines containing a manifest carcinoma, observed in the present series, there were associated adenomas in 13 instances. In the 10 large intestines containing an adenoma with carcinomatous transition there were associated adenomas in 8 instances. A comparison of the 25 cases of manifest carcinoma with the 10 cases of adenoma with carcinomatous transition shows that both groups were associated with additional adenomas in over 50 per cent of the cases. This common association is denied by Saint, who

# HELWIG EVOLUTION OF ADENOMAS OF LARGE INTESTINE

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stated that the two conditions are not frequently found in the same intestine. However, the figures in the present study lend support to the concept of an intimate association between adenomas and carcinomas.

TABLE VI — SITE AND INCIDENCE OF CARCINOMA

Site	Manifest Carcinoma	Carcinoma arising in adenoma	Carcinoma arising direct from mucosa
Cecum	3		
Ascending colon	4	3	
Hepatic flexure	1		
Transverse colon	1		
Splenic flexure			1
Descending colon	10	7	1
Sigmoid colon	6	3	
Rectum			

Another important factor is the correlation between the distribution of the manifest or unquestioned carcinomas and the adenomas with carcinomatous transition. In this paper tumors which occurred within 15 centimeters of the mucocutaneous junction of the anus are designated as rectal. As would be expected difficulty was encountered in determining exactly the site of carcinomas situated at the junction of two segments. If over 50 per cent of a tumor was located in a given segment it was then assigned to that segment. The inability to identify correctly the segment in which the tumor is located probably explains the variation in the distribution of carcinomas of the large intestine as recorded in the literature. It was previously shown that the sigmoid colon is the most common site of benign adenomas. From Table VI it is evident that the sigmoid colon is also the most common site of adenomas with carcinomatous transition and of the manifest carcinomas. Likewise benign adenomas adenomas with malignant transition and manifest carcinomas frequently involve the rectum, cecum and ascending colon and less frequently the flexures, transverse colon and descending colon. Thus the distribution of the tumors is another line of evidence of the intimate relationship between adenomas and carcinomas.

The incidence of adenomas is slightly more common in men than in women. In the group of 25 patients with manifest carcinoma 15 were men and 10 were women. Of the 10 patients with adenomas showing foci of carcinoma 7 were men and 3 women. Since the ratio of men to women in the entire series of patients was 17:1 there were no significant sex differences in the three groups.

## CARCINOMA ARISING DIRECTLY FROM THE MUCOUS MEMBRANE

Although there is much evidence that many carcinomas of the large intestine develop in previously existing adenomas, some carcinomas undoubtedly arise directly from the

mucosa. In the present study two small or histologic carcinomas without morphologic evidence of a pre-existing adenoma were encountered. These small carcinomas contribute informative material for study which cannot be gained from carcinomas of advanced state. Both of the tumors occurred in men. One of the carcinomas was located in the distal part of the descending colon and the other occurred in the distal part of the sigmoid colon. In neither instance were adenomas present anywhere in the large intestine. The smaller of the two tumors located in the sigmoid colon appeared as a moderately firm gray sessile elevation with a slightly depressed center. The diameters of the tumor were 6 by 3 millimeters and the height, 2 millimeters. The larger tumor was situated in the descending colon. It appeared as a firm gray sessile elevation with a slightly irregular surface. The diameters of the tumor were 11 by 13 millimeters. The periphery of the tumor was elevated up to 2 millimeters in height and the central area was slightly depressed. A transverse section of this tumor revealed gray streaks extending into the underlying submucosa and muscularis.

The microscopic characteristics of these tumors are illustrated in Figures 11, 12, 13 and 14. A small segment of the mucous membrane contains a number of abnormal glands. However not all of the glands within the given segment are altered. Thus, one or several abnormal glands are interspersed among essentially normal ones. The outstanding feature of the abnormal glands is the change in the character of the lining cells. This change may involve all of the cells lining a gland or only a few of them. The definition between the normal cells and the abnormal is occasionally abrupt. The altered cells are enlarged



## SURGERY GYNECOLOGY AND OBSTETRICS

TABLE V — AGE AND INCIDENCE OF CARCINOMA

Age group	All white patients included	With adenomas		With associated carcinoma		With carcinoma arising in adenoma		With carcinoma arising in adenoma	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
0-	18								
10	79								
20	73	3							
30	8	3							
40	10	2		5					
41-50	18			7	3				
51-60	52	17	33	5					
61-70	58	40	69	5	8	6			
71-80	24	20	83	3					
81-90									
91-100	4	3	75						

the incidence in the white race a distinct difference is noted. As previously mentioned only 2.7 per cent of 181 negro patients showed adenomas of the large intestine in contrast with an incidence of 10.5 per cent in the white race. If only those patients over 30 years of age are considered then the contrast of the 3 per cent incidence in the negro race with the 16 per cent incidence in the white race is even greater. Furthermore in this series of 181 negroes there was not a single instance of carcinoma of the large intestine. Karner and Clark have analyzed the racial incidence in Cleveland of carcinoma of the large intestine. These authors state that Cleveland is a city with a large negro population but in only 2 of 100 of their cases in which a note as to color was made was the patient a negro. Thus the data on racial incidence would indicate that both adenomas and carcinomas of the large intestine are uncommon in negroes.

Table V gives by age the incidence of (1) adenomas (2) adenomas with foci of carcinoma and (3) manifest carcinomas in the 1,279 white patients in the series covered by the present report. There were 134 patients with adenoma, 10 with adenoma with foci of carcinoma, and 25 with manifest or obvious carcinoma. From the figures in the table it is evident that in each of the three groups there is a greater incidence in the latter decades of the life span.

Among the entire group of 1,460 patients, both white and negro there were 139 large intestines containing adenomas. Of these 139 intestines having adenomas, 10 or 7.2 per cent contained one or more adenomas with malignant transition. In 8 of the 10 intestines the transition to carcinoma occurred in only a single adenoma. In the other 2 intestines carcinomatous change was present in 2 and 3 adenomas, respectively. Furthermore 2 of the 10 intestines containing a single adenoma with carcinomatous transition and the one intestine with triple tumors of this type also contained an obvious or manifest carcinoma. When the adenomas with malignant transition and the obvious carcinomas are classed together 4 of the 10 intestines each contained 2 or more malignant tumors. The occurrence of multiple primary malignant tumors has

been reported by Warren and Gates and by Brindley. The findings in the present study agree with the concept that the presence of one malignant tumor does not protect against the occurrence of a second malignant tumor and that a patient with a carcinoma is more likely to have a second carcinoma develop than the patient who is free from malignancy.

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but not uniformly so and the cytoplasm stains intensely. The nuclei generally exhibit an appreciably greater enlargement than do the cells and are distinctly hyperchromatic. The nucleoli are likely to be enlarged and prominent. A survey of several cells shows a conspicuous variation of the nuclear polarity which contrasts sharply with the basal arrangement of the nuclei of the normal cells. A number of mitotic figures are noted. However the presence of mitotic figures is of questionable significance because mitosis is a common occurrence in normal mucosa. Not uncommonly there is true stratification of the abnormal epithelial cells and occasionally intraglandular budding. In the smaller tumor the atypical glands extend downward to interrupt the muscularis mucosae. In the larger tumor the invasion is much more evident. The atypical glands have infiltrated the submucosa and extend through the muscularis into the subserosal fat. A lymph node in the subjacent fat is free from tumor. However the submucosal veins and lymphatics not only beneath the tumor but also beneath the contiguous normal mucous membrane are filled with neoplastic cells. In the smaller tumor there is a slight increase in the amount of the submucosal connective tissue which is relatively dense. The larger tumor shows a much greater increase in the amount of connective tissue and the density varies in different fields. In most fields where the tumor has infiltrated the desmoplastic quality of the tumor is demonstrated. Both of these tumors have in common many abnormal histologic and cytologic changes. In the smaller tumor the degree of invasion is slight but in the larger tumor it is unquestionable. It seems logical therefore, in view of the common cytologic and histologic alterations, to regard both tumors as carcinomas. Moreover it seems fair to consider the incipient invasion present in the smaller tumor as the initial stage in the development of unquestioned invasion. In neither carcinoma was it possible to demonstrate the structure of an adenoma. It is conceivable that a pedunculated adenoma with malignant transition existed at one time and subsequently became torn from its attachment to the colon by peristaltic action.

However in the absence of such proof it seems reasonable to conclude that these two carcinomas arose directly from the mucosa and not through the evolution of an adenoma.

In brief then small or histologic carcinoma of the large intestine occurred in 12 of the 1,460 patients in this series. On the basis of the evolution of these carcinomas, the patients can be divided into two groups.

In the first group are those patients in whom the carcinoma developed in an adenoma. There were 10 patients with tumors of this type. In 8 of these 10 the large intestine contained a single tumor, one intestine contained two tumors and another three tumors. Three of the 10 large intestines with carcinoma present in an adenoma also showed an obvious or manifest carcinoma, and all but 2 contained benign adenomas elsewhere in the large intestine.

In the second group are those patients in whom the carcinoma developed direct from the mucosa and not in an adenoma. There were 2 patients with tumors of this type. In both instances the carcinomas were single lesions and in neither instance were there adenomas or carcinomas elsewhere in the large intestine.

When both groups are considered together 4 of the 12 large intestines presented solitary tumors. In 2 cases the tumor was a carcinoma arising in an adenoma and in 2 a carcinoma arising direct from the mucous membrane. The large intestine of each of the remaining 8 patients contained at least one instance of a carcinoma arising in an adenoma and in addition either benign adenomas, a manifest carcinoma or both. In the study of 25 patients with manifest carcinoma in this series, there were either benign adenomas or adenomas with malignant transition present elsewhere in the large intestine in 13 instances. In the other 12 intestines a carcinoma was the only tumor present. Thus, both in the group of histologic carcinomas and in the group of manifest carcinomas there were other tumors of glandular origin present in over 50 per cent. The group of 12 small or histologic carcinomas does not constitute a large number of cases. Of the 12 patients, the carcinomas in 10 arose in an adenoma and in the other 2 arose direct

from the mucous membrane. If this small group is representative of the evolution of carcinoma of the large intestine in general then the majority of carcinomas of the large intestine develop in adenomas.

#### SUMMARY AND CONCLUSIONS

1 Adenomas of the large intestine are true neoplasms and not a reaction consequent to a diffuse inflammatory process.

2 The incidence of adenomas of the large intestine increases with age. An appreciable increase in the incidence begins in the fourth decade and reaches a maximum (24 per cent) in the eighth decade.

3 Adenomas are more common in the white race than in the negro race.

4 Adenomas are slightly more frequent in men than in women in all sites of the large intestine.

5 In the series here reported on 58 per cent of the patients with adenomas had single tumors. Single adenomas are more common in women (63 per cent) than in men (55 per cent).

6 Multiple adenomas are as common in the fourth decade as in the eighth decade of life in those patients who have adenomas.

7 Inflammation, hemorrhage and hemodesis are commonly observed in the larger adenomas.

8 The incidence and distribution of adenomas of the large intestine have been carefully determined in 1,460 consecutive autopsies. Histologic evidence and cytologic evidence have been presented to the effect that adenomas of the large intestine undergo malignant transition.

9 Collateral evidence of the intimate relation of adenomas to carcinomas of large intestine is cited. In this series both adenoma with malignant transition and manifest or unquestioned carcinoma are more common in the older age groups. Likewise, both adenoma with malignant transition and unquestioned carcinoma show similar sites of predilection in the large intestine.

10 Two carcinomas arising directly from the mucous membrane are described.

11 Some carcinomas of the large intestine arise directly from the mucous membrane but the majority develop in adenomas.

#### REFERENCES

1. BARGEN, J. A., CROMAN, C. D. L. and DIXON, C. F. *Arch. Surg.* 1941, 43, 192-208.
2. BARGEN, J. A., and COMFORT, M. W. *Ann. Int. M.*, 1930, 4, 122-133.
3. BRINDLEY, G. V. *South. M. J.* 1938, 31, 355-362.
4. BROOKES, A. C. *J. Am. M. Ass.*, 1932, 99, 1670-1674.
5. DAVID, V. C. *Arch. Surg.* 1940, 41, 257-286.
6. DUKES, C. *Brit. J. Surg.* 1925, 13, 720-733.
7. ERDMANN, J. F. and MORRIS, J. H. *Surg. Gyn. Obst.*, 1925, 40, 460-468.
8. FITZPATRICK, G. and RANKIN, F. W. *Surg. Gyn. Obst.* 1931, 52, 1136-1150.
9. HAUSER, G. *Arch. path. Anat. Physiol.* 1894, 138, 482-499.
10. HELWIG, E. B. *Surg. Gyn. Obst.* 1943, 76, 419-426.
11. KARNER, H. T. and CLARK, B. JR. *Am. J. Cancer* 1932, 16, 933-970.
12. LAWRENCE, J. C. *Am. J. Surg.*, 1936, 51, 499-505.
13. LOCKHART MUMFORD, J. P. *Diseases of Rectum and Colon*. 2nd ed. Baltimore: Wm. Wood & Co. 1934.
14. SAINTE, J. H. *Brit. J. Surg.* 1928, 15, 99-119.
15. SCHILLER, W. *Virchows Arch.*, 1927, 263, 279-367.
16. SCHMIDTKE, V., and WESTHUES, H. *Deut. Zchr. Chir.*, 1927, 202, 1-124.
17. SUTMAN, W. *J. Path. Bact., Lond.*, 1932, 35, 29-33.
18. SWINTON, N. W. and WARREN, S. *J. Am. M. Ass.* 1930, 113, 1927-1933.
19. VERSE, *Verhandl. Deut. path. Ges.* 1908, 12, 95-99.
20. WARREN, S., and GATES, O. *Am. J. Cancer* 1932, 16, 1358-1414.
21. WOODWARD, J. J. *Am. J. M. Sc.*, 18, 81, 142-155.

# SURGICAL FUSION OF THE VERTEBRAL ARTICULAR FACETS TECHNIQUE AND INSTRUMENTS EMPLOYED

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**C**OMPLETE bony fusion of the vertebral articular facets prevents motion of the spinal column. When these facets are fused by surgical methods and the added support of massive bone grafts is employed fixation of great strength results. In previous publications (1-3) I have illustrated the method I employed in producing adequate strength in the fused areas to withstand the stress and strain on the spinal column in action. In the past 3 years I have designed several new instruments (4) and improved the technique of fusion of the facets sufficiently to make it appear advisable to describe the method now employed. It has been obvious that there is considerable interest in this method and the results obtained from it.

In the past I have employed fusion of the intervertebral articular facets in addition to massive autogenous bone grafts with excellent results. It is now my belief that a thorough

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bony fusion of the intervertebral articular facets themselves may provide adequate fixation.

By far the greatest difficulty encountered in fusion of the facets results from inadequate exposure of the parts to be fused. In order that the surgeon may see the facets, the incision should be ample, the spinous processes and laminae thoroughly denuded, and the erector spinae muscles retracted laterally. Many retractors have a tendency to slip from the muscles and, if this occurs, it is impossible to gain access to the articular facet. Therefore, retractors of varying widths have been designed which are deep enough to reach into the depths of the wound easily; the retractor edges have short teeth bent toward the handle (Fig. 1). With such instruments it is possible to grasp the tissues, capsule, and muscle and retract them laterally well away from the lamina and maintain exposure of the facet.

It is not always easy to recognize the articular facets even when they are exposed prop-

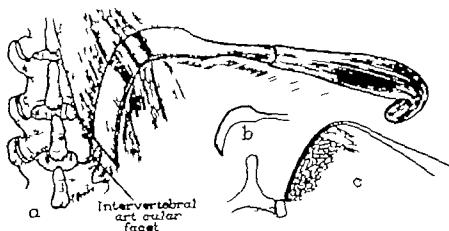


Fig. 1. Newly designed laminectomy retractor demonstrating exposure of intervertebral articular facet. *b*, Retractor showing toothed edge. *c*, Interarticular facet exposed by retraction of the capsule and muscles, laterally.

erly, for the articular spaces are narrow and sometimes are placed well laterally. The joints may be demonstrated by moving the spinous processes of the vertebrae with a forceps, thus disclosing the gliding articular surfaces. When the joints have been identified a sharp chisel is used to scrape the laminae from the bases of the spinous processes outward; this scraping turns up small shavings of bone and destroys the capsules and the posterior portions of the intra articular facets. This first stage of the operation may be sufficient in many cases to produce fusion of the facets and it was the method which was formerly employed.

The facets are true articular surfaces and it is wise to destroy them to obtain thorough bony fusion of the joint. It is necessary to have a narrow instrument to accomplish this and I formerly used a small curette. I have designed and now use a narrow chisel or a specially made sawlike eroder. No matter what type of instrument is used the cutting end absolutely must be controlled lest there be injury to the nerve tissues.

I have found a narrow bladed chisel,  $\frac{1}{16}$  inch by 10 inches (0.16 by 25.4 cm.) and strong enough to withstand the force required to enter the articular interspace (Fig. 2a) of considerable value in eroding the articular surfaces. To erode the facets the chisel is dug into the joint interspace and the debris is forced forward and outward as illustrated in Figure 2b. Bone chips then can be forced downward into the eroded interspace as shown in Figure 2c.

Recently I designed a small curved toothed saw which can be used to erode the articular surfaces of the facets even more efficiently than can the chisel (Fig. 3). The teeth are offset and the cutting edge is curved slightly. When the saw is turned slightly in the joint and is dragged toward the surgeon it is found that the erosion of a facet is accomplished in a few strokes (Fig. 4). The instrument has a large enough handle so that it permits abso-

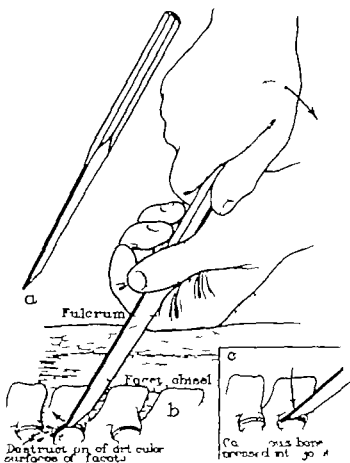


Fig. 2. a. Narrow chisel, 10 inches (25.4 cm.) long and  $\frac{1}{16}$  inch (0.16 cm.) wide. b. Chisel being used to destroy joint surfaces of vertebral articular facets. c. Chisel forcing bone chips into the eroded interspace.

lute control of the cutting edge by the surgeon.

Erosion of the articular surfaces is carried out bilaterally throughout the part of the spinal column that is to be fused. The bone shavings which were turned from the laminae and cancellous bone from the tibia then are forced into and piled about the destroyed facets. When the muscles are allowed to relax they cover the region and tend to hold the fragments of bone in position and a mass of new bone forms. When the procedure which has just been described is carried out firm fusion results. When it is employed in addition to massive bone grafts, it materially aids in the success of producing fusion of great strength (Fig. 5 left and right).

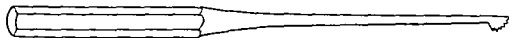


Fig. 3. Bone saw facet eroder 10 inches (25.4 cm.) in length. Teeth are offset so as to cut a groove  $\frac{1}{16}$  inch (0.16 cm.) in width.

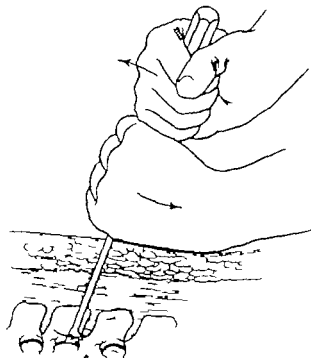


Fig. 4. Bone saw facet eroder inserted into the vertebral articular facet and cutting out the joint surfaces.

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#### REPORT OF CASES

**CASE 1:** A nurse, 40 years of age, came to the Mayo Clinic because of intermittent low back pain of about 20 years duration. Coughing, sneezing, lifting, and stooping aggravated the pain and left sciatic pain developed and persisted for 6 months. Because of the pain it became necessary for her to

give up nursing about 3½ years before admission and do clerical work. In the 4 months prior to her admission symptoms became more severe.

On examination the patient was found to be a well developed and well nourished woman with limitation of forward and lateral bending of the spinal column. The knee and ankle reflexes were normal. Roentgenologic examination disclosed narrowing of the fourth and fifth and lumbosacral interspaces with hypertrophic changes, some lumbar scoliosis and a slight defect due to spina bifida at the first sacral vertebra (Fig. 6). The history and examination suggested the possibility of protruded intervertebral disc. A spinogram showed slight posterior displacement of the air column opposite the fourth lumbar interspace consistent with protrusion of an intervertebral disc at this level. The consulting neurosurgeon and orthopedist conferred and decided to perform laminectomy to explore the fourth and fifth lumbar interspaces for a possible protrusion of the intervertebral discs and if necessary to fuse the third, fourth and fifth lumbar vertebrae and sacrum.

Operation was performed on July 30, 1945. Partial laminectomy and decompression of the cauda equina with bilateral resection of the fourth and fifth lumbar ligamenta flava were performed. The findings at the fifth lumbar interspace were not abnormal. At the fourth lumbar interspace the ligament was abnormally thickened and the nerve root was more hyperirritable on the left side than on the right. The partial laminectomy thoroughly unroofed the hyperirritable nerve roots. A distinct ridge of bone extended across the fourth interspace but the intervertebral disc was not protruded. Then the spinous processes and laminae of the third, fourth, and fifth lumbar vertebrae and upper two segments of the sacrum were scarified. Bilateral fusion of the interarticular facets was performed and bone grafts were inserted on each side. Bone chips and cancellous

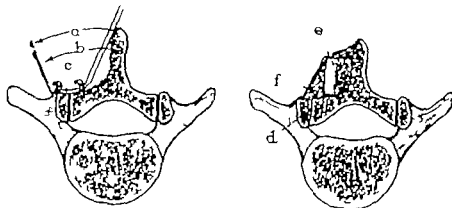


Fig. 5. Left, a, Tip and lateral portion of spineous process chiseled off and displaced laterally. b, Chisel turning bone chips laterally from the lamina and eroding the facet posteriorly. c, Facet exposed. Right, d, Eroded facet with bone chips inserted. e, The bone graft with cancellous portion of bone against roughened surface of the spineous process and lamina. f, Multiple bone chips inserted about the graft. Multiple bone chips packed above facet and between the bone graft and displaced fragment of spineous process.



Fig. 6.

Fig. 6. Case 1. Anteroposterior view. Rotation has brought out the facets on the right side.

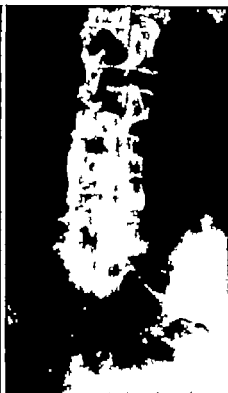


Fig. 7.

Fig. 7. Case 1. Postoperative anteroposterior roent-



Fig. 8.

genogram view 8 months later.

Fig. 8. Case 1. Lateral view showing firm fusion of the graft which extends well down on the sacrum.



Fig. 9.

Fig. 9. Case 2. Anteroposterior view of the spinal column and pelvis discloses a congenital large spina bifida occulta involving the fifth lumbar and first sacral vertebrae, and spondylolisthesis, grade 2 of the fifth lumbar vertebra on the sacrum with separation of the neural arch.

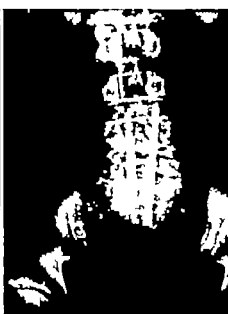


Fig. 10.

Fig. 10. Case 2. Anteroposterior view of lumbar portion of the spinal column and pelvis 5 1/2 months after operation. Double bone grafts have fused the third, fourth, and fifth



Fig. 11.

lumbar vertebrae. Grafts extend down onto the upper segments of the sacrum, bridging the spina bifida occulta of the fifth lumbar and first sacral vertebrae. The facets have been fused as shown in this roentgenogram.

Fig. 11. Case 2. Lateral view 5 1/2 months after operation showing the spondylolisthesis of the fifth lumbar vertebra on the sacrum. The bone graft covers third, fourth and fifth lumbar vertebrae and upper half of sacrum.



bone obtained from the tibia were packed at the ends and under the grafts to make better contact.

Convalescence was uneventful and the patient was dismissed from the hospital on the thirtieth postoperative day at which time she was wearing a lumbosacral corset. She returned to her home physician for further observation.

The patient returned to the Clinic 8 months after operation. She stated that she felt better than at any time in the past 20 years. She had gained 8 pounds (3.6 kgm) and had no backache. Roentgenograms showed that firm fusion of the bone grafts and fusion of the articular facets had occurred (Figs. 7 and 8).

**CASE 2.** The patient registered at the Mayo Clinic for the first time in 1940 when appendectomy was performed. He complained of backache and pain in the right hip of 2 years' duration and a diagnosis of spondylolisthesis was made at that time.

The patient was seen again at the Clinic in June, 1945, and in spite of the use of a lumbosacral support and other conservative treatment he still complained of backache and of pain in the left hip. These symptoms were aggravated by standing and the pain was projected to the calf of the left leg. It was suspected that possibly a protruded intervertebral disc complicated spondylolisthesis (2). Roentgenograms disclosed spondylolisthesis grade 2 (on a grading basis of 1 to 4 in which 1 represents the mildest and 4 the

most severe form) of the fifth lumbar vertebra on the sacrum separation of the neural arch and a large spina bifida occulta involving the fifth lumbar vertebra and the sacrum (Fig. 9). Following neurologic and orthopedic consultation a combined operation was recommended. The neurologic surgeon explored the fourth and fifth lumbar interspaces after left laminectomy. Nothing abnormal was observed. Bone grafts were inserted on each side to include the third, fourth and fifth lumbar vertebrae and sacrum, the facets of the third, fourth and lumbosacral vertebrae were fused and multiple bone chips were inserted about the grafts.

The patient left the hospital on the twenty-eighth postoperative day. At that time he was able to walk, and the wounds were healed and in good condition. This patient was seen 5½ months later when he drove his automobile from his home community to Rochester for physical examination. Roentgenograms showed that the bone grafts were firmly fused (Figs. 10 and 11) and the facets were fused. He was advised to return gradually to further activity.

#### REFERENCES

- METZGER, H. W. *Surg. Gyn. Obst.*, 1932, 54: 377.
1. *Idem.* *J. Bone Surg.* 24, N.S. 23: 461-470.
2. *Ibid.* 1943, N.S. 3: 65-77.
3. *Idem.* *Am. J. Surg.* 94:5, 2: 67-572.

# AXILLARY APPROACH TO SCHEDE THORACOPLASTY

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**I**N the treatment of chronic empyema Schede thoracoplasty has been utilized for those infections in which the visceral pleura has failed to re-expand sufficiently to approximate the parietal pleura and in which the parietal pleura has been sufficiently rigid to prevent its approximation to visceral pleura. Schede thoracoplasty consists of mass excision of chest wall including thickened parietal pleura, ribs, rib beds, intercostal muscles, nerves, and vessels overlying the extent of the infected space to allow the fresh extrathoracic muscle tissues to fall in and obliterate the infected space.

As originally described by Schede and the earlier writers the posterior approach was advocated to visualize the ribs overlying the cavity. Through a paravertebral right angle or hockey stick incision the trapezius and rhomboid muscles were divided posteriorly and the incision continued laterally around the tip of the scapula and brought forward dividing the latissimus dorsi posteriorly. The scapula was then retracted anteriorly and the ribs, parietal pleura, and intercostal muscles resected posteriorly and as far forward as the space extended to unroof the cavity. Following this the scapula and extrathoracic muscles fell in to fill the space previously covered with parietal pleura.

Employment of the posterior approach for Schede thoracoplasty is accompanied by complications of wound healing and infection that become apparent in any experience with the operation. If the posterior wound which is exposed to infection is closed tight, any movement of the scapula will tend to reopen the wound or weaken the suture line to cause sinus formation with possible breakdown of the entire wound from the adjacent infection beneath. Similarly, the latissimus dorsi muscle, which must be divided and exposed to infection will as a result, atrophy below the incision and will form a much less healthy

muscle for muscle graft at a later date. If the entire wound is packed and not closed the scapula will remain as a movable bone separated from its muscular attachments posteriorly. Between this bone and the spine will remain a sinus or groove of infection which must heal before the space can be obliterated. Also the wound, as estimated by the exposed surface is sizable and healing will take a correspondingly long time.

Such complications have been largely eliminated since the axillary approach to Schede thoracoplasty has been employed. The incision is so placed that pectoralis major and latissimus dorsi muscles are both preserved without impairment of blood supply. After the vertical incision has been made in the midaxillary line, these muscles are retracted anteriorly and posteriorly on either side of the incision so that both anterior and posterior segments of ribs are easily reached. The chest wall to be removed is excised from below upward beginning at the diaphragm. If the empyema is a complete one, and proceeding toward the apex of the pleural cavity. The approach to the pleural space is direct with minimal damage to extrathoracic muscles which may be useful later for muscle implantation. The incision itself is smaller, and there is not the large residual wound that occurs when posterior paravertebral hockey stick approach is used. Motion of the scapula postoperatively has little tendency to open the wound nor does infection tend to burrow beneath the scapula to form sinuses that may develop in the posterior approach after the wound is sewed up. Drainage ideally is placed directly in the center of the wound in the midaxillary line and will be dependent for the space that is being unroofed.

When preliminary thoracotomy is necessary in chronic empyema it should be performed through the midaxillary line at the most dependent portion of the pleural space. If the empyema is complete drainage is made at the junction of the diaphragm with chest wall

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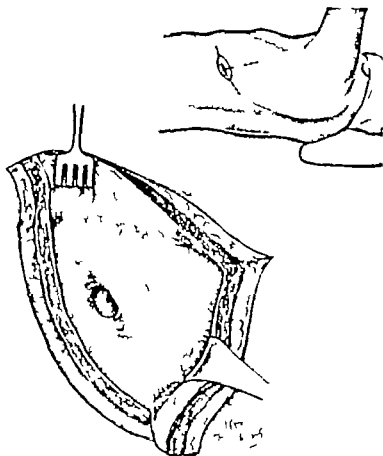


Fig. Insert shows patient placed on the operating table with the arm elevated and suspended for an axillary approach to the chronic empyema. The tube has been removed from the lower thoracotomy opening which was placed at the most dependent site of the empyema cavity in the midaxillary line. The small opening above the thoracotomy opening represents sinus at the site of the previous empyema necessitatis. T-shaped incision for the first stage Schede thoracoplasty operation is made at the dotted line extending toward the extrapleural thoracoplasty scar posteriorly.

Main picture shows T incision deepened to separate the pectoralis major from the latissimus dorsi muscles. The midaxillary line. The thoracotomy opening into the pleural space is shown extending through the plaque of regenerated ribs which has formed since previous extrapleural thoracoplasty.

Such drainage is so placed as to allow easy access to the pleural space at the time of Schede operation and to preserve musculature posteriorly. Thoracotomy is performed with removal of segments of two ribs underlying parietal pleura. Intercostal muscle and rib bed are excised to allow a large opening. Thus if delay in the Schede thoracoplasty occurs the thoracotomy opening will remain adequate in spite of the tendency of the chest wall to contract with closure of the opening. Removal of the rib bed minimizes regeneration of rib at thoracotomy

site and simplifies the initial step later in Schede procedure.

At a suitable date following Schede thoracoplasty is performed with the patient lying on the good side with the affected side up and arm abducted and elevated over the head. The arm is suspended by means of a bar over the patient's head which exposes the axilla and retracts the axillary vessels upward to allow easy access to the apex of pleural cavity.

A transverse incision is then made at the base of the pleural space to include the thorax

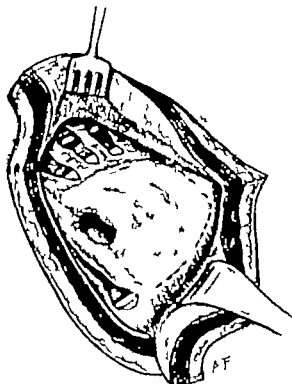


Fig. 2.

Fig. 2. Beneath the thoracotomy opening the 10th rib has been resected as have the costal cartilages of the 9th, 8th, and 7th ribs anteriorly. Dotted line outlines the limits of the underlying pleural space that is to be unroofed at this stage operation. Note that the costal cartilages have been removed an inch beyond the extent of the pleural space to allow gradual falling in of the tissues adjacent to the pleural space.

Fig. 3. Dotted line outlines the plaque of regenerated ribs, parietal pleura, and intercostal muscles that is to be removed at first stage operation. This is best performed with double action rib cutter and blunt scissors. Sharp rake retractor or hook will control the tissue to be removed, which in some cases may be over 2 inches in thickness.

Fig. 4. Pleural plaque is divided anteriorly and posteriorly care being taken to clamp intercostal vessels posteriorly as they are encountered to avoid unnecessary hemorrhage. Anterior vessels usually do not bleed sufficiently to require hemostasis. Forming the base of the saucerized space are the diaphragm below, the pericardial pleura anteriorly and collapsed lung covered by visceral pleura extending upward from the diaphragm. Note anteriorly the small edge of parietal pleura at the re-entrant angle of pericardium with chest wall which has been removed in Figure 3 to allow even approximation of tissues.

cotomy opening. The ribs beneath the opening into the pleural space are removed subperiosteally. These may lie horizontally in which case it may be necessary to remove only one rib. Usually however the ribs are situated more vertically so that segments of several must be removed to allow the tissues immediately beneath the thoracotomy opening to fall

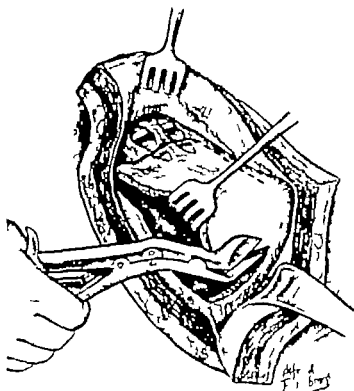


Fig. 3

in gradually. With the finger in the drainage opening it is possible to outline exactly where the parietal pleura, intercostal muscles and

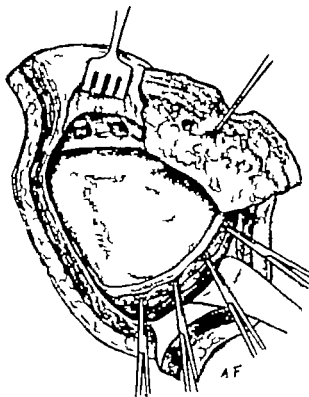


Fig. 4

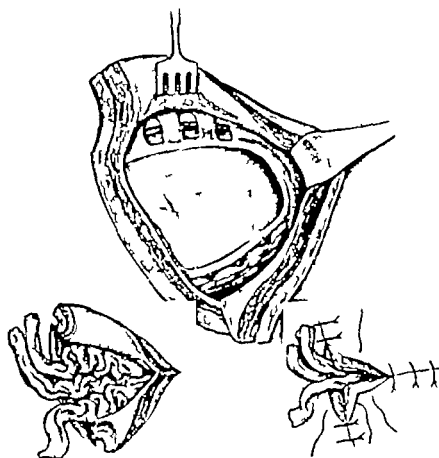


Fig. 5. The bevelled edge of parietal pleura is clearly demonstrated anteriorly and posteriorly. The remainder of the chest wall is left for the next stage of the operation. Packing placed in the pleural space walls off the freshly divided muscle planes and prevents extension of infection to newly exposed tissues. A few through-and-through stitches are sufficient to approximate the tissues and minimize the external wound surface.

rib beds are to be resected and to judge accordingly how far the ribs overlying solid tissue should also be removed.

A vertical arm is then extended upward in the midaxillary line toward the apex of the axilla. This is deepened down to the ribs underneath dividing serratus anterior fibers and the axillary tissues to separate the pectoralis major or anteriorly from the latissimus dorsi posteriorly. The tissues on either side of the incision are then retracted to expose the underlying ribs without damage to the muscles. With the index finger in the drainage site the outline of the pleural cavity is again defined and small segments of ribs are removed anteriorly and posteriorly at the re-entrant angle of the parietal pleura beneath. After such segments are

resected the large piece of chest wall is then removed with the help of large blunt scissors extending upward as far as is feasible without change in the patient's condition. Care must be taken during this part of the procedure to clamp the intercostal vessels posteriorly as they are met. A straight Kocher clamp is best utilized for this purpose. If these are not applied until the tissue is removed the patient will have lost a considerable amount of blood, which can be avoided by immediate application of the clamps. Not only should the ribs be removed beyond the limits of the empyema space but the parietal pleura should be leveled so that no ledge of tissue remains to form a groove and prevent approximation of fresh tissues with underlying visceral pleura.

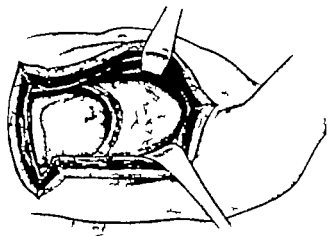


Fig 6 The ease of approach is clearly shown in this picture. At the second stage operation the wound is reopened and the axillary arm of the incision extended upward toward the apex of the pleural space. Dotted line represents the tissue to be removed overlying collapsed lung. Pectoralis major and latissimus dorsi muscles have been preserved and are retracted on either side.

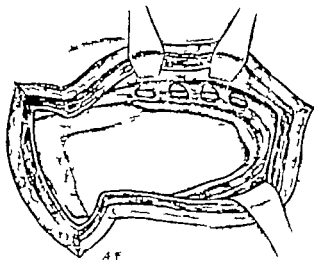


Fig 7 Segments of ribs again are removed anteriorly beyond attachment of visceral pleura to chest wall. Bleeders are clamped and tied posteriorly as they are encountered. Overlying ledge of parietal pleura must be excised as failure to do this is frequent cause of persistence of residual space.

In cases in which an extrapleural thoracoplasty has been performed before starting the Schede procedure the regenerated ribs and rib beds overlying the pleural space will consist of a rarefied mass of bone that has become confluent to form an irregularly solid bony plaque. In the past the Schede operation used to be performed by an attempt first to remove the regenerated plaque from the underlying pericosteum and parietal pleura which was followed, if necessary, by resection of the thickened pleura. As the pleura almost always had eventually to be removed and in order to avoid the formidable bleeding that is encountered in that procedure initial resection is now employed to excise the chest wall *en masse* without any attempt first being made to separate regenerated bones from parietal pleura.

As in the operation where extrapleural thoracoplasty has not been first employed the extent of the pleural space is estimated with the finger in the drainage site and ribs, pleura bony plaque and intercostal muscles are divided with the rib cutter and blunt scissors. Difficulty may be encountered in visualizing the tissues during this operation. The superficial chest wall muscles should therefore be separated by sharp dissection from their attachments to the regenerated ribs during which procedure almost no bleeding will be encountered. A sharp rake retractor may then be

hooked into the pleural mass which will control the tissue and allow the operator to visualize the intercostal bleeders as they are encountered. Again importance is laid on immediate clamping of these vessels as they will not stop bleeding on removal of adjacent bone.

As in any serious operation on a debilitated patient constant attention should be paid to the general condition of the patient during the operative procedure. In the Schede operation the best index of the patient's condition is the pulse. A sharp rise of pulse even without corresponding fall in blood pressure should suggest to the operator an early termination of the operation. The operation itself should never be performed without ample amounts of blood frequently as much as 1500 to 2500 cubic centimeters of blood being given at a single stage operation. A gradual rise of pulse during the operation indicates a pause in the operative procedure while more blood can be administered and the patient's condition improved. Occasionally a patient's pulse is rapid before the operation is begun. In such cases blood should be running into the patient's veins before any incision is made and provided the pulse remains elevated a very small amount of surgery should be attempted at that stage. Thus the operator is in constant touch with the anesthetist and can judge the amount of surgery to which the patient is to be subjected.

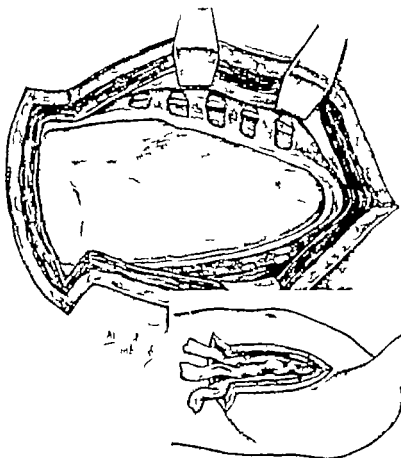


Fig. 8. Final stage of the procedure shows completed operation with parietal pleura, intercostal muscles, vessels, nerves, and ribs removed to unroof the underlying infected pleural space. Beveling of parietal pleura is shown up to the apex for even approximation of tissues. Packing will be removed after tissue planes are walled off and allow extrathoracic tissues to fall in on the visceral pleura of collapsed lung and obliterate the empyema space.

It usually requires two operations before a complete removal of chest wall can be effected although as many as six or more have been performed in patients in extremely poor condition. Since the procedure has been staged, severe postoperative reactions have been minimized and mortality markedly diminished. In earlier cases when the blood pressure was used as an indicator of the amount of surgery that should be given a patient, the patient's condition seemed satisfactory on leaving the operating table but was soon followed by a state of deep shock from which it was difficult to arouse the patient.

Patients with chronic empyema of any standing are notably debilitated. Not only are they underweight, chronically ill and with a ten-

dency to be anemic, but also they show a lack of normal blood volume which may account in large part for their inability to stand surgery of any degree. Individual patients will differ in this regard however and without careful studies it is difficult to predict in advance the response an individual will show. The importance of bearing in mind the various factors that may influence the patient's condition cannot be overemphasized as the amount of surgery that is performed will always depend in large measure on how much the patient can stand.

Finally axillary approach is well adapted for quick closure when it is necessary to terminate the operation. In contrast with the axillary wound the posterior approach must be

sutured in layers in order to effect tight closure. This step requires more time and must be considered in estimating the amount of surgery that can be performed.

Three or four through and-through sutures will approximate the axillary wound at its upper limit. Gauze packing is placed next all freshly divided tissue planes to stimulate a reaction in the tissues and to prevent extension of the infection. This packing is brought out through the dependent part of the wound and can be removed on the fifth to the seventh days. At this time when the gauze is

removed the extrathoracic tissues will fall in and adhere to the collapsed visceral pleura beneath.

#### SUMMARY

1 The technique of Schede thoracoplasty using the axillary approach is described.

2 The advantages of this approach over the posterior paravertebral hockey stick incision are emphasized, notable among which are ease of approach and closure of wound, preservation of extrathoracic musculature, avoidance of infection and postoperative complications of wound healing.



## A HEMORRHOIDECTOMY ELIMINATING THE USE OF THE CLAMP

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**A** SATISFACTORY hemorrhoidectomy must remove all the hemorrhoids and redundant tissues. With certain obvious reservations, any type of operation which achieves a desirable end result is adequate. Operations involving the use of the hemorrhoid clamp are suitable in some instances. However it is technically difficult or sometimes impossible to manipulate the clamp so as properly to cope with cases in which hemorrhoids and redundant mucosa must be resected high above the pectinate line. Some other types of hemorrhoidectomy designed to eliminate the hemorrhoidal clamp are not completely satisfactory because of failure to achieve proper fixation of the rectal mucosa, inadequate control of mucosal bleeding or the tendency of the ligature to slip.

Following is a description of an operation eliminating the hemorrhoidal clamp. Under sacrocaudal or low spinal anesthesia with the patient in the jack knife position the buttocks are retracted laterally and held by means of broad strips of adhesive tape fixed to the op-

erating table. Having thus obtained adequate exposure, appropriate preoperative preparation and draping are carried out. At this point 6 cubic centimeters of 1 per cent diathane solution is injected into the sphincter muscle for the purpose of controlling postoperative pain. Using the finger as a guide, a 1/2 inch 22 gauge needle is introduced into the posterior midline just outside the anal verge. Two cubic centimeters of the solution is injected into the muscle at this site. The needle is partially withdrawn and reinserted in a right anterolateral direction. Two cubic centimeters of the solution is placed in the lateral quadrant of the muscle on this side. In the same manner the needle is again partially withdrawn and the rest of the anesthetic is injected into the left lateral quadrant of the muscle. It is felt that the logical time for this procedure is preoperatively rather than postoperatively because the swelling which necessarily results from a rectal operation increases the possibility of abscess formation following injections in this region.

After careful dilatation retracting clamps are applied to the margins of the anus and these are drawn apart. The hemorrhoidal masses are now grasped and exposed. In this manner the hemorrhoids are demonstrated and the degree of deformity is evaluated (Fig 1). The skin adjacent to one of the hemorrhoidal masses is grasped by a straight hemostat which is pulled in the direction away from the anus and held by an assistant. A second hemostat is fastened to the skin just inside the first and upward traction is exerted on this by the operator. With the skin thus placed under moderate tension an elliptical incision is commenced on the skin between the two hemostats which includes hemorrhoid and redundant mucosa (Fig 2). The hemorrhoidal mass outlined by the incision is dissected free from the external sphincter muscle and underlying tissues from below upward. Dissection is fa-

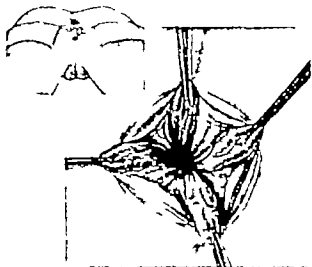


Fig. Hemorrhoids exposed. Insert shows position used for operation.

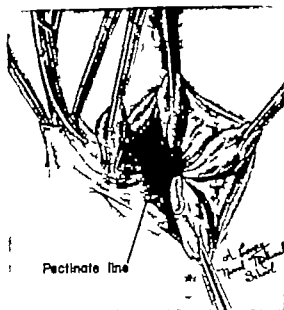


Fig. 2. Beginning the dissection of the hemorrhoidal mass.

cultated by maintenance of tension on the hemostats and the use of curved dissecting scissors. When the dissection has been completed the hemorrhoidal mass remains attached by a relatively narrow pedicle of mucosa (Fig. 3)

A ligature of No. 1 plain catgut is fixed in the following manner. The dissected hemorrhoidal mass is drawn away so as to expose the upper extremity of the line of incision on the side of the operator. The mucosa above the apex of the incision is included by a mattress suture. The ligature is now brought through the base of the pedicle on the same side. Next the superficial fibers of the internal border of the external sphincter muscle are included. The ligature is brought back through the base of the pedicle on the opposite side. Now, the hemorrhoidal mass is drawn in the other direction so as to expose the upper extremity of the incision on the side away from the operator. A mattress suture is placed in the mucosa above the apex of the incision on this side which completes the ligature. The suture is tied securely and the hemorrhoidal mass distal to the tie is amputated. Each of the hemorrhoidal masses is dissected, ligated and cut in the manner described. All bleeding points in the denuded areas are caught and tied. The stumps are carefully checked for bleeding by exposing each with a Smith rectal speculum. A thin strip of vaseline gauze or rubber dam is

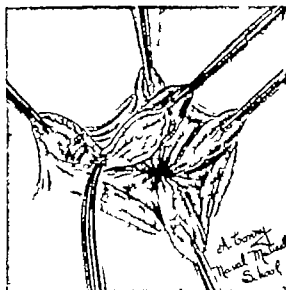


Fig. 3. Dissection complete.

inserted in the anus for drainage. A dressing consisting of a small piece of gauze is laid over the anus. This dressing will remain in place without the aid of adhesive strips or a T binder. No other postoperative dressing is required.

The postoperative care is relatively simple and uncomplicated. When sensation returns, continuous hot packs are applied locally and liberal doses of morphine or pantopon are given to control the pain. A regular diet is allowed on the day of operation. The drain is removed the day following operation. Hot

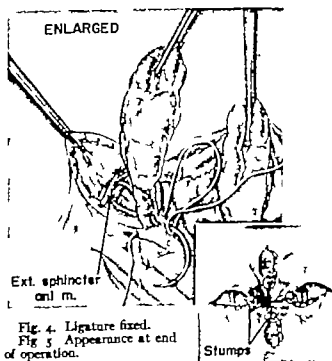


Fig. 4. Ligature fixed.  
Fig. 5. Appearance at end of operation.

packs are now discontinued and warm sitz baths are commenced three times daily. After each bath the raw areas are carefully swabbed with a cotton applicator soaked in 15 per cent alcohol following which, a small piece of dry cotton is laid across the anus. No other dressing or appliance is required. The patient becomes fully ambulatory after the first day. No attempt is made to prevent early bowel movement; the patient is encouraged to move the bowels after the first day. Laxatives are not allowed but a low tap water enema is given on the third postoperative day if the bowels have not moved by that time and every 2 days thereafter until the patient has daily unaided evacuations. Under this treatment a regular bowel habit is soon developed regardless of a previous history of the promiscuous use of laxatives or chronic constipation. Digital dilations are unnecessary because the daily dilatation produced by a formed stool is quite ef-

fective and considerably more comfortable for the patient to endure.

This type of hemorrhoidectomy presents several advantages. It is technically simple and may be used successfully for practically all types of hemorrhoids encountered. The hemorrhoid clamp is entirely eliminated. All the hemorrhoids and redundant tissues can be removed even though it may be necessary to dissect high above the pectinate line. Because of the several points of fixation the mucosa has no tendency to slip out of the grasp of the ligature. Bleeding is adequately controlled and the mucosa is well gathered in and drawn down where it is securely fixed at about the level of the pectinate line. Comparatively little raw surface remains a fact which makes the tendency toward stricture formation negligible.

The author has used this type of operation in 800 cases with excellent results.

# SURGICAL CORRECTION OF NASAL DEFORMITIES

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THE nose is the most prominent feature of the face. Real or fancied nasal deformities have a high priority in the consciousness of the owner as well as the observer and cause many patients to seek correction.

Most corrections of nasal appearance depend upon shifting the interrelationship of the component parts of the nose or changing their size and shape and a good understanding of the rôle of the anatomical parts in supplying the framework to the external nose is necessary before undertaking any such correction.

The upper third of the external nose is supported by the nasal bones and the adjacent frontal processes of the maxillae, in the middle third are the paired upper lateral cartilages, which are continuations of the nasal bones and like the nasal bones are fused with the septum in the midline (Figs. 1 and 2). Consequently both nasal bones and upper lateral cartilages in addition to forming the side wall of the nose have an important rôle in supporting the dorsum and forming a part of the profile line. Inferior to the upper lateral cartilages are the paired alar cartilages, comprising for the most part the skeletal framework of the tip. These alar cartilages are more or less free floating (Fig. 3). They are not intimately adherent to the upper lateral cartilages as the latter are to the nasal bones. Although they are adjacent to the septal cartilage they are not attached to it as are the upper laterals. Thus the alar cartilages and their continuation into the columella supply a framework which gives bulk and shape to the tip of the nose as well as height. However as supporting structures, they depend on relatively loose attachments to the upper lateral and septal cartilages through the medium of soft tissues (Fig. 2). This relationship must be remembered especially in dealing with problems in which septal support to the lower portion of the nose has been lost.

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The cartilaginous septum is the ridgepole which gives height to the lower two-thirds of the nose, supplies support to the other cartilaginous structures and oftentimes causes a shifting from the midline of the external nose when it has been displaced by trauma (Figs. 17 and 18). The septum is the one structure most often deformed and the one interfering with the function of the internal nose.

The external nose is covered with skin and an areolar type of subcutaneous tissue. The quality of this soft tissue covering differs in the upper and lower portions. Over the nasal bones the skin is thin, the subcutaneous tissue is scant in amount. The glandular structures are not as well developed or active as in the lower portion. At the tip of the nose the skin is palpably thicker and less mobile. The sebaceous glands are more active. The actual thickness of the epithelial structures is greater as is the thickness of the subcutaneous tissue. This soft tissue of the tip varies considerably the extreme being reached in the rhinophyma where the epithelial structures may sometimes be three-eighths of an inch in thickness (Fig. 28). Even under normal circumstances or slightly abnormal circumstances of seboreic inflammation the tip of the nose may be quite fleshy so that its shape is not due to the delicate lines of the cartilaginous structures but to the overlying covering envelope (Fig. 8).

## CORRECTION OF THE LARGE OR HUMP NOSE

In planning the correction the balance of the patient's features must be considered. A prominent nose may appear even more prominent because of a receding chin (Fig. 25). In one instance a nose may be shortened more than in another where a long lower jaw is present. The proper width, height, and length of the nose must be determined in proportion to the other features. It is common for a patient to insist that all that is wanted is the removal of a hump. In most instances, when one feature of a nose is corrected, other faults are im-

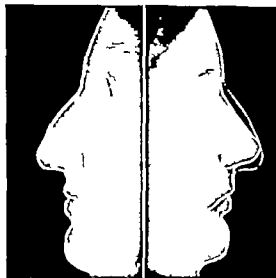


Fig. 2. Plaster cast of the face used in planning nasal correction. One-half of the nose is carved down to represent the desired change. The other half of the nose is left intact for contrast. This method is quite objective and promotes accuracy of correction.

mediately accentuated. All of the component parts must usually be altered and the preliminary planning is extremely important.

A number of rules or methods have been described for this. Some surgeons can do this free-hand, merely looking at the patient, studying the features, and making the decision without mechanical aid. It is felt that a more objective method is desirable. In every case a plaster cast is made of the face and on

this cast the correction is worked out, carving down the lateral half of the nose to represent the alteration planned and leaving the other half for comparison (Fig. 1). By this method, the surgeon may fix in his own mind what he wants to do. The patient may also see what is being planned and more accurately describe his own ideas. Moreover, having this cast at the operation enables the surgeon to make excision of bone or cartilage by fairly accurate measurement. It is easy to get lost on the individual patient if the correction is being done free hand.

Most nasoplasties involve certain standard corrections, the chief difference from one nose to the next being in the amount of excision at varying points. The more or less standard correction consists of lowering the profile line or removing a hump (Fig. 3). This results in a plateau on the top of the nose rather than a thin dorsum (Fig. 4). For this reason the nasal bones must then be narrowed, re-establishing the normally thin dimension. The tissue which is removed in correcting a hump or high profile line is the summit of the nasal bones, the portion of the upper lateral cartilages fused with the septum, which constitutes part of the width as well as the height of the hump and a portion of the septum contribut

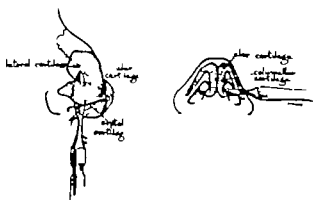


Fig. 3. a, left, The initial incision is between upper lateral and alar cartilages. The knife passes over the upper lateral cartilage and dorsum of the nose, separating all soft tissue from the cartilage and other structures constituting the hump. b, Having made the incisions in both nostrils, they are then extended medially to separate the columella from the lower border of the septum. These initial incisions do not cut cartilage but separate one cartilaginous structure from another.

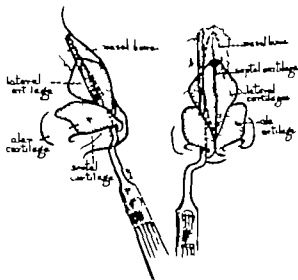


Fig. 3. After elevation of the soft tissues from the dorsum of the nose the hump is removed with the Joseph saw. The amount of excision is estimated from study of the cast, which is present at operation. Note that the hump consists of bone, upper lateral cartilage and nasal septum.





Fig. 7. Correction of pendulous columella requires excision of some of the columellar cartilage. A full correction cannot be made by additional excision of septal cartilage. The excision represents removal of skin and inferior border of the hypertrophied cartilage.

also necessary to shorten the side walls so that the length will have been reduced symmetrically. This is done by excising a triangle from the inferior borders of the upper lateral cartilages. These corrections varying in amount and degree constitute the typical nasoplasty. To meet specific problems other maneuvers may be added.



Fig. 8, above. Equally good results cannot be obtained in every case. The result of nasal correction depends upon the absorption of excess skin and the soft tissues adapting themselves properly to the newly shaped skeleton. If the skin of the nose is normally thin, it may be expected to reflect the changes in the skeleton of the nose very accurately. However, if the soft tissue covering is thick and hypertrophied, the final result will lack the delicate lines and configuration desired. This complication must be foreseen. In some cases, it is perhaps wiser not to do the operation. In others, the complication must be explained to the patient beforehand so that too much will not be expected. a, left, I this case, tip of the nose is unusually high and the skin quite thick. Because of the magnitude of the desired reduction,

*Hanging columella* In some instances a hypertrophy of the columellar cartilage causes a down bulging termed "hanging columella." It is a mistake to try to correct this displacement by excising more of the inferior border of the septum and forcing the columella up to it. A certain improvement may be gained in this manner but the full correction will come from the excision of an ellipse of skin and columellar cartilage taken on either side of the columella just above its inferior border (Fig 7). This ellipse is the length of the columella and varies in width, depending on the degree of the desired correction.

*Secondary corrections* Although in most instances full correction is gained at the first operation not infrequently small secondary corrections are desirable. There may be more relaxation of tissues and secondary drooping of the tip of the nose than are anticipated. This may produce a certain roundness of the profile just above the tip. Occasionally in dealing with large noses, the transverse distance between the base of the alae is too great. This may be narrowed at the primary operation. However it is a small procedure and it



and because of the thickness of the skin, one would not expect a really good result following an operation. In some instances, further help may be gained by excision of a prism or section of the full thickness of the skin at its junction with the cheek. This was done in this case, and the result shown in b, right, is a decided improvement.

Fig. 9, above. a, left, Facial deformity of relatively common type. Note retraction of middle portion of face. The tip of the nose is less prominent than the dorsum and is situated in a depressed area. The attachment of the skin to the cheek and the base of the columella are retracted. The columella forms an acute angle with the lip, and the lip forms too great an angle with the vertical profile line. b, Correction in one operation by technique in Figure 10.

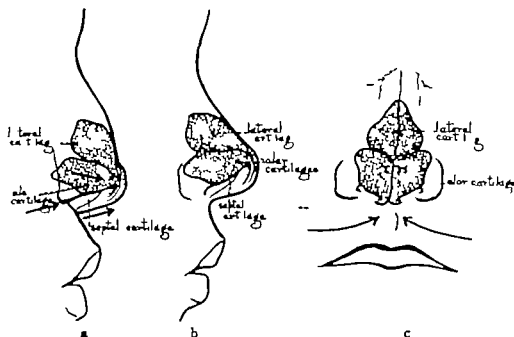


Fig. 10. a. The initial incisions are described in Figure 9. The incision separating the columella from the lower border of the septum is continued deep enough to enter the upper labial sulcus. A transverse incision is made in the upper labial sulcus from the molar region on one side to a similar point on the opposite. The upper lateral cartilages are divided from the septum on either side. The upper lateral cartilages are then sutured together over the septum to fill in the slight depression above the tip. The alar cartilages are sutured forward in an advanced position on the lower border of the upper lateral cartilages as illustrated in b. The columella is sutured in a forward position on the lower septal border. The tissues of the lip and cheek are advanced toward the midline as shown in c, and sutured in such position as to build up a greater bulk of soft tissue under the base of the alae and columella, forming a tip of the nose which is now more prominent than the dorsum, and correcting a retruded position of the base of the alae and lip.

is felt that it can be most accurately done after the nose has recovered from the operation, and the proper final relationship of the base of the nostrils to the point of the tip can be ascertained. If too much narrowing of the base of the nostrils is done then the nose viewed from below is not triangular but more globular than normal.

The nose with a very fleshy tip does not lend itself well to correction. Here the shape is due more to the thickness of the skin than to the contour of the alar cartilage. In lesser degrees, this may be corrected by trimming subcutaneous tissue from between the alar cartilages and skin and removing the attached areolar tissue from the external surface of the upper lateral cartilages.

**External excisions.** In certain larger and grotesque noses it is necessary to make excisions of prisms of skin and subcutaneous tissue from the base of the alae at their attachments to the cheek (Fig. 8). This is not often

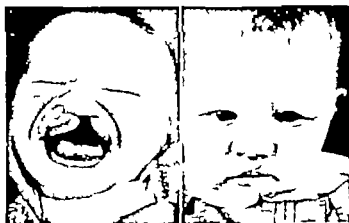


Fig. 11. Typical unilateral, complete cleft of lip and palate with the correction of the lip and nose that may be obtained at primary operation. This involves an incision between the upper and lower lateral cartilages with undermining of the alar cartilage, separating it from the skin of the nose. This wide undermining is usually done from the single incision between the upper and lower lateral cartilages. This permits shifting of the lining and covering of the ala in the process of re-establishing the floor of the nostril and curling the ala into its proper position. Often the correction cannot be made as good as it is ultimately desired. Moreover some increasing deformity may occur with growth.





Fig. 2. a, Deformity of nose secondary to cleft lip. Here inadequate primary repair was done and the deformity subsequent to the initial repair has increased. The nose is not in the midline and there is a decided slumping of the left alar border. b Shows correction obtained by shifting the nose to the mid line, reoperating upon the lip, advancing the entire left ala, and repositioning alar cartilages as shown in Figure 27. c, Shows relative symmetry of the tip and a scar above the left nasal border representing removal of crescent of skin. Such an excision should never be made at the primary repair of the cleft lip.

necessary. In general where it is necessary the overall correction of the deformity will not give a result comparable to that obtained on less extreme cases.

**Septal resection.** The operator is often at a disadvantage if a septal resection has been performed prior to the nasoplasty. The removal of a hump could result in the disturbance of the remaining septal support of the dorsum. The adequate shortening of a drooping tip could necessitate the removal of the remaining inferior septal border with loss of tip support. If the septal resection is performed prior to the nasoplasty with the knowledge that the second operation is contemplated, these factors should be considered.

#### SNUBBED TIP AND RETRUSION OF THE MIDDLE THIRD OF THE FACE

Normally the tip of the nose is its most prominent portion. In certain cases the tip of the nose may be less prominent than the dorsum (Fig. 9). This does not refer to the loss of tip support following trauma or operation but to a congenital condition. In such cases the columella is short. The alae are set in a depression, the base of the upper lip is retruded, the upper lip rather than being more or less vertical protrudes so that its border is anterior to its base at the junction of the lip with the nose and columella. The correction of such a deformity entails the advancement of the entire tip of the nose and the upper lip, so that the soft tissues on which the tip of the



Fig. 3. Case similar to that illustrated in Figure 2, showing the rather extreme alar deformity which may occur subsequent to inadequate primary repair and which may also become more noticeable with growth and development of the nose. Repair was done by the scheme outlined in Figures 27 and 27.



Fig. 14. Illustrating the improvement in general facial appearance which may sometimes be gained by doing a complete nasoplasty at the time of correction of residual cleft lip deformity. The correction of the deformed tip of the nose involved reduction in size of the alar cartilages so that they were symmetrical in size and position.

nose rests have also been brought forward (Fig. 10). The entire procedure must be made rather extreme because in the first few weeks following operation there will be a tendency for the tissues to settle and a portion of the correction will be lost.

#### NASAL ASYMMETRY ASSOCIATED WITH HARELIP

In the complete unilateral cleft lip the cleft extends through the floor of the nostril (Fig. 11). The ala and alar cartilage on the affected side are pulled out into a straightened and distorted position. This can largely be corrected at the primary operation if it is done properly. However residual asymmetries are often present (Figs. 12, 13, 14 and 15). In the partial unilateral cleft lip the cleft does not go through the floor of the nostril but there is



Fig. 15. The patient with deformity resulting from one single factor such as cleft lip may often be given a better overall result by correcting not only the primary fault, but other bad features as well. a, left. Illustrates deformity of upper lip and nose resulting from a cleft lip. Note also the prognathism. b. Illustrates the improvement which was gained by reoperating upon the lip and correcting the nose according to the technique illustrated in Figure 10. The prognathism was corrected by excising the lower border of the point of the mandible. The scar of the submental incision may be seen. The excised segment of bone is shown below.

attendant nasal deformity on this side. Provided good correction has been made at the original operation then the deformity present usually consists of a few definite distortions. The attachment of the ala to the cheek on the cleft side is often posterior to the normal (Fig. 13). The alar cartilage on the cleft side is underdeveloped and smaller than its fellow causing a slumping of the alar border. The entire alar cartilage on the affected side has a more posterior position than its fellow. This is true also in its relationship to the upper lateral cartilage. The entire nose including the bony nose, may be deviated from the midline (Fig. 21).

Often the operation may entail a complete nasoplasty and general reduction of size (Fig. 14). If this is done, then by reducing the size of the normal alar cartilage the two may be more likely to compare favorably. Otherwise the adjustment must come in repositioning the alar cartilage on the affected side. One method of doing this is as follows. An incision is made between the alar and upper



Fig. 16. a, left, Large and unattractive nose, associated with breathing difficulties. The lower border of septum blocks the left nostril. The right nostril is blocked by the angle of deflection. In this case correction was obtained by doing a typical nasoplasty, reducing the nose in size and shortening it markedly. The amount of shortening permitted excision of a large triangle from the lower septal border allowing the excision of the entire obstructing portion. It is unusual to be able to shorten nose to this degree. However in many cases, part of the correction may be so gained. b, Shows the improvement in appearance and in airway. The hanging columella operation (Fig. 7) was also carried out on this patient. No septal resection was done.

lateral cartilages on the affected side with free undermining of soft tissues. The alar cartilage is then sutured forward to climb the upper lateral cartilage to a more advanced position. The alar cartilage is then mobilized as in the usual nasoplasty with the exception that its lateral portion is not divided from the columellar portion and is mobilized submucously. The columellar portion of this cartilage is sutured to overlie the dome of the normal cartilage (Fig. 27). This deprives the columella on the affected side of this columellar cartilage and adds the columellar portion to the alar cartilage which in itself is congenitally underdeveloped and small. A considerable improvement of the tip deformity may thus be obtained. If there is still some slumping of this alar border the excision of an ellipse of skin from above the alar border at the tip of the nose may be done. (Fig. 13)



Fig. 7. a, left, Typical crooked nose resulting from childhood injury. A septal resection had previously been performed and patient's airway was adequate. b, Shows improvement which was gained by shifting the nasal bones to the midline and shortening the nose considerably. This permitted elimination of the supra tip depression. The lower lateral cartilages are advanced on the remnants of the upper lateral cartilages remaining after shortening the nose. The shortening of the upper lateral cartilages rendered them more stiff and stubby permitting better support to the nasal tip. The drooping due to partial loss of tip support in this case was corrected by substituting the support of the upper lateral cartilages for that normally supplied by the septum.



Fig. 18. a, left, Twisted nose resulting from childhood injury plus secondary loss of tip support and increasing drooping of the nasal tip following septal resection. b Shows correction obtained by shifting the bony nose to the midline, shortening the nose markedly, and gaining support by utilizing the remaining portion of upper lateral cartilages, as in Figure 17

the alar cartilages and the columellar cartilages. Secondary to this deficiency and distortion of the tissues, there is a developmental distortion resulting in malposition of such cartilage as is present. The complete correction frequently calls for multiple operations and a combination of procedures. First it is often necessary to advance the tip of the nose carrying with the columella an attached strip of tissue from the center of the upper lip thus lengthening the columella. Later, a bat wing or modified V type of incision can be made across the tip of the nose turning up the skin and underlying soft tissue and exposing the alar cartilages at the dome. These cartilages can then be sutured together in the midline to give a more pointed tip and the skin incision closed as a 'Y,' advancing the soft tissues to give a more prominent tip. Subsequent to this, the procedure as described under Snubbed Tip and Retrusion of the

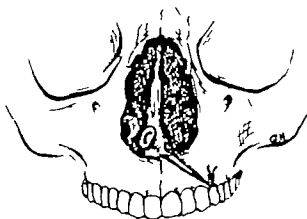


Fig. 19. It is sometimes difficult to maintain a midline position of the lower septal border. If there is a resistance to the shifting of its position a more rigid method of holding it may be desirable. In such cases a silver wire may be passed around the mobilized spine over a small lead button. This wire can be attached to a tooth on the opposite side, anchoring the displaced septum in a position of overcorrection until healing occurs.

Middle Third of the Face may be carried out. With many cleft lips, associated with cleft palates, there is some underdevelopment of the maxilla. This underdevelopment of the maxilla may be associated with a relative or combined relative and actual overgrowth of the mandible giving an appearance of prognathism (Fig. 15). In order to get the best balance of the features and to shorten the lower third of the face to make it in proportion to the middle third an excision of bone from the mandible or the point of the chin may be done.

#### DEVIATIONS OF THE EXTERNAL NOSE FROM THE MIDLINE AS THE RESULT OF TRAUMA AND ASSOCIATED SEPTAL DEFORMITY

Everyone in infancy or later has had trauma to the nose. Even relatively slight trauma in early childhood with no deformity at that time may result in increasing external deformity of the nose with growth. The typical history of such a case is that of a mild injury at 5 or 6 years of age with slight deformity beginning at about 12 years of age and reaching a maximum at 16 or 17. In these cases the anterior view of the nose shows it to be somewhat of an S-shape the bony portion being deviated to one side the middle third curving to the opposite side and the tip usually deviating in the same direction as does the bony nose (Figs. 17 and 18). It is presumed that in

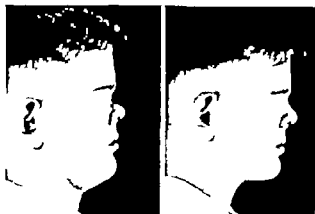


Fig. 8 a, left, Illustrating the extreme depression of bridge resulting from an abscess and loss of septum in childhood. Not only is there loss of septal support but a portion of the growth stimulus to the nose has been lost. This results in an overly short nose out of proportion to the length of the rest of the face. The soft tissue covering and lining of the nose is deficient. If allowed to persist through the growing period, correction becomes increasingly difficult because of the relative deficiency of soft tissues. b, Shows correction gained at the age of 3 years by the insertion of a section of maternal cartilage. Such a correction done at an earlier age will aid growth and development of the soft tissues of the nose, permitting the removal of the original implant and insertion of a larger one in later years.

such instances injury occurring to the septum with displacement of its attachments and perhaps hemorrhage within tissues has resulted in an increasing deformity with growth



Fig. 9 a, left, Depression of entire dorsum of nose secondary to infection in childhood. In this case the infection occurred late in childhood, and there is less shortening of the nose than in Figure 8. However there is deficiency of bone as a result of the lack of growth stimulus. In many such cases there is a widening of the nasal bones, necessitating their being narrowed prior to building up of the profile line. Correction here was done in two operations with the result shown in b. At first operation the nasal bones were narrowed, and the second, a right angle support of rib cartilage was inserted to build up the dorsum and correct the retruded position of the columella.



Fig. 10 a, left, Depression above tip resulting from abscess of the septum in adult life. Here, septal support is lost. There is no change in the shape of the nasal base since full growth had occurred prior to the infection. Then is shrinking of the soft tissues of the lower portion of the nose, secondary to the loss of supporting structures. b, Correction gained by insertion of triangular piece of rib cartilage. Such a nose can rarely be built to its original size because of the shrinking which has occurred in the soft tissues.

the external nose being carried into the deviated position by the increasing distortion of the septum. In addition any trauma in later life can cause deviation of the bony nose and of the septum. As before stated almost all corrections of the external nose are made with the technique of the typical nasoplasty as the underlying principle. This is varied to meet individual cases. Correction entails bringing the bony nose to the midline, providing adequate breathing space and straightening septal structures which are causing deviation of the lower or cartilaginous portion of the nose. This may be combined with removal of a hump or other corrections of displeasing lines of the external nose. The bony nose is brought to the midline by free mobilization of the nasal bones and shifting them according to the technique described under Nasoplasty. A removal of a certain amount of septum is usually necessary first to provide breathing space by the removal of obstructions and second to weaken the septum diminishing its resistance to straightening. The lower border of the septum often offers the greatest problem. Frequently there has been a dislocation of the septum from the vomer and the lower border may be turned almost at a right angle, one nostril being obstructed by the bend or



Fig. 23. Supratip depression as a result of trauma. Correction consisted of septal resection to restore breathing space, removal of a slight amount of the prominence of the nasal bones, shortening the nose, and building up the depression above the tip by suturing together of the upper lateral cartilages across the dorsum of the septum. No implant was done.

angle of deflection the other by the free lower margin projecting into the opposite nostril. The best correction of this condition can be obtained by shortening the nose and excising the portion of the septum which is deflected (Fig. 16). Naturally this cannot be done in many cases because often a nose cannot be shortened to this degree and preserve a good appearance. In most instances it will be necessary to straighten this lower portion of the septum so that it again is in the midline. This relieves obstruction, corrects the deviation of the tip of the nose and restores support of the septum to the tip of the nose. This involves freeing of the lower portion of the septum from the angle of deflection to the lower border so that it may be moved like the rudder of a boat. The submucous resection having been done if necessary, superior to the angle of deflection a chisel is driven along the floor of the nose, cutting free the base of the septum and vomer from the palate. If done adequately this will permit bringing the lower section of septum to the midline. If there is resistance to the shifting of the position or if it does not remain freely in the new position it may be held by wiring to a tooth on the opposite side (Fig. 19). The inferior border of the septum is set into the groove between the columellar cartilages. Following complete healing a limited secondary resection of this

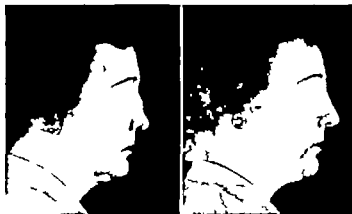


Fig. 24. Loss of septum from infection. This case was identical in history with that illustrated in Figure 21. However correction was made by utilizing local tissues entirely as in Figure 23. Having had a high nose originally it was possible to remove some of the nasal hump, making the depression relatively less deep. The nose was shortened and the upper lateral cartilages sutured together to fill the supratip defect. In this case it was possible to shorten the nose somewhat, facilitating this technique. In the patient shown in Figure 21 the nose was already too short and it was desirable to add to its length, making it unsuitable for utilization of local tissues only.

inferior portion of the septum may be necessary.

#### DEPRESSED NOSE

As the result of trauma, infection or operation the profile line of the nose may be depressed in part or throughout. If such an injury occurs in childhood the resulting defect is twofold. First there is flattening as the result of the injury and second a failure of de-



Fig. 25 a, left, Illustrating necessity of considering all of the features when planning a correction. The prominence of the nose in this case is accentuated by the receding chin. b, Shows correction of receding chin by implantation of rib cartilage to supplement the point of the mandible, and subsequent nasoplasty to reduce the size of the nose and improve its shape.

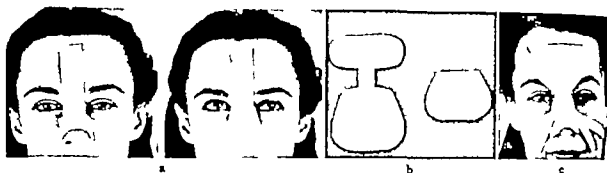


Fig. 26. The postoperative care and dressing is almost as important as the operation itself in getting a good final result. In applying this, one should remember that the dressing should attempt to do everything that was accomplished in the operation. The shortening of the nose should be maintained by holding the skin of the nose upward with adhesive strapping. The reduction of the hump should be supported by transverse strapping of the upper portion of the nose with adhesive tape. The narrowing achieved at operation must be held by splinting the nose in a narrowed position. If there has been deviation of the nose from the midline, the dressing should attempt to correct this deviation. a, Shows the adhesive strapping of the nose and the application of two small felt or adhesive pads stuck on with collodion. By application of splint over these pads, correction or even overcorrection of existing deviations may be obtained. Such pads and counterpads are usually not ap-

plied at the original dressing, but are used at subsequent dressings as indicated. b, Shows a small nasal splint of adhesive covered aluminum applied over adhesive strapping. This splint may be bent easily with the fingers and shaped by trimming with bandage scissors. It adheres to the nose through the medium of flexible collodion. c, Shows a different pattern of splint made of same material. In this case the splint is not attached to the nose with collodion, but is held in place with adhesive strapping. This adhesive strapping permits holding the splint and soft tissues of the nose backward more tightly against the skeleton. This is not commonly used as the primary dressing, changing to the smaller splint for subsequent dressings. A 12 day period of splinting is adequate for the simple uncomplicated rhinoplasty. Where corrections of deviations of the nose from the midline have been done the period of splinting may be for longer periods.

velopment of the external nose in proportion to the other features (Fig. 20) and the nose is often widened.

The correction of such a condition involves the transplantation of some solid substance to supplement the normal supporting structures and restore the proper profile line. The transplanted material may be one of several. An autotransplant of cartilage taken from the patient's ribs is perhaps the best. This material is rigid and yet may still be carved with the scalpel. It is a living transplant of the patient's own tissue that heals well in place and is not subject to absorption or extrusion. The disadvantages are that an incision into the chest is required to procure the cartilage and

after transplantation it sometimes has a tendency to curl so that the straight line obtained at operation is not maintained. Preserved cartilage at the present time is being used quite extensively, often with quite good results. Its disadvantages are that it is a foreign body, and although it usually heals in place with very little reaction it is sometimes



Fig. 27. a, left, Inferior view of deformity of alar cartilages frequently found associated with unilateral cleft lip. b, scheme utilizing columellar portion of underdeveloped alar cartilage on the cleft side to restore symmetry of nasal tip.



Fig. 28. a, left, Rhinophyma of many years' duration with associated basal cell carcinoma in limited area. b, Result from shaving down thickened skin to the basal layers and shortening nose as in typical nasoplasty. Area of malignancy excised with the cautery and allowed to heal spontaneously.

absorbed and does not tolerate infection at all well. It does not have the tendency to curl. Living bone is difficult to shape and to obtain does require operation on the patient. Ivory and synthetic materials have the advantage of being easy to obtain but are rather difficult to shape at the operating table. These also are foreign bodies and are not as well tolerated by the tissues as are some other materials. It must be remembered that any transplant to the nose may be somewhat movable so that the patient may shift it slightly from side to side over the underlying structures unless it rests solidly on periosteum of the underlying bones. If so placed it adheres tightly to the periosteum and is not movable. Any transplant should supplement the deficient structures. Usually the transplant will overlie the depressed nasal bones. Inferior to this point it will supplement the septum and upper lateral cartilages which are also depressed. A single dorsal implant may be all that is needed if this implant adheres solidly to the nasal bones and gives adequate tip support, acting as a cantilever. However oftentimes the backward pull of the tip is such that adequate support cannot be gotten from a single dorsal implant. Also it is often necessary or desirable to lengthen the nose, bringing the columella down into a lower position. In this case the most desirable implant is a right angle in shape (Figs. 20 and 22). This is not the hinged transplant described by Gillies, which we have found impractical but represents a right angled insert carved from a single piece of cartilage taken from the curve of the rib cartilage near where it articulates with the rib. This is inserted through a columella-splitting incision the longer dorsal projection resting over the nasal bones and elevating the profile of the nose. The shorter right angled portion lies in the columella, forcing it downward into a more desirable position and elevating the nasal tip. This supplements the quadrilateral cartilage and supplies the support which it normally would provide. In certain instances, rather than using a right angled insert, two separate implants can be used one in the dorsum and the other in the columella and these are attached with a silk suture at their junction. These implants are shaped at the operat-

ing table with the scalpel, the same scheme being followed if preserved cartilage is used.

Often rather severe trauma to a nose will not fracture the nasal bones at all but will depress the septum causing a depression inferior to the border of the nasal bones and above the tip (Fig. 23). Such a depression may be handled in one of several ways. Most satisfactorily some of the height of the nasal bones may be removed making the supra tip depression relatively less deep, the upper lateral cartilages can then be detached from their connection with the septum and sutured together over the dorsum of the septum to elevate a portion of the depression (Figs. 23 and 24). If the nose can be shortened this will then bring the tip or alar cartilages into a higher position encroaching on the neighborhood formerly occupied by the depression and helping to obscure it still further. Some operators prefer the transplantation of one or more thicknesses of ear cartilage for these small defects. Usually if the depression is so slight that it may be satisfactorily filled in with a thin implant of this type, it can be better corrected by superimposing normal nasal structures. Moreover it is often difficult to place small bits of cartilage accurately in such a defect, and after healing the result will not be entirely symmetrical, the implant not fitting accurately to the depression. If the defect cannot be hidden by superimposing normal nasal structures over it, then it is usually safer to use a larger implant of rib cartilage.

A deformity occasionally following septal resection is the loss of support, causing a drooping tip. This gives an effect of elongation of the nose, the tip being less high from the lip than the position it formerly occupied (Fig. 18). Correction may be made in one of two ways. Through a columella splitting incision a post of cartilage may be transplanted into the columella itself simulating the support originally given by the lower border of the septum. In other instances where appearance will permit, it is possible to shorten the nose especially the side walls rendering the upper lateral cartilages less long and therefore more stubby and stiff. This supporting stiffness of the upper lateral carti-



lages may then be transmitted to the tip of the nose by suturing the upper border of the lower lateral cartilages to the upper laterals, sub-

stituting the support of the upper lateral cartilages for the lost support of the septum (Figs. 17 and 18)

## CARCINOMA OF THE VULVA

### Results of Treatment and Effect of Special Factors on Results

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**C**ARCINOMA of the vulva represents only about 4 per cent<sup>1</sup> of all cancers of the female genital tract (4,5 8 13). Yet on account of the opportunity it offers for early diagnosis, and the obvious failure to take advantage of this opportunity, evident in most cases it deserves increased emphasis out of proportion to its incidence. This is especially so in view of the fact that increased knowledge in the treatment and prevention (19) of this type of cancer has been established during the past 5 years. Knowledge which may reduce somewhat the high mortality rate of the condition. The bulk of these cancers and this includes the vestibular and periurethral lesions, are skin cancers but because of their presence and location in a relatively specialized organ which is bathed in rich lymphatic trunks, it becomes not alone a local problem but like breast cancer one in which equal consideration must be given to the possibility and location of metastases.

Over a period of many years, a more or less standardized method of treatment has been developed for most cases of vulvar carcinoma. It is our purpose to evaluate the method in use at the Memorial Hospital with a brief description of some of the clinical and pathologic features of this disease. That this form of cancer is relatively uncommon (19) is not questioned yet despite this fact the literature is replete with statistics of end results and methods of treatment (5 13 15 16 18) histologic forms (2 10 12 21) age incidence (6 14).

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<sup>1</sup>There were 4,344 patients seen at Memorial Hospital between 1936 and 1943 who had cancer of gynecologic organ, 3 of these had cancer of the vulva, or an incidence of 4.6 per cent.

prevention (19) and general clinical description (8). However since Welch and Nathanson a review of their material reporting on life expectancy and incidence of carcinoma of the genitourinary tract material to 1933 only there have been no recent survival figures on a fairly large series. We shall present survival times of all primary cases seen at Memorial Hospital through 1940 as well as survival figures for those patients in the various stages of the disease process. Certain prognostic differences according to location and histology as well as extent of disease were also investigated.

During the 20 year period between 1926 through 1945 there have been 244 cases of cancer of the vulva at Memorial Hospital. For the purpose of this report we have divided this number into 2 groups the primary cases, 167 or those patients who came here without any form of previous treatment and the secondary cases 77 those who had received treatment in the form of either x-ray radium, or surgery at another institution. The primary group forms the basis of this report a brief discussion of the secondary cases will be given at the end. Because 16 patients did not have a histologic diagnosis of cancer this number was dropped from our study leaving an over all total of 228 histologically proved cases.<sup>2</sup>

#### ETIOLOGIC FACTORS

In our series, the youngest patient with a malignant epithelial tumor of the vulva was 27 the oldest 89. Nine patients, or 4.1 per cent, with carcinoma were below the age of 40. Although this is a relatively small percentage,

<sup>2</sup>Of the 6 patients, ( 3 per cent) are free from cancer well over 5 years, the remainder all died before the fifth year. At death the clinical diagnosis was carcinoma, vulva primary

it serves to remind one that vulvar carcinoma occurs in younger women not infrequently. Shannon and Marting reported a case complicating pregnancy in a 26 year old woman and also reviewed from the literature 5 cases of carcinoma of the external genitalia associated with pregnancy. Its presence in children where it becomes an oddity, has been reported on by Hoge and Benn. Baldwin's youngest patient was a girl of 14 who had a primary carcinoma of the vagina. In the present series, one of the patients with a melanoma was 15. Thirty-eight and seven tenths per cent of the patients were between the ages of 60 and 69, 25.4 per cent between 50 and 59, 18.3 per cent were between 70 and 79 and 8.7 per cent were 40 to 49. Forty nine and five tenths per cent of the patients were married, 36.6 per cent were widowed and 13.6 per cent were single. Seventy five and six tenths per cent had one or more children. 24.4 per cent were nulliparous. The high percentage of widowed patients is undoubtedly due to the large number in the older age groups and seems of no related significance.

Eight patients had syphilis but we were not struck by any difference in their disease as compared with the nonluetics. There were 10 diabetics recorded and 1 patient had a positive Frei test. None of these illnesses seemed to play a part in the etiology of the condition unless the vulvar pruritus commonly present in the diabetic can be termed a predisposing factor.

#### SYMPTOMATOLOGY AND SIGNS

In 70.1 per cent of the patients the presence of the lesion itself was the chief reason for seeking medical care. Pruritus, pain and bleeding in that order were the most common symptoms. Only 30 patients complained of increased vaginal discharge but a relatively high number 47 noticed urinary burning and frequency. Two patients had dyspareunia.

From our series the importance of pruritus as a cancerous and precancerous symptom is undeniable. Itching and burning about the vulva was present in 128 or 56.1 per cent of the patients. Associated with this number were 83 patients (36.4 per cent) who had leucoplakia. As pruritus is the cardinal symp-

tom of leucoplakia this is not surprising. Nevertheless, the presence of these two factors despite the absence of other signs warrants vigorous treatment in the form of excision rather than close observation and temporization. The relationship between leucoplakia as a precancerous lesion and true cancer of the vulva is too well known for conservative therapy to be the method of choice.

#### HISTOLOGY

The histologic forms present in our series were as follows: epidermoid carcinoma, 189; melanoma, 25; basal cell carcinoma, 9; adenocarcinoma—Bartholin's gland, 2; vulvar Paget's carcinoma, 1; dermatofibrosarcoma protuberans, 1. Blair Bell and Datnow state that malignant disease of the vulva occurs as squamous carcinoma in over 90 per cent of all cases. This statement is found to be closely approximated by our series in which 84.0 per cent of the patients had an epidermoid type of carcinoma. Almost two-thirds of these (63.3 per cent) were grade II lesions.

A surprisingly high number 25 or 11.1 per cent of melanomas are present in our series. Taussig (17) found 3 in his series of 155 patients. Folsome reported that he had found only 3 cases of melanoma of the vulva in the files of the University Hospital in Ann Arbor, between 1901 and 1940 or an incidence of 1 case to each 125,000 pelvic examinations. Although this type of lesion in general is rare it has been seen not infrequently at our institution, probably because we recommend excision of most pigmented tumors on and about the vulva.

Nine or 4.0 per cent of the lesions were basal cell carcinomas. Berman reported on 4 patients with this type of cancer seen in St. Louis between 1927 and 1941. Wilson describes 4 cases collected by him from a series of 32 patients with carcinoma of the vulva seen at the Duke Hospital, an incidence of 12.5 per cent. Goebel and Hamann reported an incidence of 14.7 per cent basal cell carcinomas in their group but they note that this percentage is higher than any other obtained in the 5 years previous to their report. Folsome notes that basal cell cancers of the vulva are relatively rare there being 6 cases in his report.

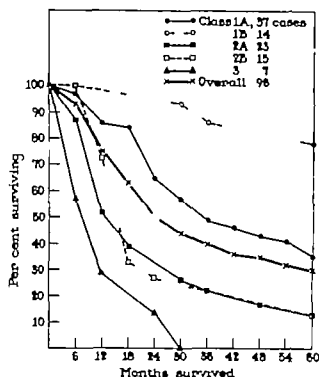


Chart 1. Survival curves.

There were 2 patients in our series with adenocarcinoma of Bartholin gland origin.

Sarcoma of the vulva is rare. It may occur initially in the tissues of the vulva, or in the vulvar end of the round ligament or it may represent sarcomatous change of a previously situated vulvar tumor. Taussig (15) notes that Leonard found 22.5 per cent of fibromas and fibroleiomyomas of the vulva that showed sarcomatous change. However Lovelady and associates, in a report on 34 benign neoplasms of the vulva, noted no sarcomatous change in any of their tumors. Folsome reported 1 out of 9 such tumors showing change.

#### END-RESULTS AND EFFECT OF SPECIAL FACTORS ON RESULTS

The end results of the primary and secondary groups of histologically proved cases seen between 1926 through 1940 is given in Table I. We have used the customary form in use at Memorial Hospital for reporting end-results. It deals solely with the overall cure rates and includes all of the histological types mentioned above. Our absolute 5 year cure rate is 26.00 per cent.

TABLE I—CARCINOMA OF THE VULVA—5 YEAR CURE RATES

Total number of cases	Primary 100	Secondary 26	Total 126
Indeterminate cases Dead of other causes—no evidence of cancer	7		8
Lost track of—no evidence of cancer	3	3	6
Total number of indeterminate cases	10	4	14
Determinate cases Total number studied minus indeterminate cases	90		112
Failures Dead of cancer	6	20	26
Lost track of—cancer present (probably dead)			
Living—cancer present			
Total number of failures	6	20	26
Successes Without evidence of cancer 5 years after application for treatment	26	13	39
Net 5 year cure-rate Successes divided by determinate cases	28.88%	26.92%	26.74%
Absolute 5 year cure rate Successes divided by total number of cases	28.88%	26.92%	26.00%

**Clinical classification.** This figure being a summation of all our cases, represents only a small part of the problem. We were especially interested in proving the importance of various factors on end results. To determine the effect of extent of disease, the cases were divided into five classes: (1) Cases without involvement of inguinal nodes—(A) with no extension of disease beyond the primary site on clinical examination and (B) those in which the inguinal nodes were dissected or biopsy tissue examined and no cancer found on pathologic examination; (2) Cases with inguinal nodes involved but operable—(A) those in which inguinal nodes were probably involved or enlarged on clinical examination and (B) those in which inguinal nodes were dissected or biopsy tissue examined and found positive for cancer on pathologic examination; (3) Inoperable cases with inguinal nodes fixed or immobile, swollen leg.

The survival curves of the primary group of patients in these classifications are given in Chart 1. All patients were treated by one or a combination of accepted methods: x-ray, radium or surgery. The total number of pa-

tients charted was 96. As would be expected those patients in class 1B those whose inguinal nodes were negative on pathologic examination, showed the highest survival figures. The rapid fall in the curves of classes 2A and 2B emphasizes the markedly changed prognosis once the disease has extended beyond its primary site.

*Results in relation to type of surgical treatment.* Twenty-one patients had a vulvectomy alone (Table II)<sup>1</sup> with one postoperative death. Five of these patients had enlarged inguinal nodes at operation and only 2 of this number survived 5 years. The overall 5 year cure rate for the 21 patients was 47.6 per cent. A higher survival rate would naturally be expected in this group as the disease was presumably limited to its original site when operation was undertaken. The fact that over 50 per cent of these patients did not survive 5 years emphasizes the high incidence of metastases which are not clinically discernible and should influence the procedure followed in treating these lesions.

Of 7 patients who had wide local excisions of the vulvar lesions mainly because of general debility and old age only 3 or 42.8 per cent survived 5 years.

There were 19 patients who had a vulvectomy with bilateral groin dissections. In all cases, the groin dissections were done at intervals of about 10 days following the vulvectomy and included dissection of the superficial and deep inguinal nodes including the so called Cloquet or femoral canal node but did not include the removal of the nodes along the hypogastric and iliac chains. Ten patients in this group (Table II) had negative inguinal nodes on pathologic examination and 8 or 80 per cent of these survived 5 years. Nine patients (Table II) had positive inguinal nodes and only 2 or 22.2 per cent survived 5 years. In 1 of these 2 survivals however, the primary lesion on the vulva was a melanoma.

Four other patients had a vulvectomy followed by bilateral groin dissections of the Basset type done at intervals of about 10 days. Three of these were patients whose in-

TABLE II — RELATION OF SURGICAL TREATMENT TO END-RESULTS

Class	Vulvectomy		Vulvectomy and bilateral groin dissection			
	A and 2A(5)		B		B	
	N	Per cent	N	Per cent	N	Per cent
Number of cases					9	
Alive 1 year		57	0	00	3	33
Alive at 5 years		47.6	8	80		22

guinal and iliac nodes were positive for carcinoma and they died within 2 years. The remaining patient is without evidence of disease today well over 5 years but her nodes showed no evidence of cancer on histologic examination.

Six patients had a vulvectomy and a unilateral groin dissection of the more superficial type. Four of these whose nodes were positive died within 2 years. One whose nodes were negative died within 30 months. The sixth patient had a melanoma which did not metastasize to the inguinal nodes until 7 years after a vulvectomy was performed. She died 6 months following a unilateral groin dissection.

Since 1940 almost all of the groin dissections done at Memorial Hospital have been of the Basset type but it is still too early for definite end results to be drawn. No postoperative deaths were encountered following any of the groin dissections.

*Effect of radiation therapy.* The inadequacy of x ray and radium in treating either the primary or metastatic foci of this condition is well known (4, 7, 17, 18). Only 4 patients were given x ray therapy to the vulva alone. All died within 18 months but 2 of these were beyond cure at the onset of treatment. One had a node removed from the supraclavicular area which on pathologic examination was consistent with a vulva primary.

There were 8 patients who received radiation to the vulva and groins and of these only (25 per cent) have been well over 5 years. In each of these the primary lesion was believed to be limited to the vulva only.

Eighteen patients were treated by vulvectomy and then were given radiation in the form of x ray, radium element pack or radon

<sup>1</sup>As given, majority of patients succumb within 5 years, this figure is also given.

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TABLE III — RELATION OF ANATOMIC LOCATION TO END-RESULTS

Location	Labia majora		Labia minora		Clitoris		Posterior commissure	
	No	Per cent	No	Per cent	No	Per cent	No	Per cent
Number of cases	24		3				8	
Alive at 5 years	21	87.5	3	100	3	100	7	87.5
Alive at 1 year	24	100	3	100	3	100	8	100

seed implantation into the nodes. Only 1 (5.5 per cent) of this group survived 5 years and 1 died as a result of the radiation. Half of this group had enlarged nodes on original examination. The one successful case was in a patient whose nodes were deemed enlarged and suspicious of containing cancer.

*Location and its effect on end results.* The site of origin of the disease cannot always be made with great accuracy because of the contiguity of the structures and because the growth shows extension in all directions. Nevertheless, we were able to determine the localization of the disease with a fair degree of accuracy in most cases. Of 223 cases tabulated 133 or 59.6 per cent, originated on the labia majora 47 or 21 per cent on the labia minora and vestibule 27 or 12.1 per cent, on the clitoris and 13 or 5.8 per cent on the posterior commissure and perineal body. There were 2 cases of Bartholin gland origin also 1 on the mons veneris and one of the urethral meatus.

Table III shows the survival percentages of the primary group when divided according to site of origin. It has been our impression (and others, 16) that lesions of the clitoris are more virulent than those situated elsewhere. Although the number of cases is small the figures substantiate this impression.

*Histology and its effect on end-results.* In Table IV we have listed according to histologic type the 5 year cure rate of the primary group of cases. As would be expected the melanomas have the lowest number of survivals. One of the two 5 year survivals with this type of lesion died of disease at 7 years and although the other successful case had inguinal nodes positive for metastatic disease the outlook for most patients with this

TABLE IV — RELATION OF HISTOLOGIC TYPE TO END-RESULTS

Histology	Grade I		Epidermoid Grade II		Grade III		Melanoma		Basal cell carcinoma	
	No	Per cent	No	Per cent	No	Per cent	No	Per cent	No	Per cent
Number of cases	5		5		6		14		1	
Alive at 5 years	3	60	2	40	2	33.3	6	42.8	1	100
Alive at 1 year	5	100	5	100	6	100	14	100	1	100

type of histology is very poor. Because of this, we advocate removal of nearly all pigmented tumors in this region.

Of the 5 patients with basal cell carcinomas 2 did not survive 5 years. However 1 of these patients died of another cause entirely unrelated to her cancer. Basal cell cancers, as is known are of a less virulent nature and tend to recur rather than metastasize but because of the exceedingly dangerous character of any cancer in this region we feel that vulvectomy and not so called wide local excision is the method of choice. These cancers do metastasize although not of course with the frequency of an epidermoid lesion. In Wilson's report of basal cell carcinomas in his own patients and those collected from the literature, 36 per cent died before reaching the fifth year.

The prognosis of the low grade epidermoid tumors appears from our series, to be approximately the same and undoubtedly is due to the vigorous form of treatment given a relatively weak lesion. The figures are too small for comparison of the grade II lesions with those of a more anaplastic type. It is our clinical impression however that most tumors more differentiated than grade I have a fairly similar clinical course. There was 1 patient with dermatofibrosarcoma protuberans of the vulva who is alive and well over 5 years.

## SECONDARY GROUP

The patients falling into this classification were followed separately and analyzed in an identical manner. Treatment of patients was the same throughout. In general the survival times for this group are similar to those of the primary this is especially so as regards overall 5 year cure rates (Table I). Of 16 patients in class 1A (lesion localized to the vulva clinical

ly) 7 or 43 7 per cent survived 5 years this is a somewhat higher figure than in the primary group. Of 9 patients whose nodes were "suspicious" or thought to be enlarged (class 2A) but not dissected, only 1 (11.1 per cent) patient survived 5 years.

Fifteen patients fell into class 2B (positive inguinal nodes) and of this number 3 or 20 per cent survived 5 years this, too, is slightly better than the other group. In 2 of these successful cases the groin dissection performed was unilateral. All of these dissections were of the superficial type. Four other patients had 2 bilateral but no patient survived more than 3½ years. Treatment with x ray and radium gave equally poor results. When analyzed as to location lesions on the clitoris and labia minora seemed most virulent but the number of patients involved is small. Histologic types likewise showed no variation from the primary group there was only 1 patient with basal cell carcinoma and she died of cancer in 3½ years. In comparing the two large groups the similarity of end results is evident. This is so despite the fact that the secondary cases received treatment elsewhere and were treated by us in what we may assume is a later stage of the disease. In some cases therefore it would seem that there is a favorable period in which the disease is amenable to therapy, but once beyond this point no treatment appears successful.

#### COMMENT

It is needless to point out the marked difference between the early low grade lesions and those which have become metastatic and invasive. After studying groups of patients it becomes apparent that those who have received more vigorous and prompt treatment do better. Vulvectomy with at least a bilateral superficial groin dissection should be done in all cases adequate for surgery. Firm basis for this is seen in the high percentage of survivals (80 per cent) in the group with negative nodes (1B) where this was done, and the relatively poor showing (47.6 per cent) of the group (1A) where only vulvectomies were done because the nodes were thought to be negative at the time.

Our experience with the Basset type of groin dissection is still too young for definite opinion. Empirically one is always justified in removing all areas to which the disease may spread but it is somewhat questionable if in this condition removal of cancerous iliac nodes changes the prognosis. In Taussig's (15, 16, 17, 18) series this type of dissection was done in a large number of patients but only 48.4 per cent of his operative cases had nodes positive for carcinoma and we do not know whether the inguinal nodes alone or the inguinal and iliac nodes together were involved. If the former circumstance exists a groin dissection as done by us in the series just reviewed should remove all positive nodes in this region. It would not, of course, remove any more highly placed metastatic deposits removal of which theoretically at least may give a higher survival rate.

We have no way of telling from our series whether excision *en masse* (i.e. groins and vulva together) or in stages as practiced by us at present, is the procedure of choice. Certainly a high percentage of patients in this age group are not ideal surgical risks and a two or three stage procedure may be tolerated with less difficulty.

Because of the very malignant nature of melanomatous lesions of the vulva it seems that removal of all pigmented tumors in this area is the only safe course to follow. As it is impossible to tell when a neuronevus or pigmented mole will begin to show cancerous change its local excision before this eventuality removes the threat which is ever present.

#### SUMMARY

Two hundred and twenty-eight cases of cancer of the vulva were studied. The condition is most prevalent during the seventh decade over half the patients experienced pruritus, and more than 80 per cent of the lesions were of the epidermoid variety. The melanomas showed the lowest survival rate. One hundred cases form the basis for the report of 5 year cure rates. Best results were obtained when a vulvectomy and bilateral groin dissection without removal of the iliac nodes, was performed. When the disease extends to the inguinal lymph nodes the prog-

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nosis is markedly altered. The overall absolute  
5 year cure rate was 26.00 per cent

## REFERENCES

1. BALDWIN L. G. *Am. J. Obst.* 193 728
2. BERMAN W. *Am. J. Obst.* 194 42 70-076
3. BLAIR BELL, W. and DARTMOUTH W. *Brit. Empire* 035, 43 755
4. FOLDSOME, CLAIR, L. *J. Am. M. Ass.* 1940, 4 1400
5. GOEBEL, H. and HAWKINS I. *Zbl. Gyn.* 937 6
6. HOCK, R. H. and DIXON I. L. *Am. J. Obst.* 043
7. KNIGHT R. *Am. J. Obst.* 043, 40 5 4 524
8. LEVIN S. S., and CLARK H. M. *Surge. Clin. N. America*, 1944, 24
9. LOVELADY S. B., McDOUGALL J. R. and WADEN, J. M. *Am. J. Obst.*, 1941 43 304-309.
10. MORSE A. H. *Am. J. Obst.*, 1930, 9 320
11. NOVAK, E. and STEVENSON R. R. *Am. J. Obst.*, 1945, 50 611-650.
12. SCHREINER, H. F. and WELCH, W. H. *Surg. Gyn. Obst.*, 1914, 58 1021
13. SHANKOV W. F. and MARTINO F. *Am. J. Obst.*, 1914, 58 1021
14. TAVASIO, I. J. *Diseases of the Vulva*, New York Appleton & Co. 1933
15. Idem. *In Treatment of Cancer and Allied Diseases* by G. T. Jack and I. M. Livingston, p. 113, New York Paul B. Hoeber, 1919, 40 764 770.
16. Idem. *Am. J. Obst.*, 1919, 40 764 770.
17. Idem. *Am. J. Obst.*, 1919, 40 764 770.
18. Idem. *Cancer Res.*, 1911, 1 901-904.
19. WELCH, C. E., and NATHANSON, J. T. *Am. J. Cancer* 1937, 3 580.
20. WILSON J. S. *Arch. Surg.*, 1941 43 1112.

# MEDULLARY NAILING OF FRACTURES OF THE LONG BONES

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THE treatment of fractures of the long bones by means of medullary nailing was introduced by Kuentscher in 1940. During the war the procedure was used rather extensively in Germany, and there are numerous reports on the subject in German literature. Boehler (2) in 1944, after studying the histories of more than 500 patients and over 10,000 x-ray films published a book on medullary nailing. The treatment has also been discussed to some extent in South American literature and Jimeno-Vidal and Guttner reported on approximately 100 cases. No reports on the use of medullary nailing by surgeons in this country have yet appeared although a few foreign reports have been reviewed in our literature (3, 8, 9). The treatment has interesting possibilities and this preliminary report on an adaptation of the method in the treatment of 7 fractures is presented with a view to provoking discussion.

In principle the Kuentscher method consists of introducing a long metallic splint through the medulla of both fragments. The splints are constructed of V<sub>2</sub>A<sub>3</sub> steel and are bilaminar and V shaped in cross section. They are made in different sizes and lengths. The nail is introduced at a distance from the site of the fracture. Its upper end which is perforated, remains outside the bone permitting the removal of the nail after healing has been established.

In the cases reported herein nails made of tantalum were used which is a nonelectrolytic metal and free from the flaws in metals requiring casting. The technique consisted of first opening the site of fracture and cleaning the ends of the fragments. The nail was introduced into the proximal fragment then the fragments were approximated and the nail was directed into the wound and driven into

the medulla of the distal fragment. With increasing study of this method it has seemed that a nail with a slight curve would provide for greater leverage and better immobilization than would the straight nail.

Medullary nailing has several advantageous features. It ensures the prompt establishment of absolute immobilization. The adjacent joints however remain free permitting motion to be started promptly. Because of the complete fixation ambulation or use of the extremity is possible at a surprisingly early date. It is particularly impressive to see a patient with a fracture of the mid femur walking with the aid of crutches in less than 3 weeks after the reduction. No supportive apparatus or plaster cast is necessary. Patients with fractures of both bones of the lower leg can walk in less than 2 weeks. A patient with a fractured humerus has good use of the arm in less than 2 weeks. Such early motion obviates the sequelae of rigidity, circulatory disorders and atrophy from disuse. Because of the complete immobilization the patient is free from pain. When the patient is elderly the advantages of early motion are obvious.

The indications for medullary nailing are still not well defined. During the war it was used in Germany in treating fresh fractures of the femur, tibia, humerus, elbow, radius and clavicle as well as in cases of pseudarthrosis but there is still no authorization for such wide application of the procedure. Boehler (2) concluded from his intensive study that only a limited number of fractures are suitable for medullary splinting and that the best results are obtained in transverse and short oblique fractures above the middle of the femur. Boehler (2) recognized definite contraindications in fresh open fractures of the leg, infected fractures and in fractures in children. On the other hand, Ehalt used the method principally, and with success in open fractures of the lower leg.

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Fig. 1 left. M. B. The original fracture with medial displacement of the distal fragment.  
Fig. 2. M. B. Roentgenogram taken 9 weeks after medial medullary splinting.



Fig. 3 left. A. M. Roentgenogram showing comminuted fracture with displacement following unsuccessful attempt at open reduction with screw fixation.  
Fig. 4. A. M. Roentgenogram taken 6 months after medial medullary splinting showing solid union.

At the present time the method seems suitable for selected cases. Whether its field of application will broaden with more extensive use remains to be determined. The procedure offers a solution for the treatment of simple fractures of the femur that are situated just below the greater trochanter in which it is difficult to overcome and control the medial displacement of the distal fragment. Also comminuted fractures in this area, which ordinarily require long surgical procedures for fixation by plates are suited for the medullary method. Indications may be recognized in slanting and comminuted fractures of the up-

per end of the humerus that are difficult to treat. The method may be considered in treating fractures of both bones of the lower leg at the junction of the mid third which, under other forms of treatment, may require prolonged immobilization that prohibits early motion at the ankle joint, and in which non-union may occur if the fragments are not perfectly aligned.

There are several features of the method of medullary fixation that have come under discussion. The question is raised as to the danger of infection from introducing a long metallic splint into the medullary canal. German operators claim that such danger is minimized by the insertion of the splint at a distance from the site of the fracture. In the 7 cases reported herein in which the fractures were opened no infection was encountered. The routine use of penicillin of course, minimizes such danger.

The advisability of using the method in open fractures has been discussed. Some operators as Boehler (2) believe that its use is limited in these fractures. Other operators, as Ehalt, have reported excellent results in open fractures. In 1 of the cases included in this paper the fracture was an open one in which a fragment had protruded for as much as 6



Fig. 5, left. M. S. Roentgenogram showing long refracture of the humerus with angulation.  
Fig. 6. M. S. Roentgenogram taken 3 months after medial medullary nailing, showing callus formation.



Fig 7

Fig 8.

Fig 9.

Fig 7. C. N. Roentgenogram of the original fracture showing the protrusion of the proximal fragment through the wound.

Fig. 8. C. N. Roentgenogram taken immediately after medullary nailing.

Fig. 9. C. N. Roentgenogram taken 3 weeks after medullary nailing, showing callus formation.

inches outside the wound for a period of more than 6 hours before the medullary splinting. There was no unfavorable reaction following the fixation.

The necessity of the removal of the splint is another question that may be raised. Most patients prefer to have foreign material removed. When tantalum is used the removal of the splint may not be considered necessary.

Whether callus formation takes place earlier with consequent accelerating of the healing process as Kuentscher and other operators have claimed has been much debated. Boehler (2) Schneider and Swiss operators (1) have noted that the development of callus was slow and Boehler found that non-union not infrequently resulted. It would naturally be concluded that callus formation would be stimulated as the result of the complete and uninterrupted immobilization provided by this method. In 1 of the 7 cases being reported which was a fracture of both bones of the lower leg the appearance of callus in the third week after medullary fixation was particularly striking (Fig 9).

#### CASE REPORTS

**CASE 1.** M. B. a woman aged 78 years sustained a fracture of the right femur on September 4, 1945. The roentgenographic examination disclosed a fracture at the junction of the middle and upper thirds, with medial displacement of the distal fragment and about  $1\frac{1}{2}$  inches of overriding of the fragments (Fig 1).

On September 11, 1945 a medullary nailing was carried out according to the following technique. An incision was made beginning just above the greater trochanter and extending downward to about 2 inches below the site of the fracture. The greater trochanter and fracture cavity were exposed and the blood clots and torn tissues were removed. A drill hole was made in the greater trochanter and enlarged by introducing a curved hemostat. The medullary nail was inserted into the medulla of the proximal fragment and driven through to the fracture site. The fragments were aligned. The nail was then driven into the medulla of the distal fragment. The deep tissues were closed with chromic catgut and the skin was closed with silk. A roentgenogram was taken to check the position.

The disorientation of the patient made it necessary to place the limb on a Braun's splint and apply 5 pounds of traction. Movement of the ankle joint and toes was begun on the day following the operation. In 1 week when the patient's mental condition had improved, the splint was removed, and she

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Fig. 10.

Fig. 10. A. G. Roentgenogram of the original fractures of the tibia and fibula.



Fig. 11.

Fig. 11. A. G. Roentgenogram showing unsatisfactory treatment of the fractures by skeletal traction.

Fig. 12. A. G. Roentgenogram taken following medullary splinting.

Fig. 12. A. G. Roentgenogram taken following medullary splinting.

began to exercise the hip and knee freely and with out pain.

From that time recovery was rapid. Within 3 weeks she was walking with the aid of crutches. A roentgenogram taken on November 14, 1945 shows the callus formation in 9 weeks after the medullary splinting (Fig. 2).

**CASE 2.** A. M., a 79 year old male fractured the right arm on March 15, 1945. The roentgenographic examination showed a comminuted fracture of the upper humerus with displacement. Several unsuccessful attempts were made to reduce the fracture by manipulation. On March 18, 1945, an open reduction with screw fixation was carried out without success (Fig. 3).

On April 5, 1945, a medullary nailing was carried out according to the following technique. An incision was made to expose the fracture cavity and the upper end of the humerus. A drill hole was made in the humeral head and enlarged by means of a curved hemostat. A medullary nail was introduced into the medulla of the proximal fragment. The fragments were approximated and the nail was driven through the distal fragment. The wound was closed and the position of the fragments checked by a roentgenogram.

Within 2 weeks the patient was using the arm and had no complaint. Union took place rapidly. A roentgenogram taken on October 11, 1945, 6 months after the medullary nailing showed solid union (Fig. 4). The patient refused to consider the removal of the splint.

**CASE 3.** M. S., a woman aged 25 years, refractured the upper end of the humerus on December 23, 1945. She had previously fractured the humerus on August 19, 1945. The site of the fracture was in the upper end just below the tuberosity. At that time the fracture had been treated conservatively by another physician. Union was slow and a roentgenogram taken on December 20, 1945, showed a slight amount of callus with angulation of the fragments. Figure 5 shows the refracture with a 40 degree angulation that caused a noticeable protuberance on the anterior aspect of the shoulder.

On December 28, 1945, a medullary nailing was carried out according to the technique that has been described under Case 2.

Motion was started at the elbow and shoulder on the twelfth day after the operation. In less than 3 weeks the patient was using the arm. Eight weeks after the reduction, all motions were normal except abduction of the shoulder which was limited 5 degrees. The patient had returned to work. Fourteen weeks after the reduction, abduction was limited 10 degrees but this limitation was due to the protruding end of the splint hitting against the acromion. Removal of the splint was advised. A roentgenogram taken on April 2, 1946 shows the union (Fig. 6).

**CASE 4.** C. N., a 9 year old child, on March 1, 1946, in a coasting accident, sustained a compound fracture of the right tibia and fibula. The fracture was of the spiral type, and the proximal fragment protruded through a lacerated wound for about 6

inches (Fig 7) It was 6 hours before the fracture was operated upon

Medullary fixation was carried out as follows A thorough débridement was performed and the fractured ends were cleaned. The medullary splint was introduced into the medulla of the proximal fragment of the tibia the fragments were aligned and the splint was driven into the medullary canal of the distal fragment. The wound was closed (Fig 8) Penicillin was advised

On March 14, 1946, 2 weeks after the reduction the patient was walking with the aid of crutches. She had no pain. The temperature was normal A roentgenogram taken on March 21 1946 3 weeks after the reduction, showed callus formation (Fig 9)

CASE 5 A. G. a male aged 51 years fractured both bones of the lower leg on February 27 1946 The fractures were of the spiral type with comminution, and the distal fragment of the fibula was displaced posteriorly (Fig 10) Reduction was attempted by another physician by the use of skeletal traction with a Steinmann pin through the os calcis but the result was unsatisfactory (Fig 11)

On February 28, 1946 medullary nailing of both the tibia and fibula was done (Fig 12) The splint was introduced into the fibula from the distal end.

In addition, 1 other subtrochanteric fracture of the femur and 1 comminuted fracture of the upper end of the humerus have been treated by medullary nailing The rapidity of recovery of motion and functional capacity has paralleled that in the cases described

## SUMMARY

A series of 7 fractures of the long bones which were treated by an adaptation of the Kuentscher medullary splinting method has been reported.

The method is still in its infancy, and many of its features are under discussion Indications for its use are not yet well defined, but it would seem to offer a solution of treatment for certain selected fractures. The method has the great advantage of providing for absolute immobilization yet at the same time leaving the adjacent joints free, thereby making possible the use of the extremity at a surprisingly early date

## REFERENCES

1. BURCHER, E. Personal communication 1945
2. BOKSILER, L. Die Technik der Knochenbruchbehandlung im Frieden und im Kriege. Vienna W Maudrich, 1944
3. Idem. Chirurg, 1943, 15 8. Abstracted in Bull. War M. Lond., 1943, 4 16
4. EHALT W. Zbl. Chir., 1942, 69 1849.
5. JIMENO-VIDAL, F., and GUTIERREZ, L. Rev. méd. Chile, 1943, 71 383.
6. KUENTSCHER, G. Zbl. Chir. 1940, 67 1145.
7. SCHNEIDER, E. Zbl. Chir., 1942, 69 1854.
8. TORDTOR, B. V. and MORTS, E. J. J. Am. M. Ass. 1945 128 792
9. WESTERBORN, A. Acta chir. scand. 1944, 90 89 J Bone Surg 1945, 27 530.

## SURGERY GYNECOLOGY AND OBSTETRICS

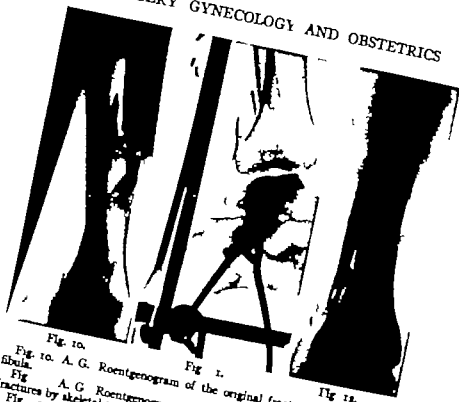


Fig. 10.

Fig. 10. A. G. Roentgenogram of the original fractures of the tibia and fibula.

Fig. 11.

A. G. Roentgenogram showing unsatisfactory treatment of the fractures by skeletal traction.

Fig. 12.

A. G. Roentgenogram taken following medullary splinting.

began to exercise the hip and knee freely and with out pain.

From that time recovery was rapid. Within 3 weeks she was walking with the aid of crutches. A roentgenogram taken on November 14, 1945 shows the callus formation in 9 weeks after the medullary splinting (Fig. 2).

**CASE 2.** A M. a 79 year old male fractured the right arm on March 15, 1945. The roentgenographic examination showed a comminuted fracture of the upper humerus with displacement. Several unsuccessful attempts were made to reduce the fracture by manipulation. On March 18, 1945, an open reduction with screw fixation was carried out without success (Fig. 3).

On April 5, 1945, a medullary nailing was carried out according to the following technique. An incision was made to expose the fracture cavity and the upper end of the humerus. A drill hole was made in the humeral head and enlarged by means of a curved hemostat. A medullary nail was introduced into the medulla of the proximal fragment, the fragments were approximated, and the nail was driven through the distal fragment. The wound was closed, and the position of the fragments checked by a roentgenogram.

Within 2 weeks the patient was using the arm and had no complaint. Union took place rapidly. A roentgenogram taken on October 11, 1945, 6 months after the medullary nailing showed solid union (Fig. 4). The patient refused to consider the removal of the splint.

**CASE 3.** M. S. a woman aged 35 years, refractured the upper end of the humerus on December 23, 1945. She had previously fractured the humerus on August 19, 1945. The site of the fracture was in the upper end just below the tuberosity. At that time the fracture had been treated conservatively by another physician. Union was slow and a roentgenogram taken on December 20, 1945, showed a slight amount of callus with angulation of the fragments. Figure 5 shows the refracture with a 40 degree angulation that caused a noticeable protuberance on the anterior aspect of the shoulder.

On December 28, 1945, a medullary nailing was carried out according to the technique that has been described under Case 2.

Motion was started at the elbow and shoulder on the twelfth day after the operation. In less than 3 weeks the patient was using the arm. Eight weeks after the reduction, all motions were normal except abduction of the shoulder which was limited 35 degrees. The patient had returned to work. Fourteen weeks after the reduction, abduction was limited 10 degrees, but this limitation was due to the protruding end of the splint hitting against the acromion. Removal of the splint was advised. A roentgenogram taken on April 2, 1946, shows the union (Fig. 6).

**CASE 4.** C. N. a 9 year old child, on March 1, 1946, in a coasting accident, sustained a compound fracture of the right tibia and fibula. The fracture was of the spiral type, and the proximal fragment protruded through a lacerated wound for about 6

inches (Fig 7) It was 6 hours before the fracture was operated upon.

Medullary fixation was carried out as follows. A thorough débridement was performed and the fractured ends were cleaned. The medullary splint was introduced into the medulla of the proximal fragment of the tibia, the fragments were aligned and the splint was driven into the medullary canal of the distal fragment. The wound was closed (Fig 8). Penicillin was advised.

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CASE 5. A G. a male aged 51 years fractured both bones of the lower leg on February 27, 1946. The fractures were of the spiral type with comminution and the distal fragment of the fibula was displaced posteriorly (Fig 10). Reduction was attempted by another physician by the use of skeletal traction with a Steinmann pin through the os calcis, but the result was unsatisfactory (Fig 11).

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A series of 7 fractures of the long bones which were treated by an adaptation of the Kuentscher medullary splinting method has been reported.

The method is still in its infancy and many of its features are under discussion. Indications for its use are not yet well defined, but it would seem to offer a solution of treatment for certain selected fractures. The method has the great advantage of providing for absolute immobilization yet at the same time leaving the adjacent joints free thereby making possible the use of the extremity at a surprisingly early date.

## REFERENCES

1. BIRCHER, F. Personal communication, 1945.
2. BOEHLER, L. Die Technik der Knochenbruchbehandlung im Frieden und im Kriege. Vienna: W. Maudrich, 1944.
3. Idem. *Chirurg.* 1943, 15: 8. Abstracted in *Bull. War M. Lond.* 1943, 4: 10.
4. EHRLICH, W. *Zbl. Chir.* 1942, 69: 1849.
5. JOHNSON-VIDAL, F. and CUTTNER, L. *Rev. méd. Chile* 1943, 71: 383.
6. KUENTSCHER, G. *Zbl. Chir.* 1940, 67: 1145.
7. SCHNEIDER, E. *Zbl. Chir.* 1942, 69: 1854.
8. TORDJIAN, B. M. and MOEHR, E. J. *J. Am. M. Ass.* 1945, 128: 792.
9. WESTERBORN, A. *Acta chir. scand.* 1944, 90: 89. *J. Bone Surg.* 1945, 27: 530.

## SURGERY GYNECOLOGY AND OBSTETRICS

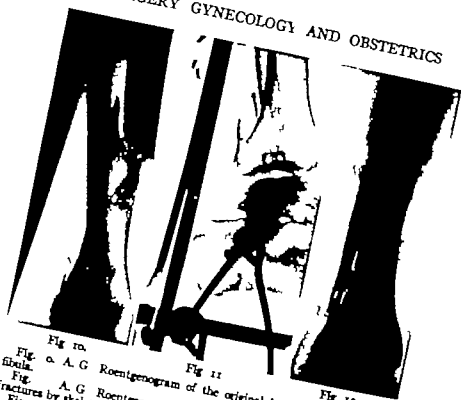


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Fig. 12. A. G. Roentgenogram taken following medullary splinting.

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CASE 3. M. S. a woman aged 35 years, re-fractured the upper end of the humerus on December 23, 1945. She had previously fractured the humerus on August 19, 1945. The site of the fracture was in the upper end just below the tuberosity. At that time the fracture had been treated conservatively by another physician. Union was slow and a roentgenogram taken on December 30, 1945 showed a slight amount of callus with angulation of the fragments. Figure 5 shows the refracture with a 40 degree angulation that caused a noticeable protuberance on the anterior aspect of the shoulder.

On December 28, 1945 a medullary nailing was carried out according to the technique that has been described under Case 2.

Motion was started at the elbow and shoulder on the twelfth day after the operation. In less than 3 weeks the patient was using the arm. Eight weeks after the reduction, all motions were normal except abduction of the shoulder which was limited 35 degrees. The patient had returned to work. Fourteen weeks after the reduction, abduction was limited 10 degrees, but this limitation was due to the protruding end of the splint hitting against the acromion. Removal of the splint was advised. A roentgenogram taken on April 3, 1946 shows the union (Fig. 6).

CASE 4. C. N. a 9 year old child, on March 4, 1946 in a coasting accident, sustained a compound fracture of the right tibia and fibula. The fracture was of the spiral type, and the proximal fragment protruded through a lacerated wound for about 6

suprapubic approach fails because partial prostatectomy is usually done (2, 3), thus leaving a stump of prostate and urethra which may be the seat of carcinoma. Such was the case in S P (Montefiore Hospital No 34945) in whom residual neoplasm was found in the posterior urethra and in the prostatic stump after a suprapubic total cystectomy. This patient subsequently died with multiple metastases.

The perineal approach to the bladder neck and prostate, proposed by Kuester (1) and employed by others (2, 9, 12), when it is combined with a suprapubic incision permits a truly radical extirpation of the unopened bladder with the entire prostate both seminal vesicles and posterior urethra in 1 piece (Figs. 5, 6, 7, 8). The perineal incision simplifies the mobilization of the urethra, prostate and bladder neck and affords excellent dependent drainage.

The operation is done in 2 stages. Prior to each, the patient is prepared with sulfasuxidine, colonic irrigation, and cathartics. At the first stage the right ureter is implanted extraperitoneally into the sigmoid colon by the Coffey 1 or 2 technique (5, 8). At the second stage total cystectomy total prostatectomy bilateral seminal vesiculectomy and posterior urethrectomy are performed by the combined perineoabdominal method, and the left ureter is implanted into the sigmoid colon.

#### TECHNIQUE FOR THE COMBINED PERINEO- ABDOMINAL OPERATION

*1 Perineal incision* With the patient in the exaggerated lithotomy position and a Lowley prostatic tractor in the bladder, an inverted U incision is made through the perineal skin (Fig. 2). The central tendon is identified and divided. The exposed fibers of the rectourethralis are cut, separating the bulb from the rectum. The glistening fascia of Denonvilliers is brought into view, and its posterior layer incised transversely exposing the apex of the prostate and the urethra. The posterior leaf of Denonvilliers fascia is then bluntly separated from the posterior surface of the prostate seminal vesicles, and bladder as high as the finger can reach. The urethra is isolated doubly tied and divided, as far ante-

riorly as desired (Fig. 3). The ligated proximal stump of the urethra is then drawn downward exposing the anterior surface of the prostate and bladder (Fig. 4). The pubo-prostatic ligaments are brought into view and cut along with other adhesions.

At this stage the trigone, the vesical neck, the prostate the seminal vesicles, and the posterior urethra have been mobilized and hang attached only to the upper portion of the bladder (Fig. 1). Bleeding vessels are tied, and the perineal skin is approximated by interrupted plain catgut sutures with a soft rubber tube for drainage.

*2 Suprapubic abdominal incision* With the patient flat on his back in moderate Trendelenburg position a wide transverse skin incision is made about 3 centimeters above the symphysis pubis. The anterior rectus fascia and the fascia of the external oblique are cut transversely the full length of the incision. The rectus muscles are bluntly separated in the midline and retracted laterally. In some cases, part of the pubic insertion of the rectus must be severed in order to obtain adequate exposure. The dome of the bladder is then separated from the peritoneum by sharp and blunt dissection.

The peritoneum is opened sufficiently for inspection and exploration and then closed with a continuous chromic catgut suture. The anterior, posterior and lateral walls of the bladder are freed from the surrounding tissues by sharp and blunt dissection the strands containing the various vesical arteries and veins being doubly tied and cut. The region of the bladder neck and prostate already mobilized through the perineal incision, is soon reached. The bladder now lies free attached only by the vasa deferentia and the ureters. These structures are isolated, doubly tied and cut, thus allowing the unopened bladder with its attached organs to be removed from the wound.

The ligated right ureter is left in place since its proximal portion has already been implanted in the sigmoid colon at the preliminary operation. The left ureter is implanted extraperitoneally by the Coffey 1 or 2 technique. The abdominal wound is closed in layers with the long through and through rub-



## TOTAL CYSTECTOMY BY THE COMBINED PERINEOABDOMINAL METHOD

SEYMOUR F WILHELM M D., F.A.C.S New York, New York

**E**XPERIENCE has shown that surgical excision offers the best hope for the cure of infiltrating carcinoma of the bladder. If the neoplasm is confined to the dome or to the movable walls and is not too extensive partial resection of the bladder may suffice. On the other hand if the carcinoma involves the trigone and region of the vesical neck or if the tumors are multiple removal of the entire bladder prostate and posterior urethra is often the only effective procedure.

In 67 cases of partial bladder resection Beer and Hyman (3, 7) reported an immediate operative mortality of over 25 per cent and a recurrence rate of at least 32 per cent. Eight additional patients died eventually of carcinoma. These results clearly indicate that partial resection is frequently not sufficiently radical. Carcinoma cells often infiltrate in the submucous layers of the bladder far beyond the apparent limits of the growth. The occult nature of these infiltrations unfortunately deludes the surgeon into believing that an adequate resection has been done. Such was the case with L. G. (Beth Israel Hospital No 165289) in whom a solid neoplasm was excised from the left lateral wall with a generous surrounding rim of apparently normal bladder. However biopsies from the edge of the seemingly normal bladder wall still in the body revealed carcinoma in the submucosa. This patient was reoperated upon a total cystectomy and prostatectomy were done.

Pioneers in the field of total cystectomy have reported an operative mortality of from 18 to 59 per cent (3, 6, 11). This alarming prospect has deterred many urologists from ever attempting the operation. However improved technique, earlier operation and the use of sulfa drugs have greatly reduced the operative risk. In the series forming the basis

of this report, 15 total cystectomies were done without an operative death.

In the first 8 cases operation was done by the Beer technique (4) in which a total cystectomy and partial prostatectomy (6 men) were done extraperitoneally through a suprapubic abdominal incision with cutaneous implantation of the ureters, in 1 stage. Although the patients withstood the operative procedure rather well they subsequently all had a good deal of trouble with the care of their ureterostomy tubes. leakage of urine recurrent attacks of pyelonephritis, and calculus formation. The carcinoma was well advanced in most of the patients, 4 having previously undergone less radical bladder operations. Ultimately 3 patients died with metastases, the other 5 succumbing to renal infection and uremia. The outlook following total cystectomy with cutaneous ureteral implantation is certainly far from encouraging. No patient lived much over 2 years or was able to lead a comfortable normal life.

The unsatisfactory results following cutaneous ureterostomy have encouraged us, whenever possible to implant the ureters into the sigmoid colon especially since the advent of sulfasuxidine and the other sulfa drugs. Following successful ureterosigmoid implantation, our patients have lived a comfortable normal life voiding through the rectum with control.

Infiltrating carcinoma in the region of the trigone and the bladder neck not uncommonly invades the prostate and the posterior urethra. Therefore any operation intended for the cure of such a lesion must be designed to extirpate completely in one piece the unopened bladder with the entire prostate, both seminal vesicles and the posterior urethra. In the female the suprapubic abdominal approach is usually adequate for a total excision of the bladder along with a generous portion of the urethra. In the male on the other hand, the

From the Genitourinary Surgical Service, Beth Israel Hospital, New York.

both kidneys. On May 4, 1944 the patient left the hospital in good condition voiding every 2 hours through the rectum.

He re-entered the hospital on August 10, 1944 complaining of pain in the region of the pubis, groins and thighs. Seven weeks before, the suprapubic wound had spontaneously opened with persistent purulent drainage. An x-ray film of the pelvis showed no evidence of metastasis. The wound was irrigated with Dakin solution and both sulfadiazine and penicillin were administered. Following a course of x-ray therapy to the pubic area, the pain abated and the purulent discharge diminished. The patient left the hospital improved on August 26, 1944.

He was again admitted to the hospital on December 10, 1944, for further revision of the suprapubic sinus and left 2 days later. He re-entered the hospital on January 15, 1945, suffering from lobar pneumonia. During this time, the wound was packed and irrigated and gradually healed except for a pinpoint sinus tract.

On June 8, 1945, there was moderate bulging of the suprapubic wound. The general condition was excellent, the patient voiding every 2 or 3 hours through the rectum, with good control.

The patient remained well and on September 15, 1945, the wound had practically healed. When last seen at the Follow up Clinic on June 6, 1946, the patient had no complaints and was in good health.

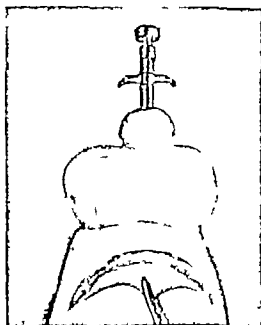


Fig. 2. Perineal skin incision with tractor in place.

**CASE II** (Beth Israel Hospital No. 168686) This 65 year old man first entered the hospital on December 8, 1944, complaining of frequent and painful urination for the past 9 months. He had noticed that his urine was cloudy and had for some time been treated with urinary antiseptics and prostatic mas-

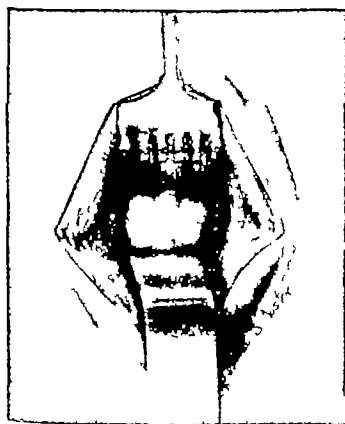


Fig. 3. The prostate is exposed prior to the mobilization of the urethra.

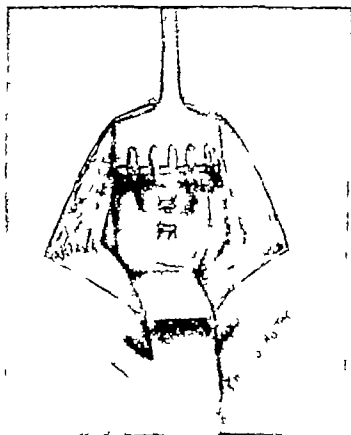


Fig. 4. Urethra tied and divided, thus exposing the pubo-prostatic ligaments.

## SURGERY GYNECOLOGY AND OBSTETRICS

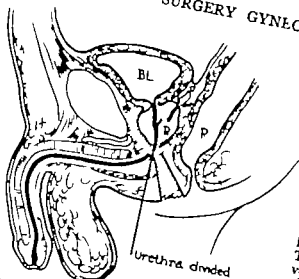


Fig. 1. Diagram showing the approximate extent of mobilization attained through the perineal incision.

ber drainage tube from the perineal wound coming out in the midline.

Five of the 6 patients operated upon by the perineoabdominal method with ureterostomy implantation, are living comfortably voiding through the rectum with good control. The remaining one (Case 12) suffered from an advanced carcinoma and died 5 months after operation with recurrent neoplasm filling the pelvis.

## CASE REPORTS

**CASE 9.** (Beth Israel Hospital Nos. 160361 and 161992) This 61 year old man entered the hospital on February 3, 1944, complaining of frequent painful bloody urination for the past 3 months. About 8 months before he had undergone a 2 stage supra pubic prostatectomy.

Cystoscopic examination revealed a large tumor mass on the left lateral wall of the bladder extending anteriorly and downward to the trigone surrounding the left ureteral orifice. Biopsies disclosed carcinoma. Excretory urography on February 3 showed good excretion and no abnormality of the renal pelvis and ureters. The cystogram showed an irregular filling defect on the left side of the bladder.

On February 5, 1944, a partial resection of the bladder was done. The excised specimen included the neoplasm with a generous cuff of apparently normal bladder wall surrounding it. Since the resected segment included the left ureteral orifice and part of the trigone, the left ureter was reimplanted in the posterior wall near the dome of the bladder. At the time of operation, biopsy specimens were taken from the normal-appearing edge of the trigone which remained in situ. These revealed submucous

carcinoma and, therefore total cystectomy and prostatectomy were advised.

On April 13, 1944, the right ureter was implanted extraperitoneally into the sigmoid colon by the Coffey 1 technique. On May 5, 1944, a total cystectomy prostatectomy seminal vesiculectomy and posterior urethrectomy were done by the combined perineoabdominal method. The left ureter was implanted extraperitoneally into the sigmoid colon by the Coffey 2 technique. The patient did well after operation and left the hospital on May 21, 1944.

An excretory urogram on May 18, 1944, revealed excellent excretion of both kidneys with, however, some increase in the dilatation of both pelvis and ureters. The patient improved steadily gained weight, but voided frequently through the rectum. He complained of pain over the pubis and, on August 1, 1944, re-entered the hospital for revision of a persistent draining suprapubic sinus. Biopsy of the tract showed inflamed tissue. The wound was packed and by December 1 was entirely healed. A short course of deep x ray therapy was given to the pubic area.

Excretory urography on January 16, 1945, showed fair excretion from both kidneys with dilatation of the left ureter. Blood nonprotein nitrogen on April 17, 1945 was 46 milligrams per cent.

An excretory urogram on November 26, 1945, showed excellent excretion from both kidneys and normal outlines of both pelvis. On May 14, 1946, the general condition was excellent, the patient's only complaint being frequent rectal urination.

Excretory urography on May 28, 1946, revealed excellent excretion from both kidneys and normal outlines of both pelvis and ureters.

**CASE 10.** (Beth Israel Hospital No. 161390) This 56 year old man entered the hospital on March 16, 1944, complaining of frequent and intermittently bloody urination of 6 months duration. On cystoscopic examination, an infiltrating partly papillary and partly solid tumor was seen on the right lateral wall, surrounding the right ureteral orifice and extending to the trigone and bladder neck. Repeated biopsies revealed papillary and infiltrating carcinoma. Excretory urography showed normal function of both kidneys and normal outlines of both renal pelvis and ureters. The cystogram showed a filling defect on the right side of the bladder.

On March 25, 1944, the right ureter was implanted into the sigmoid colon extraperitoneally by the Coffey 1 technique. Fourteen days later a total cystectomy prostatectomy seminal vesiculectomy and posterior urethrectomy were done by the combined perineoabdominal method (Figs. 5, 6). The left ureter was implanted extraperitoneally into the sigmoid colon by the Coffey 2 technique.

The postoperative course was smooth except for a right epididymitis with chills. An excretory urogram on April 26, 1944, showed excellent function of both kidneys with moderate dilatation of the pelvis and ureters. Another, on February 17, 1945, showed normal pelvis and ureters and excellent function of

ectomy seminal vesiculectomy and posterior urethrectomy were done by the combined perineoabdominal method. The urethra was divided 3 centimeters distal to the apex of the prostate (Figs 7-8). The left ureter was implanted into the sigmoid colon by the Coffey 2 technique.

The postoperative course was smooth, and an excretory urogram made on November 23, 1945, showed excellent excretion from both kidneys with only slight dilatation of the left ureter. The patient left the hospital on November 25, 1945.

On January 16, 1946, the patient felt well, had gained over 20 pounds, and was voiding through the rectum every 2 or 3 hours with good control. The perineal wound was healed but a pinpoint sinus still remained in the midportion of the abdominal scar.

The wounds healed and the patient returned to work. On May 23, he was feeling well and voiding through the rectum every 2 hours. The blood non-protein nitrogen was 36.7 milligrams percent, and the patient had gained over 30 pounds since operation had been performed.

**CASE 14** (Beth Israel Hospital No. 179761.) This emaciated 64-year-old woman entered the hospital on January 9, 1946, complaining of hematuria of over 8 months duration. At cystoscopy an infiltrating carcinoma was found involving almost the entire trigone and extending upward on the right lateral and posterior walls. Excretory urography showed excellent excretion from the left kidney and none from the right. The lower left ureter was moderately dilated. A left nephrostomy was done on January 11, and 24 days later the entire bladder with an attached portion of the urethra was excised through a transverse suprapubic incision. Because of the precarious condition of the patient, the left ureter was not implanted into the sigmoid colon, but was ligated *in situ* just above the bladder. The right ureter was reimplanted into the abdominal skin. On



Fig. 8. Case 4. Anterior view of excised specimen. Bladder has been opened.

February 28, the poorly functioning infected right kidney was excised.

Following these operations, the patient slowly regained her strength and left the hospital on March 24, 1946, with all the wounds healed. The nephrostomy was functioning well.

On May 22, the patient had gained 8 pounds and was strong enough to do light housework. Physical examination failed to reveal any evidence of recurrence or metastases, and the left nephrostomy was functioning well.

**CASE 15** (Beth Israel Hospital No. 181470.) This 57-year-old man entered the hospital with an extensive infiltrating carcinoma involving the trigone and posterior urethra and extending upward on the posterior and lateral walls of the bladder. On March 22, 1946, Dr. William Gunsberg and I implanted the right ureter into the sigmoid colon. Convalescence was satisfactory, and on April 11, the entire bladder with an attached segment of infiltrated peritoneum, the prostate, the posterior urethra, and the seminal vesicles were excised by the perineoabdominal method. The left ureter was implanted into the sigmoid colon.

Following operation, the temperature was elevated, and on the fifth postoperative day there was discharge of fecal material through both wounds. This gradually decreased in amount. Excretory urography on May 8, 1946, showed excellent excretion from both sides with mild dilatation of the right pelvis and ureter and normal outlines of the left pelvis and ureter. The patient left the hospital on May 2, 1946, in good physical condition voiding through the rectum with normal control. A small fistula persisted which occasionally discharged fecal matter.



Fig. 9. Case 4. Posterior view of excised specimen consisting of the entire bladder, the prostate, the posterior urethra, and the seminal vesicles.

## SURGERY "GYNECOLOGY AND OBSTETRICS

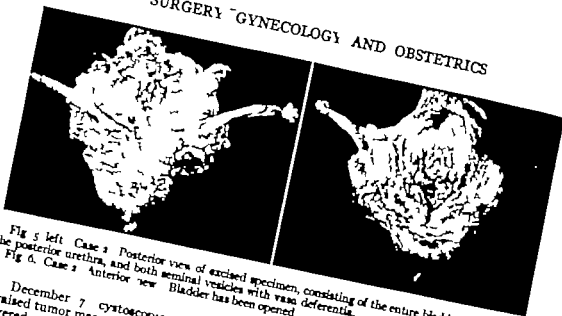


Fig 5. left Case 2. Posterior view of excised specimen, consisting of the entire bladder, the prostate, the posterior urethra, and both seminal vesicles with vas deferentia.  
Fig 6. Case 2. Anterior view. Bladder has been opened.

On December 7 cystoscopic examination showed a raised tumor mass about the size of a half dollar covered with slough, extending from the urethrovesical junction upward to the left posterior wall of the bladder. The first biopsy showed only inflammatory tissue but a subsequent biopsy revealed carcinoma with severe inflammation. On excretory urography there was poor excretion from both sides but no gross abnormality of the kidney or ureter. The cystogram showed a marked irregularity of the inferior and left lateral border of the bladder.

On December 21, 1944, the right ureter was implanted into the sigmoid colon extraperitoneally by the Coffey 1 technique. The new stoma, however, failed to function and no urine was excreted by the right kidney. A fecal fistula formed which persisted until January 10, 1945. On January 11 a right nephrostomy and decapsulation were done. There was a gradual return of renal function and the tube was draining well on January 23.

A total cystectomy, seminal vesiculectomy, prostatectomy and posterior urethrectomy were done on February 3, 1945, with implantation of the left ureter into the sigmoid colon by the Coffey 2 technique. Pathological examination showed partly papillary and partly solid carcinoma. Following operation, urine drained through the rectum and through the nephrostomy tube. The patient continued gradually to improve and on March 3, 1945, a retrograde pyelogram through the right nephrostomy tube revealed that the right ureter now communicated with the bowel. The patient was discharged to the Outpatient Department on April 4, 1945, with a functioning right nephrostomy.

On April 6 the right nephrostomy tube was closed for 3 days without ill effect and on April 10, it was removed. On April 26 the wound was closed and healed. An excretory urogram, taken the following day, showed fair excretion from both sides; the pelvis and calyces partially visualized, were not dilated. There was a large amount of opaque material in the sigmoid colon.

By June 8 the patient had gained 50 pounds. He continued to improve remarkably and when seen on November 3, 1945, had gained 33 pounds and was feeling well. Excretory urograms showed fair function of both kidneys. The patient voided through the rectum 3 times daily and once at night with good control.

When last seen on May 18, 1946, the patient's condition was excellent.

CASE 13 (Beth Israel Hospital No. 17738S.) This 63 year old man was first seen on October 9, 1945, complaining of frequent bloody urination of 5 weeks duration. Urination was hesitant and sometimes painful the stream was small. Five years ago, a papillary tumor of the bladder had been electrocuted and since then the patient had had no symptoms until the present illness.

Cystoscopy revealed considerable enlargement of both lateral lobes of the prostate, intraurethrally and intravesically. On the surface of the protruding left lateral lobe there was an elevated irregular red dened area which had the appearance of an infiltrating carcinoma. The neoplasm extended upward along the left lateral wall of the bladder and also anteriorly into the urethra for a short distance.

The patient entered the hospital on October 11, 1945, and on the next day biopsies were made and a transurethral prostatic resection was done, the visible portion of the neoplasm being removed entirely. The pathological report showed extensive papillary and solid carcinoma invading the left lateral prostatic lobe. Tissue removed from the right lateral lobe showed only benign hypertrophy. Excretory urography showed fair excretion from both sides. The right pelvis and ureter were normal, but the left revealed irregularity of the right lateral wall and inferior surface of the bladder with some trabeculation. The right ureter was implanted into the sigmoid colon extraperitoneally by the Coffey 2 technique, on October 19, 1945. Convalescence was uneventful and on November 1 a total cystectomy, prostate

ectomy seminal vesiculectomy and posterior urethrectomy were done by the combined perineoabdominal method. The urethra was divided 3 centimeters distal to the apex of the prostate (Figs 7-8). The left ureter was implanted into the sigmoid colon by the Coffey technique.

The postoperative course was smooth, and an excretory urogram made on November 23, 1945, showed excellent excretion from both kidneys with only slight dilatation of the left ureter. The patient left the hospital on November 25, 1945.

On January 16, 1946, the patient felt well, had gained over 20 pounds and was voiding through the rectum every 2 or 3 hours with good control. The perineal wound was healed but a pinpoint sinus still remained in the midportion of the abdominal scar.

The wounds healed and the patient returned to work. On May 23, he was feeling well and voiding through the rectum every 2 hours. The blood non-protein nitrogen was 36.7 milligrams percent and the patient had gained over 30 pounds since operation had been performed.

**CASE 14.** (Beth Israel Hospital No. 179761) This emaciated 64-year-old woman entered the hospital on January 9, 1946, complaining of hematuria of over 8 months duration. At cystoscopy an infiltrating carcinoma was found involving almost the entire trigone and extending upward on the right lateral and posterior walls. Excretory urography showed excellent excretion from the left kidney and none from the right. The lower left ureter was moderately dilated. A left nephrostomy was done on January 11 and 24 days later the entire bladder with an attached portion of the urethra was excised through a transverse suprapubic incision. Because of the precarious condition of the patient the left ureter was not implanted into the sigmoid colon but was ligated *in situ* just above the bladder. The right ureter was reimplanted into the abdominal skin. On



Fig. 8. Case 4. Anterior view of excised specimen. Bladder has been opened.

February 28 the poorly functioning infected right kidney was excised.

Following these operations the patient slowly regained her strength and left the hospital on March 24, 1946, with all the wounds healed. The nephrostomy was functioning well.

On May 22 the patient had gained 8 pounds and was strong enough to do light housework. Physical examination failed to reveal any evidence of recurrence or metastases and the left nephrostomy was functioning well.

**CASE 15.** (Beth Israel Hospital No. 181470) This 57-year-old man entered the hospital with an extensive infiltrating carcinoma involving the trigone and posterior urethra and extending upward on the posterior and lateral walls of the bladder. On March 22, 1946, Dr. William Ginsberg and I implanted the right ureter into the sigmoid colon. Convalescence was satisfactory and on April 11, the entire bladder with an attached segment of infiltrated peritoneum, the prostate, the posterior urethra and the seminal vesicles were excised by the perineoabdominal method. The left ureter was implanted into the sigmoid colon.

Following operation the temperature was elevated and on the fifth postoperative day there was discharge of fecal material through both wounds. This gradually decreased in amount. Excretory urography on May 8, 1946, showed excellent excretion from both sides with mild dilatation of the right pelvis and ureter and normal outlines of the left pelvis and ureter. The patient left the hospital on May 27, 1946, in good physical condition voiding through the rectum with normal control. A small fistula persisted which occasionally discharged fecal matter.



Fig. 7. Case 4. Posterior view of excised specimen containing the entire bladder, the prostate, the posterior urethra, and the seminal vesicles.

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## SUMMARY

Fifteen consecutive total cystectomies have been reviewed. There were no operative deaths.

In the first 8 cases operation was done through a suprapubic abdominal incision with bilateral cutaneous ureterostomy in 1 stage. None of these patients lived much over 2 years nor did any lead a comfortable life after this operation. Three died with distal metastases or with residual neoplasm in the stump of the prostate and urethra. 5 succumbed to renal infection and uremia.

Six male patients were operated upon by the combined perineoabdominal method with implantation of the ureters into the sigmoid colon. Five of the 6 men operated upon by this plan are living comfortably voiding through the rectum with normal control. The 1 remaining an advanced case survived the operations but died 5 months later with a large residual carcinoma.

The operation is done in 2 stages at the first, the right ureter is implanted extraperitoneally into the sigmoid colon at the second stage the bladder seminal vesicles prostate and posterior urethra are removed in 1 piece through a combined perineoabdominal approach, and the left ureter is implanted extraperitoneally into the sigmoid colon. In males the preliminary mobilization of the urethra prostate and bladder neck

through the perineal incision simplifies greatly the subsequent suprapubic excision of the bladder.

The combined perineoabdominal method is recommended in men suffering from infiltrating carcinoma of the vesical neck and trigone because it permits a truly radical excision of the bladder together with the attached posterior urethra the entire prostate and the seminal vesicles.

## REFERENCES

- ALABRAN J. *Médecine opératoire des voies urinaires*. P. 638. Paris Masson, 1900.
- BECK J. *Ann. Surg.*, 1929, 90, 864.
- Idem. *Tumors of the Urinary Bladder*. Baltimore: William Wood and Co., 1931.
- Idem. *Am. J. Surg.*, 937, 35, 92.
- COPPEY R. C. *Brit. J. Urol.*, 1931, 3, 353.
- HILMAN F. *The Principles and Practice of Urology*. P. 667. Philadelphia and London W. B. Saunders Co., 1935.
- HYMAN A. *Treatment of Cancer and Allied Diseases*. Vol. 3, p. 845. New York and London Paul Hoeber, 1940.
- PRIESTLEY J. T. and STROM, G. W. *J. Urol.*, 1945, 59, 30.
- SMITH, G. G. T. *Am. Ass. Genito-Urin. Surg.*, 1927, 30, 30.
- VOELCKER, F., and BOEHMKE, H. *Handbuch d. Urologie*. Vol. 1. Springer, 1926. Pp. 127-133. Berlin Julius and C. Fischer, 1926.
- WATSON F. S., and CUNNINGHAM, J. H., Jr. *Diseases of the Genito-Urinary System*. Vol. 1. Philadelphia and New York Lea and Febiger, 1908.
- YOUNG H. H., and DAVIS, D. M. *Practice of Urology*. Vol. 1, p. 508, and Vol. 2, p. 366. Philadelphia and London W. B. Saunders, 1927.

# THE SPLIT THICKNESS GRAFT—A USEFUL ADJUNCT IN TUBE PEDICLE PREPARATION

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THE tube pedicle is subject to complications which may delay its use or destroy valuable tissue. The most common complications are infection due to excessive tension and hematoma formation. The answer to these serious problems is the use of split thickness graft in the donor site area, which relieves tension and also allows adequate tissue to be taken. There is no undermining necessary thereby preventing hematomas. The purpose of this paper is to emphasize a method that will prevent the numerous difficulties that arise from the ordinary methods of tube formation.

Possible complications from tube pedicle formation are (1) infection which may be caused by (a) separation at angles, (b) separation of donor site suture (c) wide undermining (d) hematoma formation secondary to undermining and (e) excessive use of suture material (2) lowering of patient's resistance through loss of blood shock and prolonged

surgery and greater morbidity due to enlarged operative field from undermining (3) decreased blood supply and possible necrosis of tube due to undermining near each end of tube pedicle.

The prevention of infection in the tube determines its usefulness. The healing of each angle is extremely important in the use of any tube pedicle flap. These angles are necessarily dangerous and invite infection because of increased local tension at the junction of four contiguous suture lines. Circulation at the angle is embarrassed and the necessary sutures do little to improve this diminished blood supply.

Many have advocated various means to obliterate the dangerous angles, such as staggering incisions, and flap advancement beneath the tube. These techniques ingenious as they may be, still call for undermining to close the donor site, and invite the complications listed.

The split skin graft over the donor site and beneath the pedicle prevents these difficulties and assures an intact angle. Angle separation

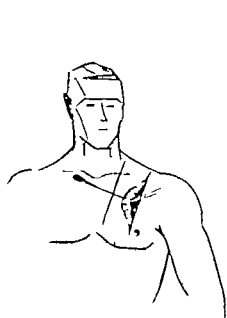


Fig. 1.

Fig. 1. Diagram showing lines of incision for neck-chest tube.

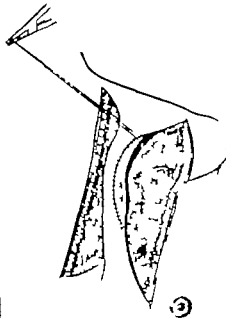


Fig. 2a.

Fig. 2. a. Closure of tube and suturing skin edges to fascia. b. Split thickness graft covering donor site.



Fig. 2b.



## SURGERY GYNECOLOGY AND OBSTETRICS

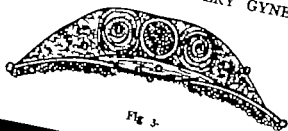


Fig. 3.

Fig. 3. Diagram of technique of dressing. 1 gauze roll to protect tube. 2 mechanical waste. 3 zeroform gauze. 4 gauze pressure pad to fit grafted area. 5 split thickness dermatome graft. 6 fat. 7 adhesive dressing. 8 size.



Fig. 4.

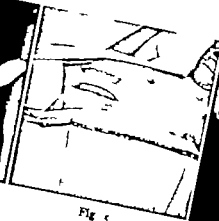


Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.

Figs. 4 to 7. Defect of hand reconstructed by thoracoparietal tube. 10th day postoperative. Note skin grafting donor site.

Figs. 8 to 11. Defect of foot reconstructed by thigh tube. 10th day postoperative. Note skin grafting donor site.

is eliminated because the graft produces countertraction at the angle and reduces tension at this danger point.

This graft technique (Figs. 1, 2 and 3) eliminates wide undermining which greatly jeopardizes the blood supply at the center of the tube. It eliminates the use of much heavy suture material to overcome lateral flap tension and approximation. With the former proposed tube by the need for enough skin laterally to reclose the donor site. When using a split thickness graft in the donor site ade-

quate tissue can be taken and still the donor site be closed with ease. The length of time necessary to close the resultant defect from the formation of a large tube must also be considered. In the routine tube preparation, when the donor site is closed either with or without layer approximation a thin wide tender scar results.

## TECHNIQUE

The common sites used in this clinic are abdominothoracic region, inner aspect of thigh, neck-chest, and upper arm. The pro-



Fig. 12.

Fig. 13

[ Fig. 14.



Fig. 15.

Fig. 16



Fig. 17

Fig. 18.



Fig. 19.

Fig. 20

Fig. 21.

Fig. 12 to 14. Defect of thigh reconstructed by thigh tube.  
 Fig. 12. Defect of thigh.  
 Fig. 13. Transfer of tube pedicle flap to defect.  
 Fig. 14. Defect completely covered with tube pedicle flap.  
 Figs. 15 and 16. Covering stump of forearm to preserve length for prosthesis by large thoracoepigastric tube.  
 Fig. 15. Attached tube flap to forearm.

Fig. 16. Stump covered with tube pedicle flap.  
 Figs. 17 to 21. Defect of scalp covered by arm tube.  
 Fig. 17. Recurrent epithelium forehead (basal cell carcinoma).  
 Fig. 18. Split thickness graft to cover excision defect.  
 Fig. 19. Arm tube grafting of donor site.  
 Fig. 20. Tube pedicle flap attached to forehead.  
 Fig. 21. Defect completely covered with tube pedicle flap.

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posed flap is undermined down to deep fascia between two parallel incisions which determine its width. One side at a time is undermined so as to determine the amount needed for a soft pliable tube in which there will be no tension on closure. If patient is obese, this is especially important and the procedure is relatively more difficult from beginning to end. The flap is then tubed until closure is prevented by slight tension at each end. The hemostasis must be as perfect as possible for upon this depends the success or failure of the procedure. Several interrupted subcuticular sutures are used, approximately 1 centimeter apart, to prevent dehiscence of the tube. Following this, the skin edges are approximated with interrupted sutures. The tube donor site skin edges are attached to the deep fascia with interrupted subcuticular immobilizing sutures. The graft is taken from any desired region approximately 0.25 to 0.30 of an inch thick. The graft is sutured into position with closed in direct approximation and not overlapped the surrounding skin. At each corner direct tailoring of the graft is necessary so that there will be no overlapping or folding of the skin, thereby maintaining normal skin tension. Xeroform gauze is cut to the shape of the graft pattern and laid directly upon the graft. A wet gauze stent pattern assures adequate pressure. Xeroform gauze is then placed above the stent to protect the suture line of the tube. The dressing is held in position by strips of sterile adhesive or Scotch tape which will run beneath the tube and across the tube to maintain the desired pressure. Two additional strips crossing beneath the tube diagonally hold pressure at each corner of the graft. Beneath these we have found it advisable to place small triangles of gauze stent so as to give additional pressure at each angle of the graft. Following this, two rolls of gauze slightly larger than the tube itself are placed parallel to it on each side, to give additional pressure to the graft and prevent any constriction across the center of the tube which might cause necrosis in this region. An overall immobilization dressing is used for final protection. A window may be made through the dressing to permit inspection of the tube as frequently as indicated to assure oneself that there is no embarrassment of the circulation at its center. The dressing is done on the sixth to the tenth day.

## CONCLUSION

The technique which uses a split graft beneath the donor site is described. It has been used routinely for all tubes except those of the neck. The tubed pedicles so prepared show rapid healing and few complications.

# GANGLIONEUROMA OF THE SYMPATHETIC NERVOUS SYSTEM

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**T**UMORS composed of sympathetic ganglion cells and sheathed neurites with or without myelin have been well known for at least 76 years since Loretz in 1870 described one which grew in the mediastinum. During that time cases have gradually accumulated until now there are more than 250 on record. Without making an exhaustive search, the writer has been able to find available reports of 233 patients in the literature and to assemble 10 additional unpublished cases. A study of these furnishes a great deal of information yet even now it is impossible to gain an entirely comprehensive conception of this interesting tumor form because of the extreme paucity of follow up data. In all these reports I could find only 6 in which the case had been followed more than 3 years after removal of the tumor (14, 19, 25, 40, 64, this series Cases 1 and 3) and 4 more in which the tumor was known to have been in existence for more than 3 years without removal (11, 24, Glinski 115). This paucity of information regarding the curative value of operation is all the more lamentable when it is realized that attempts at removal or operative explorations have resulted in at least 21 post operative deaths, 11 intra abdominal tumors (2, 5, 10, 51, 59, 71, 83, 88, 106, 116, 117), 9 mediastinal tumors (49, 12, 20, 23, 26, 27, 30, 62, 114, Case 2) and 1 neck case (75). If at attempts at removal of these deep seated tumors are so hazardous, it would be extremely valuable to have accurate data about the results of removing them both when they are excised in whole or in part and when they are not treated at all. What little information exists will be considered here but it is so incomplete that it is indecisive.

The anatomical distribution of these tumors is shown in Table I. It confirms the general impression that the commonest sources

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of origin are the great chains of sympathetic ganglia which extend from the base of the skull into the pelvis passing through the neck posterior mediastinum and the retroperitoneal regions including the suprarenal medulla. It also shows that on occasion the smaller sympathetic ganglia in a variety of situations can give rise to these tumors but that this is an event of extreme rarity. No doubt as time passes it will be found that they can arise in other places not mentioned here. This paper records for the first time finding them attached to the spermatic cord (Case 3) and in the tongue (Case 11). Other solitary examples in bizarre situations are reported by Bertini in the stomach, Lages Netto in the breast, Foster in the knee joint, Jorge and Latuenda in the maxilla, Cramarossa, Fingerland and Siki, Meyer Rindfleisch in the uterus, and questionable cases in the vulva by Lovelady, McDonald and Waugh, and in the kidney by Wright. Rarely they are associated with von Recklinghausen's disease (40, 66, 95, 120, 115, Case 12). There are a few examples with multiple tumors in the skin which may also be unusual varieties of von Recklinghausen's disease (58, 60, 81, 112). Ashanazy found a case with multiple peritoneal tumors. When these tumors involve the intestinal tract or appendix they may be diffuse proliferations which cause a giant overgrowth of a whole portion of it. This has been described by Jentzer and Fatzer, Masson, Martinez Gutierrez, Pick and Bielchowsky, Poate and Inglis, Oberndorfer and Schultz. These tumors are not limited to man for Thomas has reported one in a codfish.

Table II shows that 60 per cent of these tumors are found before the age of 20 years with the greatest concentration in the first decade of life. Females predominate over males in the proportions of 3 to 2. Contrary to the impression gained by the earlier writers as expressed by Coenen there is no preponder

blasts is potentially and sometimes actually metastasized. The third group with nodules of neuroblastoma distinct from the nodules of ganglioneuroma are fully malignant with metastases in 13 or 65 per cent of 20 cases. A somewhat similar division of the tumors into groups was suggested by Goodhart in 1918 and by Fischer in 1922 and by Scott *et al* in 1933 but without an exact tabulation of the degree of malignancy of the different forms.

It would seem from this study that it is probably always desirable to excise ganglioneuromas completely, especially if they be long to the second and third groups. If ever the tumor belongs to the first group and it is found impossible to remove all of it because of its anatomical relationships it would seem justifiable to remove as much of the tumor as possible rather than to make no attempt to excise it. It is doubtful if this would accelerate its growth and it might prevent extension through an intervertebral foramen which is an extremely serious and often fatal complication and would obviate at least for a time the unpleasant effects of a very large retroperitoneal or mediastinal tumor. If it continued to grow *in situ* subsequent operations of partial removal might keep it in check indefinitely. If the pathologist is familiar with these types it should be easy to recognize them in a quick frozen section. But what is most urgently needed is more information as to the ultimate fate of many more treated and untreated cases so that the surgeon may be guided in his attack by knowledge rather than hypothesis.

#### SUMMARY

A brief study has been made of 233 previously published cases of ganglioneuroma of the sympathetic nervous system and 10 new ones. This shows that the common site of these tumors is along the route of the great chain of ganglia extending from the base of the skull into the pelvis including the supra renal medulla but with a few examples arising from ganglia in other situations. It is possible to divide the cases into three groups (1) a fully differentiated one which does not metastasize and which includes a great majority of

the tumors (2) a partly differentiated one which occasionally gives rise to metastases; and (3) a third small but complex group made up both of fully differentiated ganglioneuromas and fully malignant sympatheticoblastomatous nodules, the great majority of which metastasize. The histological and biological features of these three varieties is displayed so far as the lamentable lack of follow up information permits.

**CASE 1:** E. R., white American girl, 2½ years of age. At 5 weeks of age a mass appeared on the right side of the neck. It gradually increased in size. Examination showed a soft mass extending from the jaw to the lower third of the neck. At operation March 6, 1917 a large mass was removed which extended from the thyroid cartilage to behind the sternomastoid where it reached the vertebrae. The internal jugular was posterior and the common carotid was external to it. Following operation the child developed a Horner's syndrome which persisted several years but finally disappeared and on March 12, 1924, 7 years after operation, there was no recurrence. Gross examination showed a 7 by 4 by 3.5 centimeter nodular encapsulated mass. Microscopic examination revealed that the tumor was made up of rather large collections of cells which showed many stages of differentiation from sympatheticoblast to fully developed adult ganglion cell. The latter were in the minority. These cells were set in a matrix of delicate fibers which were acidophilic and resembled glia. It was impossible to know how many neurites were present. These collections were enclosed within a dense fibrous stroma in which there were certain Schwannian structures but the preparations were not good enough to say how many. No mitoses were recognized (Figs. 1 and 2). Diagnosis was diffuse, partly differentiated ganglioneuroma of the cervical sympathetic ganglion (Stout, 1924).

**CASE 2:** M. B. white American boy, 2½ years old. When 7 months of age he began to have abdominal pains. Four months before admission he began to develop cord pressure symptoms and finally was unable to sit up and had lost all sphincteric control. A ray examination showed a dense shadow in the upper left thorax. A needle biopsy showed a ganglioneuroma. Because of the paraplegia, the case was considered inoperable. Seven months later the child was operated upon at the Neurological Institute in an attempt to relieve the cord pressure symptoms which had become progressively worse. A very long encapsulated extradural tumor was found in the spinal canal extending from the upper dorsal into the lower cervical region and continuous with the chest mass through an intervertebral foramen. The child died shortly after the termination of the operation. At microscopic examination, sections of the needle biopsy (illustrated in the published paper) showed groups of differentiated ganglion cells which



Fig. 1. Case 1. Partly differentiated ganglioneuroma of cervical sympathetic. Topographical photomicrograph showing relative proportion of cells to stroma. X20

varied in size from large cells with three nuclei to forms much smaller than normal. They did not have satellites and were set in a loose textured stroma with very few Schwannian structures. The tissue from the spinal canal showed small groups of similar cells scattered at wide intervals in a very thick dense fibrous stroma in which there were apparently many nonmedullated nerves. No special stains were available to confirm this. Diagnosis was fully differentiated ganglioneuroma of upper mediastinum with extension to spinal canal (114, 115).

CASE 3. T. F. white American male aged 25 years came to the hospital because he was rejected for employment on account of a left indirect inguinal hernia. At operation for cure of this July 28, 1927 a soft spongy mass was found loosely attached to the right spermatic cord just above the testis but separated from it. This was excised and the hernia repaired. Eleven years later there was no recurrence of the tumor. Gross examination showed a firm bilobed tumor measuring 4.5 by 3.5 by 2.5 centimeters encapsulated pallid and resembling fibrous tissue when sectioned. Microscopic examination showed that nonmedullated nerve fibers furnished with Schwannian and endoneurial sheaths coursed in various directions held together by loose textured connective tissue. Scattered at wide intervals were isolated fully differentiated sympathetic ganglion cells with satellites pigment and occasionally two nuclei. Diagnosis was fully differentiated ganglioneuroma of spermatic cord.

CASE 4. A. M. a Spanish girl 9 years old 2 years before admission had an attack of vomiting and fever. She was admitted to another hospital where a retroperitoneal orange-sized tumor was felt. Since then there had been no symptoms. On examination a firm not freely movable abdominal mass was felt just to the left of the vertebral column in the lumbar region. X-ray films showed no relation to kidney



Fig. 2. Case 1. Detail which shows undifferentiated sympathicoblasts and partly differentiated ganglion cells. X205.

but left ureter was deviated laterally. Exploration by Dr. William G. Hecks done March 30, 1942 revealed a tumor 12 by 10 centimeters firmly attached to the posterior abdominal wall along the left lumbar vertebrae. Biopsy only was done. Twenty-five months later the mass was still palpable and had not apparently increased in size. Microscopic examination showed this tumor to be made up of widely scattered adult fully differentiated sympathetic ganglion cells with satellites, pigment and neurites set in a fibrous stroma containing vast numbers of nonmedullated neurites sheathed by



Fig. 3. Case 4. Differentiated ganglioneuroma of lumbar retroperitoneal region. Above Topographical photomicrograph showing distribution of ganglion cells in the neurofibromatous stroma. X20. Below Detail showing an adult bipolar ganglion cell and neurites. Cajal impregnation. X205.

## SURGERY GYNECOLOGY AND OBSTETRICS



Fig. 4. Case 5. Partly differentiated ganglioneuroma of suprarenal medulla. Above: Topographical photomicrograph.  $\times 30$ . Below: Detail showing mature and almost mature ganglion cells. Elsewhere there were sympathetic blasts in small numbers.  $\times 305$ .

Schwannian cells and endoneurium (Fig. 3). Diagnosis was fully differentiated ganglioneuroma of the lumbar retroperitoneal region.

CASE 5. SF. A 4 year old Cuban female had abdominal enlargement of 10 months duration. On examination a mass was felt which displaced the right kidney downward and the intestines to the left. The kidney function was not impaired. X-ray examination showed areas of calcification in the tumor. At operation May 11, 1942 a large solid tumor was found lying superior to the right kidney and pushing it caudad. It was encapsulated not adherent to kidney or liver. The mass was retroperi-

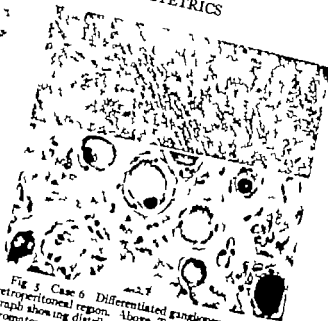


Fig. 5. Case 6. Differentiated ganglioneuroma of retroperitoneal region. Above: Topographical photomicrograph showing distribution of ganglion cells in the neurofibrinous stroma.  $\times 30$ . Below: Detail of ganglion cells, satellites and Schwannian sheaths.  $\times 205$ .

toneal and its blood supply came from the adrenal vessels. It was easily excised by Dr. George Cahill. The child made a good recovery and 32 months later showed no evidence of recurrence. Gross examination by Dr. Dorothy H. Andersen showed an encapsulated mass measuring 9.5 by 8.5 by 7.1 centimeters and weighing 330 grams. It seemed to be made up of one large and several smaller flattened nodules. When cut open the knife grated against several areas of calcification. Microscopic examination revealed that this tumor was made up of numerous rather large groups of ganglion cells many of which were fully differentiated while some were only partly differentiated and occasionally sympathetic many Schwannian and endoneurial structures which probably enclose neurites. The whole tumor has suffered from degeneration with patches of calcification so that accurate histological study is difficult (Fig. 4). Diagnosis was diffuse partly differentiated ganglioneuroma of right suprarenal gland.

CASE 6. J. LaP. white married American female of Slovak extraction, 18 years old was a primipara who was found to have a mass in the hollow of the sacrum indenting the rectum during routine antepartum examination. This necessitated delivery of the baby at term April 10, 1943 by cesarean section. The tumor was entirely retroperitoneal extending from the promontory of the sacrum to its fourth segment slightly to the left of the midline. It was firm rubbery and irregular in consistency. It was 8 centimeters long and varied from 3 to 5 centimeters in width. It had a very firm attachment to the sacrum and because of this removal was not attempted. The capsule was from 2 to 3 millimeters thick. Tumor biopsies were taken. The child was a normal baby. The patient recovered and was alive April 25.

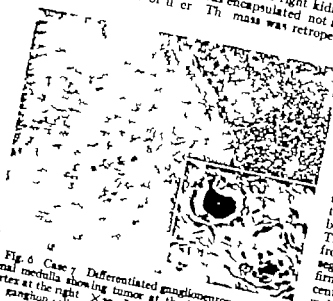


Fig. 6. Case 7. Differentiated ganglioneuroma of suprarenal medulla showing tumor at the left and suprarenal cortex at the right.  $\times 30$ . Inset shows partly degenerated ganglion cell and satellites.  $\times 305$ .



Fig. 7. Case 8. Differentiated ganglioneuroma of pelvic inlet. Topographical photomicrograph above  $\times 20$  and detail of cells below  $\times 205$ .

1946 nearly 3 years later with the tumor apparently stationary. Microscopic examination revealed that the tumor was enclosed by a thick fibrous capsule with a small area of calcification. It is made up of numerous endoneurial and Schwannian sheaths without myelin which course in various directions at haphazard loosely held together by a delicate fibrous stroma. Scattered at rather infrequent intervals are groups of fully differentiated pigmented sympathetic ganglion cells attended by satellites. Some of them have two nuclei and many are without nuclei. The majority are normal in size but occasionally small forms are encountered. All appear fully differentiated. In one section some small rounded cells are collected about a capillary. These appear to be lymphocytes monocytes and plasma cells rather than an example of Scherer's development centers (Fig. 5). Diagnosis was fully differentiated ganglioneuroma of pelvic retroperitoneal region.

CASE 7. S. I. 22081 G. L. aged 71 years died with a cancer of the larynx and autopsy was performed at the Pilgrim State Hospital West Brentwood L.I. by Dr. Edward W. Gray. The right adrenal was enlarged to dimensions of 14 by 10 by 7 millimeters by the presence of an encapsulated medullary tumor 1 centimeter in diameter. Microscopic examination showed a tumor made up of countless interlaced nonmedullated nerve fibers enclosed within Schwannian sheaths. Scattered among these at intervals are fully differentiated ganglion cells in various stages of degeneration and generally enclosed by satellite cells (Fig. 6). Diagnosis was fully differentiated ganglioneuroma of suprarenal medulla.

CASE 8. Female aged 14 years began to menstruate 1 year before admission to Fordham Hospital. For an unstated period she had suffered from intermittent attacks of abdominal pain and a mass



Fig. 8. Case 9. Partly differentiated ganglioneuroma of cervical sympathetic ganglion metastatic in cervical lymph node. Detail showing undifferentiated sympathocolasts and almost fully differentiated ganglion cells.  $\times 205$ .

in the left lower quadrant which had not changed in size. Examination showed an egg-sized hard smooth mass in the left lower quadrant a little below the umbilicus. Intravenous pyelogram showed that the left ureter was displaced outward by a retroperitoneal mass. At operation the mass lay between the left ureter and the left common iliac artery. It was excised without difficulty. The patient made a good recovery but was not followed after she left the hospital. The specimen was examined by Dr. Nathan Block. It was an irregularly globoid solid encapsulated mass 6 centimeters in diameter which on section showed a homogeneous moist light brown surface streaked with grayish yellow fine bands. Microscopic examination showed the tumor to be made up of groups of ganglion cells most of which



Fig. 9. Case 2. Tumor cells in lymph sinuses.  $\times 205$ .



## SURGERY GYNECOLOGY AND OBSTETRICS



Fig. 6. Case 1. Differentiated ganglioneuroma (or hyperplastic ganglion) of the tongue. Above: A tangential section showing part of the lesion beneath the mucosa.  $\times 30$ . Below: Detail showing ganglion cells and nerve sheaths.  $\times 205$ .

were fully differentiated pigmented and often furnished with satellites. Large forms with two or even three nuclei could be found and also small cells which are otherwise fully differentiated. Some cells had vacuoles and appeared to be disintegrating. The ganglion cells were scattered throughout a stroma made up of numerous endoneurial and Schwannian sheaths in a fibrous framework varying from loose textured to dense. No myelinated nerves were recognized (Fig. 7). Diagnosis was fully differentiated ganglioneuroma of lumbosacral retroperitoneal region.

CASE 9. G. H. white male, 30 months of age at 7 months of age had had a severe cold and the cervical

nodes enlarged especially on the left side. During the succeeding months there were a number of similar attacks with fever. Finally tremor of the head and neck developed with weakness and obstructive breathing. Examination showed numerous enlarged nodules on the left side of the neck. X-ray films of chest were negative. Finally a biopsy of one of the neck continued to increase reaching the size of two fists at 10 months after biopsy. (Information and material furnished by Dr. J. H. Ferguson, Syracuse University, N. Y.) Microscopic examination showed the sections to include portions of what appeared to be a lymph node which had been partially replaced by a tumor which tended to spread along the inner coblasts in various stages of differentiation. They never attained the status of fully differentiated ganglion cells but approached it occasionally when polar cells were formed. There were no satellite cells and the tumor cells were set in a matrix resembling glia. No special stains were available so that it was unknown how many neurites were present. It was assumed that there were some because some of the cells had polar prolongations. No mitoses were found nor were there any rosettes or pseudorosettes (Figs. 8 and 9). Diagnosis was diffuse partly differentiated ganglioneuroma of cervical lymph node metastatic from the cervical sympathetic ganglion.

CASE 10. 24054, E. W., white married female, aged 26 years for 11 months had suffered from increasingly severe pain in left side with extension down the legs on standing but relieved by lying down with legs pulled up. She had given birth to two children and had had no miscarriages. Examination revealed a fixed nodular mass in the left axilla 2 inches in diameter. At operation August 9, 1945 a solidly fixed tumor overlay the left common iliac vessels behind the peritoneum. It was removed.



Fig. 7. Case 2. Photograph of area involved by neurofibroma. The dark pigmented areas are pigmented moles.

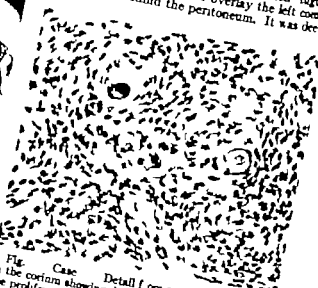


Fig. 8. Case 2. Detail from a neurofibroma area in the corium showing differentiated ganglion cells among the proliferated Schwannian cells.

inoperable and only a biopsy was taken. There was marked bleeding during the operation and the patient went into shock. She was given 3 plasma and 1 blood transfusion but died 9 hours after termination of the operation. It was not decided whether death was from shock or pulmonary embolism. There was no autopsy. (The clinical history was furnished by Dr. Leona Kasten and the pathological material by Dr. Alvin O. Severance of San Antonio, Texas.) Microscopic examination showed the tumor to be composed of great numbers of Schwannian and endoneurial sheaths growing in various directions embedded in dense fibroblastic tissue. Set in this at wide intervals were small groups or isolated units of adult sympathetic ganglion cells furnished with satellites. A few cells had two nuclei and many showed vacuolization and other signs of degeneration. A vast majority of the sheaths were nonmyelinated but at least two myelinated ones were recognized. Diagnosis was fully differentiated ganglioneuroma of pelvic retroperitoneal region.

CASE 11: Age and sex of patient were not stated. A swelling was noted for several months in the region of the circumvallate papillae. It was assumed that the swelling was an enlarged circumvallate papilla. A slide of the lesion was contributed by Miss Leila M. Hawkesley, pathologist of the Royal Cancer Hospital (Free) of London, England. Microscopic examination revealed that the swelling had been produced by the presence in the submucosa of a mass composed of numerous small nerve bundles with both myelinated and nonmyelinated neurites, held together by a generous but loose textured fibrous stroma. Scattered at infrequent intervals there were isolated sympathetic ganglion cells with satellites and pigment. They appeared fully differentiated. The involved area extended diffusely and was not encapsulated. In places it had included ducts of the local serous and mucous glands. It had the appearance of a much enlarged normal sympathetic ganglion (Fig. 10). Diagnosis was ganglioneuroma of tongue.

CASE 12: C. F. A Puerto Rican girl, 21 months old ever since birth had had a raised pigmented hairy lesion which occupied the bridge of the nose, the right infraorbital region and lower eyelid and the right zygomatic area as far as the hair line. It was soft nodular elevated a centimeter in some places showed many pigment dots and had many fine silky hairs growing out of it. A large portion of it measuring 11 by 4 centimeters was excised by Dr. J. P. Webster January 3, 1930. Following this the tumor reappeared in the cicatrix and continued to grow. A second attempt to excise the recurrence was made July 25, 1930 but the child died during the operation (Fig. 11). Microscopic examination showed that in this highly complex tumor the skin was thickened by a growth composed of plexiform neurofibromatous nerves which as they approached the epidermis occasionally formed terminal neuromas containing adult sympathetic ganglion cells with satellites. In places the Schwannian cells had proliferated around the

nerves to form sheaths of atypical and quasi malignant aspect. Just beneath the epidermis were groups of pigmented mole cells. In places these were in direct continuity with the proliferated Schwannian cells (Fig. 12). This condition was evidently a manifestation of von Recklinghausen's disease in which the plexiform neurofibromas had formed multiple small ganglioneuromas in the skin. Diagnosis was ganglioneuromas of skin of face forming parts of the plexiform neurofibromas of von Recklinghausen's disease.

## REFERENCES

1. ADAMS, F. E. and McLEAN, J. *Am. Res. Nerv. Ment. Dis.* 1937 16 447.
2. ANITSCHKOW, N. *Virchows Arch.* 1913 214 137.
3. ARKANARY, M. *Arb. Path. anat. Inst. Tubingen* 1914, 9 147.
4. BRENN, R. J. *Surg. Gyn. Obst.* 1916 23 348.
5. BENDA, C. *Verh. Deut. path. Ges.* 1904, 7 866.
6. BENEKE, R. *Beitr. path. Anat.* 1901 30 1.
7. BÉRAUD, P. *Les tumeurs communes au système nerveux sympathique et aux paraganglions. Symptômes embryonnaires et ganglioneuromes.* Paris P. & A. Davy 1930.
8. BERKEL, J. J. *Beitr. path. Anat.* 1922, 70 203.
9. BERTINI, G. *Arch. sc. med. Tor.* 1936, 61 566.
10. BIOLIKER, J. A., and HOVINE, A. *Am. J. Dis. Child* 1932 43 1552.
11. BLACKLOCK, J. W. S. *J. Path. Bact. Lond.* 1934 39 37.
12. BLAND-SUTTON, J. *Lancet, Lond.*, 1918, 1 429.
13. BOHNER, J. V., and LINCOLN, E. M. *J. Thorac. Surg.* 1934, 3 365.
14. BORST, M. *Die Lehre von den Geschwülsten* Vol. 1 p. 241. Wiesbaden J. F. Bergmann 1902.
15. BOSS, M. D. *SOFFEL, J. A. NETTROOF, W. S. and ROMM, J. Z. Am. J. Surg.* 1934, 65 120.
16. BROSSOK, G. *Beitr. klin. Chir.* 1911 74 31.
17. BUELLER, E. *Arch. path. Anat.* 1928, 268 300.
18. BUCHER, E. *Acta path. microb. scand.* 1928 5 289.
19. CAPALDI, B. *Frankl. Zchr. Path.* 1927 35 83.
20. CAPELLI, D. F. *J. Path. Bact. Lond.* 1929, 33 41.
21. CLARKE, J. M. *Australas. N. Zealand J. Surg.* 1938 8 199.
22. COHNEN, H. *Die Geschwulste* Lief. 17 aus *Die Chirurgie*. Berlin Urban & Schwarzenberg, 1927.
23. CRAMAROSA, V. *Ann. ostet. ginec.* 1935 57 326.
24. CRILE, G. W., and BALL, R. P. *Surg. Gyn. Obst.* 1929 48 449.
25. CURENCO, H., and WOLBACH, S. B. *Am. J. Path.* 1927 3 203.
26. DE QUERVAIN, F. *Arch. klin. Chir.* 1899 58 1-30.
27. DISTEFANO, G. *Tumori*, 1935 9 215.
28. DOBRZANSKI, W., and STANKIEWICZ, S. *J. Chir., Par.* 1936 48 785.
29. DUNN, J. S. *J. Path. Bact. Lond.* 1914-15 19 456.
30. IDEM. *Glasgow M. J.*, 1915, 84 95.
31. EDEN, K. *Brit. J. Surg.* 1941 28 549.
32. FALE, F. *Beitr. path. Anat.* 1907 40 601.
33. FARMER, A. W., and LINFEL, E. A. *Brit. J. Surg.* 1934, 21 534.
34. FELS, E. *Zbl. Gyn.* 1933 57 89.
35. FIGUERA, Tumor, 1914, 3 569.
36. FINGERLAND, A., and SIKI, H. *J. Path. Bact., Lond.* 1938, 47 611.
37. FISCHER, R. F. *von Frank. Zchr. Path.* 1922 28 603.

## SURGERY GYNECOLOGY AND OBSTETRICS

- 37 FOOT \ C. Arch. Path., Chic. 040, 30 77  
38 Idem. Pathology in Surgery. Pp. 430-438. Phila  
delphia J B Lippincott Co. 1945  
39 FOSTER J H. T. Am. Laryng. 1042, 64 32  
40 GETTMULLER, I. Beitr klin Chir 1042, 64 32  
41 GOODHART G W. Lancet Lond 0 9, 5 7  
42 GRAY H. K., Sutcliffe D V. and DICKERTY  
M. B. Arch. Surg. 044, 48 208  
43 GUZZETTI, P. Arch. Sc med Tor 03 55 4 5  
44 HAECKEL, W. Frankl. Zachr Path 03 40 3  
45 HAECKEL, E. Deut. Zachr Chir 000, 40 3  
46 HART F D. and FILLIS P O. Lancet, Lond  
037 1 458  
47 HAYEN H and WEIL, A. J. h P th Chir 037  
13 3  
48 HENRICI D. Zbl. allg Path 031 15  
49 JACKSON, C. and BARCKA W. W. Surg Clin A  
merica, 1913  
50 JACOBSTHAL, A. Verh. Deut. path Ges 000, 3 343  
51 JENSEN A. and FILLIS P O. Arch. Surg 1037, 8 506  
52 JERGENS F H. J. Ch. Path. Chic 33, 6 14  
53 JOACHIMOWITZ, R. Zbl. Chir 03 55 2007  
54 JONES, H. M. Lancet, Lond 0 3, 7 56  
55 JONES, J. M. and L. THIND, R. I. Ch. Soc  
argent. de anal. norm. v. path 04 3 80  
56 KANTZKY, B. Virchow Arch 1042, 300 6  
57 KRAVITZ, T. B. and GIOVATTI T. I. Neurolog. path  
1040, 9 97  
58 KRAVITZ, K. Virchow Arch 1042, 300 6  
59 KOPPEL, G. Frankl. Zachr Chir 040, 37 245  
60 KREDEL, L. and BENYER R. Deut. Zachr Chir  
00 07 39  
61 LA ES NETTO D J. Am. J. Dis. Child 044 67  
62 LAZARI L. L. PARD L. R. and A. REF J V  
Presma med. argent 037 24 200  
63 LAW A. L. Surg. Gyn. Obst. 0 5, 7 340  
64 LEW S D. and G. SCHWARTZ C F. Arch. Surg.  
034, 25 6  
65 LEVIA, D. and HART D. Ann. Surg. 030, 9 96  
66 LEUCHESTEIN, J. and DUMAS, R. Bull. Am. f. Cancer  
020, 0 3  
67 LEUCHESTEIN, B. W. and RUJIN, A. B. Arch  
Path. Chir 1937, 24 80  
68 LORITZ, H. Virchow Arch 870, 49 435  
69 LOVELADY S. B. McDONALD J. R. and WATSON  
J. M. Am. J. Obst. 94 4 309  
70 LUGHEZZI B. and COCCO R. P. Atti Acad. scient  
Scienze, 933 1 8  
71 McFARLAND J. Arch. Path. chic 03  
72 McFARLAND J. and SAPPITOV, S. W. Am. J.  
Path. 035, 470  
73 MACN. CORTIO JONIA, H. Proc. R. Soc. M. Lond  
0 2, 5 287  
74 MARTINEZ-GUTIERREZ, M. Rev. med. Chile  
75 780  
75 MARTINEZ, K. Frankl. Zachr Path 045 4 4  
76 Idem. Les névroses ganglionnaires du grand ym  
pathique. Thèse de Paris, 009  
77 MONTARELLI, L. Pathologica, Genova, 03 24 454  
78 MONTARELLI, L. Virchow Arch 043, 30 437  
79 MONTARELLI, H. and O'LEARY J. A. Arch. Derm  
Syp. Chic. 934, 20 26  
80 MONTARELLI, J. Toulant P and FOUSSAT J. Ann  
ocul. Pa 039, 76 18  
81 MONTARELLI, J. Toulant P and FOUSSAT J. Ann  
ocul. Pa 039, 76 18  
82 MONTARELLI, J. Toulant P and FOUSSAT J. Ann  
ocul. Pa 039, 76 18  
83 MORTO D. and ECHEGARAY E. M. Rev. 45  
argent., 1914, 45 1365  
84 MURRAY J. R. and STOUT, A. P. Unpublished data  
Handbuch der speziellen path. Anat. u. Hist. 0  
7 part 2, pp. 534-537 Berlin J Springer, 1913  
85 NECKMANN H. D. In Henke F. und Labarthe O.  
Usp. Arch. Gyn., Berlin, 1928, 31 506  
86 OBERVONDERER S. Beitr. klin. Anat., 1907 41 206  
87 Idem. Zachr. ges. Neuropath., 03 71 105  
88 OTTER, L. Beitr. klin. Chir. 1900 30 66-  
60  
89 PARRERA, H. and PRATT M. D. Arch. pat., 1944  
04 25 608  
90 PATERSON D., and PITCHER, R. S. Brit. J. Surg  
0 23 608  
91 PETERS H. Frankl. Zachr Path 013, 13 14  
92 Idem. Beitr. klin. Chir 10 2, 16 6  
93 Idem. Beitr. path. Anat. 0 3, 7 56  
94 POATE, H. and KIGLIS A. Brit. J. Surg. 028 24  
211  
95 POTTER E. L. and PARRERA, J. M. Am. J. Path.  
1042, 8 141  
96 RAPP L. Inaug. Dissert. Heidelberg 03 14  
Beitr. klin. Chir 10 3 87 570  
97 RASKA, K., and SKORNIK, I. Ca. 47 47  
98 RIBBERT H. Geschwulstlehre für Ärzte und  
Studierende Pp. 437 44. Bonn F. Cohen, 04  
RIGGS, T. F. and GOOD L. P. Arch. Surg. 1920  
10 300  
99 RIGGS, T. F. and GOOD L. P. Arch. Surg. 1920  
10 300  
100 RIBBON, R. Quoted by Meyer  
Los Tumores del Sistema Nervioso Central y Perif.  
férico. Pp. 14 48 Madrid 033  
101 RIBBON, R. Verh. Deut. path. Ges. 000, 3 24  
102 ROMAN, B. and ARNOUD, P. Arch. 0 5, 120 47  
Hosp. 1924, 88  
103 ROSENBAUM, I. Verh. Deut. Ges. Chir. 882, 34  
00 SALAZAR P. Voz. Zbl. Gyn. 030 00 71  
104 SCHAFFNER, V. D. SMITH R. and TAYLOR, H. F.  
J. Thorac. Surg. 043, 24  
105 SCHREIBER H. J. Virchow Arch 014, 202 470  
106 SCHULTZ A. Zbl. allg. Path. 03 33  
107 SCOTT, E. OLIVER, M. G. and OLIVER M. H. Am  
J. Cancer 033, 17 100  
108 SOKRY, I. Inaug. Verh. Heilkunde, 577 1 45-  
109 SPITZER, A. Zachr. Laryng. 070, 9  
110 STOUT A. P. Med. Surg. Rep. Pseudotubercularis Hosp  
1918, 3  
111 Idem. J. Am. M. Ass. 1924, 82 70  
112 STRADEL, F. Thromb. med. argent 027 3 28  
113 STREHMANN P. Verh. Deut. Ges. Gyn. 9 5 5  
114 THOMAS, S. Bull. Am. f. Cancer 0 7 6 302  
115 TREST, J. Raza. Ter. Pat. clin. 03 3 88  
116 TURKUNEN A. Acta obst. gyn. scand. 040, 20 75  
117 VEROCCHI J. Festschrift f. Meand. 009, p. 378  
118 WARD, H. K. J. Med. Res. 014 3 205  
119 WARD, H. K., and CRAIG, P. L. Am. J. Path. 034  
4 707  
120 WILLMOTT, I. BERTRAND L., and PATEL, J. J. Chir  
033 41 680-705  
121 WILLMOTT, M. Surg. Gyn. Obst., 028, 46 774  
122 WRIGHT, F. H., and PATEL, B. H. J. Pediat. S. Lond.  
030, 14 37  
123 WRIGHT, R. D. J. Path. Bact. Lond. 038, 47 800  
124 ZACHAROFF F. R. Arch. ocol. gin., 033, 20 458

# PLANTAR NEUROMAS, MORTON'S TOE

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IN 1876 Morton described and cited examples of a peculiar and painful affection of the fourth metatarsophalangeal articulation. His observations and descriptions need little amplification except to emphasize that here is a condition in which the exact pathologic process is now known and the cure is in the hands of physicians. Morton succeeded in obtaining cures in this condition by excision of the metatarsophalangeal joint and surrounding soft tissues including the nerves distributed about the joint. Diseased tissues however were not identified by him.

There ensued a number of articles confirming Morton's observations (3, 4, 10) and making the condition a clear-cut clinical entity which has received his name. In an interesting lecture in 1887 on "Pain in the Feet" giving full credit to Morton and adding a few cases of his own, Mills expressed the belief that the trouble was limited to the branches of the external plantar nerve going to the fourth and fifth toes. He suggested that this nerve might be resected or stretched.

In 1893 Hoadley reported data on 6 cases of metatarsalgia. In one of his cases (II) in which the condition failed to respond to conservative treatment, he performed operation. His findings were significant. Unfortunately for patients suffering from this condition these findings were not generally known for nearly 5 decades. In the case in question Hoadley exposed the digital branches of the lateral plantar nerve to the fourth toe and found a small neuroma. He then resected the nerve.

A prompt and perfect cure was obtained. He expressed the opinion that if operation was advisable, excision of the nerve was simpler and recovery prompter than excision of the metatarsophalangeal joint as advised by Morton.

Robert Jones and Tubby in a lengthy article in 1898 reviewed past literature and discussed

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the subject thoroughly. Pathologically they observed a "well marked state of neuritis of the digital nerves" in 2 of their cases in which operation was performed. Apparently they missed the significance of Hoadley's observations although they referred to him in the bibliography. They held to the operation of resection of the metatarsophalangeal joint though they noted that the nerve could be destroyed by cautery, by injections of phenol or lastly by resection of the digital plantar nerve. They objected to the plantar approach to the nerve.

Not until 1940 was the thread of constructive surgical treatment and exact pathologic basis picked up by Betts of Australia who reported the true situation in a concise and valuable article. Unequivocally he attributed true Morton's metatarsalgia to a plantar neuroma, excision of which through a plantar incision produces a prompt cure.

In this country McElvenny separately came to the same conclusion as Betts and published his work in 1943. He expressed preference for a web splitting incision because of the early ambulation which this method affords. He observed that the tumor is rather on the lateral branch of the median plantar nerve which innervates the third and fourth digits.

The most recent confirming article is that of Baker and Kuhn, who reported 14 operations with removal of plantar neuromas, cures being obtained.

We hope that this work may stimulate others to consider operative treatment in the care of intractable pain due to Morton's toe. We also should like to add a bit more on the histopathology of this condition.

## CLINICAL ASPECTS

Typically the symptom complex known as Morton's toe is rather stereotyped and has been described many times. The patients have severe paroxysms of pain which usually arise beneath the heads of the third and fourth metatarsals and extend into the opposing

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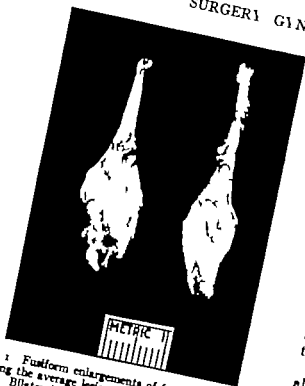


Fig. 1. Fusiform enlargements of fourth digital nerves typifying the average lesion found in Morton's metatarsalgia. Bilateral involvement.

sides of the third and fourth digits. Of the cases reviewed 1 patient had bilateral pain into the second and third digits and in 4 feet pain extended into the fourth and fifth digits. The pain may extend up the posterior aspect of the leg as far as the hip. Most commonly the attacks come on while the victim is walking. However 5 patients studied described paroxysms of pain which came on while in bed, some being awakened from sound sleep as a result.

Paresthesias into the affected toes were experienced by 15 of the 18 patients studied. Cramping of the foot and toes was fairly common. Four patients stated that their trouble was much more frequent during warm weather than at other times and was relieved somewhat by cold applications. Vasomotor changes in the form of cyanosis of these toes have been noted in 1 case.

In this series there were 16 women and 2 men whose ages ranged from 25 years to 67 years. The majority of these patients tended to be somewhat overweight. Symptoms had been present from 3 months to 12 years, occurring in the right foot in 12 cases and in the left foot in 12 cases. In 5 of the cases the

symptoms were bilateral, and in 1 case 3 neuromas were removed. Symptoms were classified as atypical in 3 cases and questionably typical in 2 other cases.

**Physical findings.** In 16 of the 18 patients studied there was a well localized tender spot over the site of the neuroma. In contrast to reports in the literature when firm deep pressure with a rounded blunt instrument was exerted over the site of the neuroma, the affected toes were reproduced in the majority of patients. Compression of the ball of the foot and rough manipulation of the third and fourth metatarsals in some cases caused similar symptoms. Occasionally subjective numbness in the third and fourth toes was noted on light touch.

**Treatment.** Conservative treatment should always be given a preliminary trial. The irritation of this nerve or neuroma may be stopped by shoes of sufficient length and width. External transverse bars or suitable padding within the shoe may relieve the symptoms. Persistent symptoms are best treated surgically.

In all but 1 of this series a plantar incision between the heads of the metatarsals was used. It is felt that since the nerves lie just beneath the plantar fascia and below the deep transverse metatarsal ligament, better exposure and a wider resection can be carried out through this incision. The proximal end of the nerve can be severed well back into the short muscles of the foot and future irritation of the inevitable amputation neuroma is avoided. The allow visualization through a dorsal or web splitting incision without severing the deep transverse metatarsal ligament. There occasionally is an anomalous nerve lying on the upper surface of this ligament, but none have been encountered in this series. Several neuromas have been removed which were proximal to the heads of the metatarsals in these cases an approach through the web would have been difficult.

These neuromas may occur in 3 different sites along the plantar nerves. They may be distal to the bifurcation in the digital branches. They may be at the bifurcation of the nerve

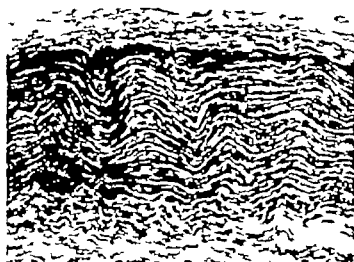


Fig. 2



Fig. 3



Fig. 4



Fig. 5

Fig. 2. A normal fourth digital nerve showing wavy myelinated nerve fibrils with neurilemma nuclei (hematoxylin and eosin  $\times 145$ )

Fig. 3. Morton's metatarsalgia, early lesion showing swelling of the nerve trunk from neural and perineural edema. Only a few fibrils appear to be well myelinated (hematoxylin and eosin  $\times 75$ )

Fig. 4. Morton's metatarsalgia. The outstanding features of this neuroma are seen to be neural edema and a

marked proliferation of neurilemma nuclei. Perineural tissue shows edema and beginning fibrosis. One well formed vessel is seen (hematoxylin and eosin  $\times 40$ )

Fig. 5. Fourth digital neuroma showing some perineural edema with marked fibrosis and hyalinization. Islands of hyaline tissue are seen invading the nerve substance, which also shows residual proliferation of neurilemma nuclei. The lesion is a moderately late one (hematoxylin and eosin  $\times 50$ )

into its digital branches or the neuroma may be in the median branch of the plantar nerve before its bifurcation

Healing of this incision has been prompt and complaints of minor tenderness in the scar were voiced by only 2 patients. The advantage of early weight bearing and ambulation when a dorsal or web splitting incision is made is important. It may be that with further use this approach will prove the better.

The operation is done with a tourniquet around the lower part of the leg, a large Penrose drain being wrapped about the leg at the

musculotendinous junction of the gastrocnemius muscle. After the neuroma is removed the incision is accurately and carefully closed with interrupted sutures of No. 0000 zytel. Weight bearing on the ball of the foot is allowed in 2 weeks.

**Results** We cannot report perfect results in all 18 of the cases herein reported. We may have been somewhat overenthusiastic in our endeavors to relieve chronic distress in the feet. However in all of the cases recorded neuromas were proved histologically. In 1 case exploration was performed and the pa-



Fig 6 Fourth digital neuroma approaching the end stage with the nerve difficult to identify in a mass of actively cellular collagenous and hyaline fibrous tissue (hematoxylin and eosin  $\times 78$ )

tient was relieved of distress although the sections were not conclusive of a neuroma. This patient was not included. Thirteen of the 18 patients were very pleased with the result, having complete relief of pain. Two patients had some but not complete relief. One patient was operated on whose history would make one suspect that she had painful osteoporosis of the foot secondary to a plantar neuroma. A neuroma was found and removed but at the time of writing the result is unsatisfactory.

Two patients have been operated on too recently to evaluate the result. The gratitude of patients who have benefited is ample proof of the value of this rather minor operation.

#### PATHOLOGIC ASPECTS

Grossly the neuromas presented either as pancake-like thickenings or as fusiform swellings of the involved nerve trunks. These thickenings tapered away proximally and distally into the adjacent and grossly normal nerve segments. The average size was small, with a length of about 15 millimeters and the diameter half that of an ordinary lead pencil (Fig 1). The bulkiest of the tumors was 2.5 centimeters in length and 1 centimeter in diameter while some of the smaller lesions brought the size of the involved nerve to a thickness only twice or three times that of the normal nerve.

All of the tumors were pearly white and all were encapsulated. The consistency was firm but in some of the early lesions the tissue appeared to be edematous. Cut sections failed to reveal any regions of cyst formation, which had been noted by McElvenny in his series. The location of these tumors has been described earlier in this paper.

Microscopically certain pathologic processes involved (1) the nerve trunks and (2) the surrounding connective tissue sheath (Figs 1 to 6 inclusive). Early and late lesions were found in both locations. The commonest and the earliest nerve change consisted in interstitial edema spotty in character associated with irregular demyelination and swelling of the entire nerve trunk. Accompanying a shortly following this there appeared to be a rather marked proliferation of the neurilemma nuclei giving a picture of pronounced cellularity. In some, the proliferation was central and in others predominantly peripheral, but in general the proliferation was quite diffuse. Like the edema the proliferative process was often spotty or focal in distribution. A combination of edema and proliferation in 4 instances gave rise to the formation of tissue clefts or small cysts within the substance of the nerve. In long standing lesions moderate to severe degrees of fibrosis and even hyalinization were seen to affect the thickened nerve bundles but this process seemed to represent an invasion from without rather than a primary nerve change. Three of the lesions were classified as being early to late and the remainder showed changes of an intermediate grade. One could not always estimate the duration of symptoms from a microscopic examination of the neuromas.

As noted by McElvenny and by Baker and Kuhn the neuromas consisted for the most part of collagenous tissue encasing the abnormal nerve lesions described previously. Again what might be termed early and late changes were observed. In the early changes, perineural edema, usually marked in degree, was almost always associated with proliferation of connective tissue fibroblasts. The edema often produced a spidering of these fibroblasts the nuclei of which appeared degenerated and vacuolated with loss of nucle-

olar substance Pseudocyst formation was noted in 5 cases in which high grades of edema were present Edematous collagen seen in the early stages was replaced by the hyaline substance of long standing lesions the end result being a perineural scar which as noted previously tended to invade the substance of the encased nerve, the fibers of which often became widely separated as a result

All of the lesions appeared fairly vascular microscopically In older ones the vessels appeared thick walled and sclerotic with endarteritis and occasionally thrombosis In the early stages edema was often present in the walls of the vessels suggesting the effect of trauma rather than that of any special lesion like thromboangitis obliterans

**Pathogenesis** Practically all of the patients who have Morton's toe are women Almost all of them had been in the habit of wearing small high heeled shoes and had resorted to the more homely but hygienic slipper for relief of their foot trouble Two of our patients were men one wore narrow shoes because his feet were too wide The other dated his trouble to a period when he was working in a war plant and was forced by plant regulation to wear ill fitting steel capped boots These and other features point to trauma and weight bearing as the prime causes of the affliction Traumatic edema of the nerves causes swelling and demyelination which further expose the nerves to trauma and complete a vicious circle Proliferation of the nerve fibers and of the perineural fibrous tissue is but a natural consequence of this edema and local irritation Although complete scarring is the theoretical end result, enough nerve fibers escape so that in none of our cases did the pain disappear with the passage of time But why should the fourth digital nerve be selected for the development of the neuroma? Betts set about to discover the reason and developed his hypothesis on an anatomic basis His findings were confirmed by McElvenny and by Baker and Kuhn we have personally substantiated them in a number of dissections The principle is demonstrated in Figure 7

The fourth digital nerve unlike its neighbors, is of double derivation being formed through the anastomosis of branches from

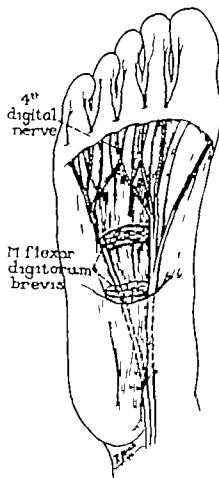


Fig. 7 Diagram made from an actual dissection showing the dual derivation of the fourth digital plantar nerve to the transverse sling across the belly of the flexor digitorum brevis muscle Anchoring of the nerve resulting from this anatomic relation is supposed to lead to trauma of the nerve

both medial and lateral plantar nerves It is consequently somewhat thicker than its mates—a fact which in itself might indicate increased vulnerability to trauma But more importantly the arc described by its two constituent branches forms a transverse sling across the outer or superficial aspect of the flexor digitorum brevis muscle Whereas the other digital nerves lying as they do in deep grooves between the muscles of the foot, enjoy a certain degree of mobility in a longitudinal direction the fourth nerve is more or less anchored posteriorly Stretching of the aforementioned loop occurs during dorsiflexion of the foot and toes and in walking the degree of stretch is intensified by contraction of the enclosed flexor belly

Finally in all fairness to the opposition it must be admitted that the offending loop is sometimes absent in these cases and that



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tumors of comparable nature affect the other branches of the plantar nerves Baker and Kuhn expressed the belief that in some of these cases nerve irritation was brought about by anomalous positions of the nerves in relation to the transverse metatarsal ligament

tomic peculiarities in composition There is considerable evidence that trauma from weight bearing in small or otherwise ill-fitting shoes is responsible for the pathogenesis of the lesion In intractable cases the most promising treatment is resection of the affected nerve

## SUMMARY

The affliction formerly called Morton's toe or Morton's metatarsalgia has its pathologic basis in a tumefactive perineural fibrosis of the fourth digital nerve of the foot Degenerative as well as proliferative nerve changes along with neural and perineural edema are additionally present The lesion may affect digital nerves other than the fourth the predilection for which may be determined by ana-

## REFERENCES

- BAKER, L. D. and KUHN, H. H. *South. M. J.* 1941, 37, 23-27
- BETTS, L. O. *Med. J. Australia*, 1945, 1, 514-515
- BRADFORD, L. H. *Boston M. & S. J.* 1891, 13, 52-55
- GUTHRIE, J. G. *Lancet*, Lond., 1892, 1, 626
- HODGLEY, A. E. *Chicago M. Rec.*, 893, 5, 12-17
- JONES, ROBERT, and TURNEY, A. H. *Ann. Surg.* 1894, 38, 297-326
- McELVERRY, R. T. *J. Bone Surg.*, 1943, 5, 615-677
- MILLS, C. K. *J. Nerv. Ment. Dis.* 1893, 15, 1-20
- MORTON, T. G. *Am. J. M. Sc.*, 1876, 7, 37-41
- OSBORNE, O. T. *N. York M. J.* 895, 62, 270-277

# ANTERIOR TRANSPLANTATION OF THE POSTERIOR DELTOID FOR SHOULDER PAISY AND DISLOCATION IN POLIOMYELITIS

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**T**RANSPLANTATION of muscles at their superior attachment or origin for any purpose has not been widely practiced or attempted. Since the orthopedic surgeon performs muscle and tendon shifts most frequently in patients with residual paralysis from poliomyelitis it would be expected that the need for shifting the origin of muscles would be encountered for the most part in this group of patients. Ober has described three operative procedures that may be utilized to restore some of the abduction power lost at the shoulder by paralysis of the deltoid. By one method the origin of all or a portion of the pectoralis major is transferred to the spine of the scapula. In another technique the short head of the biceps and the long head of the triceps are transferred to the region of the acromion process. This author also recently described the same method employed in this case, but he did not use it for the cure of paralytic dislocation at the shoulder. Steindler's shift of the forearm flexors is well known.

Large transplanted the origin of the vastus lateralis to the external surface of the ilium in lateral hip muscle palsy. Legg shifted the origin of the tensor fasciae femoris backward to the iliac crest to improve abduction at the hip. The results from these two latter procedures have not been spectacular possibly because of overwhelming paralysis in other hip muscles. It has been recognized though that such origin transplants contract actively after the operation. Silfverskoild described a technique for transplanting the origins of the long head of the biceps and the semimembranosus and the semitendinosus downward into the posterior femur for flexion contracture

of the knee. Girard described an operation transplanting the origin of the hamstring muscles to the symphysis pubis to increase adduction power.

Although it is well recognized that portions of the deltoid may atrophy from the effects of poliomyelitis there is no description of the end results of cases in the literature in which the origin of the remainder of the functioning deltoid has been transplanted to improve the abduction power of the arm. In the case the outcome of which after 4 years is recorded in this report the origin of the remaining functioning posterior third of the deltoid was transferred from the scapular spine to an anterior site corresponding to the normal origin of the anterior deltoid (see Figs. 2 and 3). This transplant effected a cure of dislocation of the upper humerus which occurred habitually when the patient contracted the remaining posterior third of the deltoid in attempting abduction prior to the transplantation. The posterior third unopposed by the middle and anterior third pushed the humeral head anteriorly as it contracted along a line posterior to this structure (see Fig. 2). It was obvious that an anterior and more direct line of contraction would utilize the function of the remaining fibers more effectively and at the same time would tend to restrain the humeral head. The effectiveness of the posterior deltoid prior to transplantation in this case was further reduced by the mechanical disadvantage produced by dislocation.

## REPORT OF CASE

R. M. male aged 11 years was first seen in 1940 3 years after an acute attack of anterior poliomyelitis. The acute paralysis was said to have involved the whole arm on the right side. He had received efficient and continuous after-care and had recovered a fair degree of muscle power in the right arm. His appearance at the time is shown in Figure 1a. There was extensive muscle atrophy around the right

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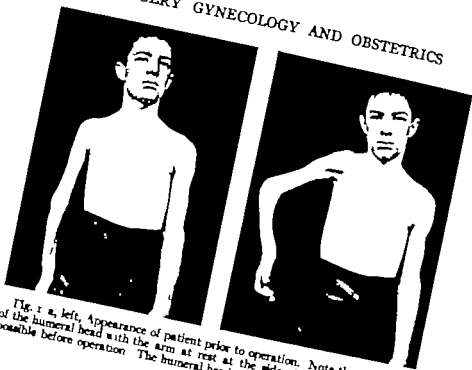


Fig. 1 a, left. Appearance of patient prior to operation. Note the prominence of the humeral head with the arm at rest at the side. b Maximum abduction possible before operation. The humeral head is dislocated anteriorly.

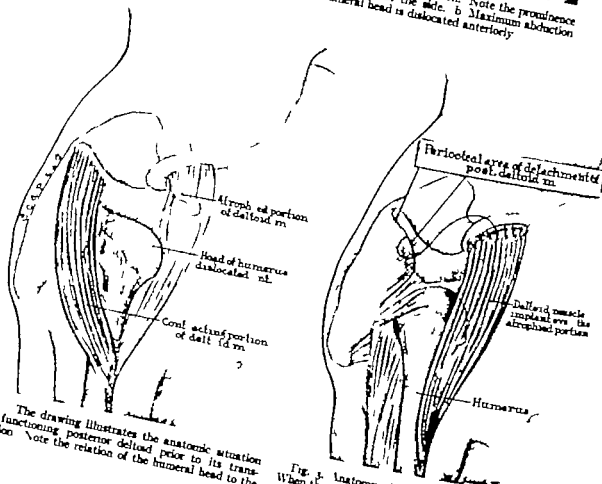


Fig. 2. The drawing illustrates the anatomic situation of the functioning posterior deltoid prior to its transplantation. Note the relation of the humeral head to the muscle.

Fig. 3. Anatomy of the transplanted deltoid remnant. When the transplant contracts it retains the humeral head in the glenoid as well as exerting more direct pull to abduction in neutral and the frontal plane.

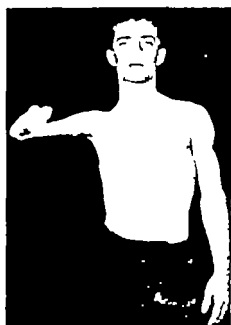


Fig 4 a, left. Appearance of the patient 4 years after operation when the right arm is held at right angle abduction. b Hyperabduction as carried out at the same time interval. Note hypertrophy of the deltoid transplant and the increased range of active motion.

shoulder and in the arm and forearm of the same side. The humeral head could be seen and palpated with ease since the anterior and middle portions of the right deltoid were reduced to nonfunctioning fibbons. The posterior deltoid remained functional but its mass was less than that of the corresponding portion of the normal left deltoid. The right biceps brachii was functioning but its strength was inadequate. The wrist was semilabile. The only muscle power remaining in the forearm was the atrophied weakened long flexors and extensors of the thumb and fingers. Of the group of wrist extensors and flexors only the weakened flexor carpi ulnaris remained. The grasping power of the fingers was inadequate due to inability to fix the wrist. Another major mechanical difficulty with the right upper extremity was a pathologic anterior dislocation which occurred whenever the patient attempted to abduct the left arm (see Fig 1b). Due to the combined effects of muscle weakness and mechanical disadvantage of dislocation, the right upper extremity was useless. The indications were to stabilize the joint and to improve the function of the upper arm and shoulder.

On December 16, 1940, an arthrodesis of the proximal carpals to the right radial epiphysis was done and a tenodesis of the right upper humerus carried out by burying the scarified upper tendon of the long head of the biceps under osteoperiosteal flaps raised from the acromial groove. Although protected adequately after the operation, the right shoulder again began to dislocate during the spring of

1941 and within a few more months it was obvious that restraint by the atrophic biceps tendon was not sufficient. The radial carpal arthrodesis improved the function of the hand to a marked degree.

On April 6, 1941, transplantation of the posterior deltoid origin was performed. An S inch curved incision was made extending from the middle third of the clavicle slightly downward but chiefly backward to the middle of the scapular spine. Flaps of skin and subcutaneous tissue were raised superior and inferior from the line of incision. The active posterior third of the deltoid was detached subperiosteally from its scapular origin and freed distally on a plane beneath the muscle to about half its length. This maneuver was carried out carefully to avoid injury to the branches of the axillary nerve. In this instance these branches were unusually long and allowed good mobilization of the deltoid remnant. The outer third of the clavicle was bared by periosteal dissection. The free former origin of the muscle flap was then anchored by many interrupted stitches of cotton to the outer clavicular site. The wound was closed and the arm retained in a frontal plane in 10 degree abduction by a body and arm plaster pipe.

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The upper half of the arm portion of the cast was removed after 3 weeks, the stitches removed and light massage and active motion begun. The whole cast was removed after 1½ weeks and the arm supported upon an aero-plane brace. Active abduction exercises were continued. The patient could easily hold the arm against gravity for a few minutes at 6 weeks but he continued to wear the brace for protection for 4 months more. The transplanted deltoid continued to improve in function. When last seen in March, 1946 almost 4 years after the transplant the function of the right shoulder was nearly normal. Abduction could be performed smoothly, against considerable added resistance and the degree of abduction could be maintained against both gravity and added resistance at any height. There were no jerky throwing motions such as were present prior to operation. Figures 4, a and b show his appearance at this time as he held the arm at two levels of abduction. By this time the transplanted posterior deltoid had hypertrophied to a muscle mass of at least three times its size prior to operation. There has been no recurrence of dislocation at the right shoulder since operation had been performed.

An additional bone grafting operation to span the distal ulna and carpus to the fifth metacarpal for preventing increasing ulnar de-

viation of the hand was done a year previous to the last observation. The graft was fixed to the ulna and fifth metacarpal with two metal screws at each site. This procedure achieved its purpose.

## SUMMARY

A case report is presented demonstrating the result after 4 years of transplanting the origin of the functioning posterior deltoid to an anterior site in poliomyelitic paralysis of the middle and anterior portions of this muscle. Habitual dislocation of the shoulder has not recurred since the operation. The transplanted muscle has hypertrophied on use to more than three times its mass prior to operation. The function of the shoulder has been virtually normal during the last 2 years of observation.

## REFERENCES

- (1) IRVING, P. M. *J. Bone Surg.* 1943, 5, 69.
- (2) IRVING, P. *Chir. Orthop. Traumatol.*, 32, 5, 7-13.
- (3) IRVING, J. *Am. M. Ass.*, 93, 3, 90-91.
- (4) IRVING, J. Transplantation to improve the function of the shoulder joint and exterior function of the elbow joint. *Lectures on Reconstruction Surgery of the Extremities*, 1944. *Instructional Courses of the American Academy of Orthopaedic Surgeons*.
- (5) LAWRENCE, F. *Am. J. Orthop. Surg.* 91, 8, 1.
- (6) LEOG, A. T. N. *England J. M.* 93, 3, 300-2.
- (7) STEINBERGER, N. *Quoted by Steinler, A. Orthopaedic Operations*. P. 146. Springfield, Ill. Charles C. Thomas, 1939.
- (8) STEINBERGER, N. *Am. J. Surg.* 93, 4, 54-60.

# EDITORIAL

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## SURGERY Gynecology and Obstetrics

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JANUARY 1947

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### PROBLEMS OF NURSES AND DOCTORS

THE primary purpose of this editorial is to provoke thoughtful consideration of the growing schism between the medical and nursing professions. An effort will be made to enumerate and to analyze some of the difficulties that have arisen; one approach to their solution will be suggested.

There is real dissatisfaction on the part of many doctors with the nursing profession and there is similar dissatisfaction on the part of some nurses with the doctors. This situation is unfortunate. It seems to be growing worse. In fact, one of the leading surgical associations of the country has recently appointed a fact-finding committee to enquire into the degree and character of the surgeons' complaints. In any co-operative endeavor both partners lose when friction occurs. It is important then to separate our real problems from imaginary ones and to seek the solution of these real difficulties with determination and good will.

To begin with, it is obvious that there is not just a single point of difference between the doctors and the nurses. The relationship between these two groups varies greatly in different communities. The complaints of the surgeons in Chicago are not identical with those of their confrères in Boston, Dallas, or Hagerstown. There are, however, certain basic dissatisfactions. These are widespread and easily recognized. The first is that doctors everywhere complain about the inadequate number of nurses and about the high cost of nursing care. Furthermore, most doctors are not in sympathy with the rising educational requirements of the nursing schools. On the other hand, the leaders in nursing (the heads of schools, associations, and licensing boards) are provoked with the doctors for this lack of sympathy. Finally, many nurses, particularly the older ones, are keenly aware of a loss of *esprit de corps* in their group.

There are insufficient nurses to meet the needs of our civilian population. This is due to several factors, such as the increasing demand of the public for nurses, the requirements of the Government services, and the failure of nurses after discharge from the armed services to return to civilian work. The most important factor is the failure of the profession to attract and to hold young women. This failure is primarily an economic one. The period of preparation is out of proportion to the compensation given graduate nurses. An additional factor that applies only to nurses continuing in their field is the ever increasing boredom of their task. The doctor has three great forces to hold his interest in his work, one is the increasing responsibility of a growing practice, a second is the en-

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larging financial reward and a third is the mental stimulus of keeping up with advances in medical knowledge. The average graduate nurse has none of these stimuli to enliven her work. For her the glamor of the uniform soon fades and she does the same work for the same pay year in and year out. The leaders of the nursing world have not devised any method of making the work of the graduate nurse in a really interesting or increasingly responsible

Although many people complain about the cost of nursing care the fact remains that graduate nurses are underpaid. This difficulty arises from an improper distribution of work. No method has been developed for relieving the highly trained graduate of that part of her work that can be done by less skilled workers. During the recent War the Nurses Aids showed how much can be accomplished in this direction but are these exceptional women continuing to work in our hospitals? If not what steps are being taken to replace them? Under the present allocation of work it is impossible to pay nurses adequately or to provide nursing care to patients at a reasonable cost.

Another widespread criticism of nursing schools, associations, and boards is that the effort to raise the educational requirements for pupil nurses has been pushed too fast and too far. In all fairness, however it must be said that the road travelled by the nursing profession has been a long and ever broadening one. The leaders have tried to keep nursing education abreast of the rapidly advancing front in medical knowledge. They have recognized the increasing complexities of scientific medicine and have insisted on higher and still higher qualifications for the young woman who wanted to study nursing. They have expanded and increased the number of didactic courses in the curriculum of the pupil

nurse. They have encouraged universities to foster schools of nursing. They have pressed for the goal of a college degree as a prerequisite for nurses training. This laudable effort has much to commend it but there are at least two undesirable consequences that make it imperative for the leaders in nursing education to pause and take their bearings. These unfortunate results are first, the failure of this program to attract and to hold an adequate number of young women to meet the needs of the country and second the nurse of today is not being trained primarily to care for the patient. The situation in the field of education of nurses poses a dilemma for the leaders. Medicine is becoming increasingly complex, hence the need for more and more education, but each additional didactic course in the curriculum leaves less time for the pupil nurse to learn bedside care.

It seems clear that the kernel of this problem lies in the failure of the directors of nursing to devise ways of passing along part of the nurses work to subordinates. In the practice of medicine this is being done constantly. A fitting illustration is the matter of transfusions. Thirty five years ago a blood transfusion was considered a surgical procedure and was performed in the operating room by a surgeon with two assistants. Then, as the indirect method was perfected transfusions were entrusted to a resident and were carried out in the patient's room. Later the interne took over and now in many hospitals the blood is matched in the blood bank and the transfusion is given by a nurse. Directors of nursing policies have been so intent on increasing the educational content of the curriculum that they have not devised ways of providing trained personnel to relieve the graduate nurse of unimportant tasks. Probably eighty per cent of the actual nursing care of the average patient can be done by high

school graduates who have had a short period of practical training. It is equally true, however, that there are seriously ill patients and also there are administrative positions that require highly intelligent, highly educated nurses.

The final complaint that was noted at the beginning of this article has to do with one of the intangibles—a loss of *esprit de corps*. This is reflected in the feeling of many nurses that they are no longer participants in a profession, but merely employees. The doctors are largely to blame for this condition. The leaders in nursing are partly to blame for they have neglected the graduates and in some institutions catered to the cadet nurses with great partiality. All of us have been too busy during the War to give much time or thought to the nurses, but the war is over now and every surgeon worthy of the name should make a real effort to win back the enthusiasm

and good will of the nurses with whom he works.

It is not the intention of this writer to make definite recommendations for the solution of the difficulties that have been considered. It would be presumptuous for any single person to do so. The correction of these problems is primarily the responsibility of the leaders in nursing. To assist these leaders is an obligation of every doctor. The schism that has developed between the nursing and medical professions is not irremediable; it can be closed. It is imperative that steps be taken to do so. In fact, the present situation offers a wonderful opportunity for intelligent leadership to perfect the integration of the two professions. Let us then critically examine the conditions in our own community and seek the solution of our mutual problems with courage, common sense, and above all in a spirit of good will.

W M FIOR





STONEWALL. ALKNOT BORN FORT 12 ON THE FLANK ROAD IN ANY ONE OF HIS LINE OF BATTLE.

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## THE BOOK SHELF

### SHENANDOAH TRAGEDY

WILLARD BARTLETT A.M. M.D. D.Sc. St. Louis, Missouri

MY own compelling interest in Thomas J. Stonewall Jackson and the tragedy of 1863 was aroused by a visit to General Custis Lee, brother of the great leader at Lexington Virginia, when he was president of Washington and Lee University. A young friend and I had just graduated from college when we decided to ride our bicycles from Central Illinois to the Shenandoah Valley and explore that historic region which had been soaked with the best of Southern and Northern blood. It was just twenty nine years after the unspeakable misfortune of which I write an event which may have determined the outcome of the war one which certainly shook the military world.

The little city of Lexington seemed very lovely that summer day when General Lee, a stately gentleman just past middle life took me up to the Virginia Military Institute for one of the most stimulating experiences of my life. We stood in the class room in which Jackson had taught during the ten years which preceded the secession. I shall never forget Lee's recital of the incident of cadet impatience to be off as soon as war had been declared. The teacher is said to have cautioned them against haste then to have offered to lead them when the proper time arrived at which the fifteen year old boys screamed with merriment on hearing such war like words from their always moderate and peace loving teacher. When the proper time came he did lead them marching away bravely together the cadets to graves in the Valley the leader to that Valhalla which is the eternal home of all heroes.

Thomas J. Jackson was born in Clarksburg West Virginia (a part of Virginia itself until it seceded) on January 21 1824. He was orphaned at seven grew up on a farm was appointed to West Point at the age of eighteen though his preparatory education had been poor he never having reached a high school grade. He graduated

at West Point in 1846 took part in General Scott's campaign from Vera Cruz to Mexico City was twice brevetted for good conduct later had army duty at Fort Hamilton, New York and Fort Meade Florida. He resigned from the army in 1851 then taught philosophy and artillery tactics for ten years at Virginia Military Institute. He was an earnest member of the Presbyterian church was greatly interested in slaves and conducted a Sunday school for them.

Jackson was a tall spare man with a full beard singularly handsome but a man of few words. He was twice married first to Miss Eleanor Junkin and secondly to Miss Mary Ann Morrison.

A few days after the secession of Virginia General Jackson took over command of the troops at Harper's Ferry a few weeks later he became commander of a brigade and remained one until Bull Run where he acquired the title Stonewall. There he was made Major General. In November of 1861 he took command of the Shenandoah Valley and that portion of Virginia northwest of it his speciality being rapid movements against one enemy then another keeping them all bewildered. In December 1862 he was advanced to the rank of Lieutenant General, commanding the right wing of the Confederate Army.

The campaigns which brought him most fame seem to have been Bull Run, Richmond, Manassas, Harper's Ferry, Antietam and Chancellorsville. This brilliant tactician lived but thirty nine years as it happened because on May 1 1863 Lee ordered him to attack Hooker at Chancellorsville, causing the latter to withdraw into the wilderness to establish new lines. Next day he was early again on the march and highly successful then between eight and nine o'clock of that moonlight Saturday evening he rode forward to reconnoiter but when returning his party was mistaken for Federal troops and was fired on by the 18th North Carolina regiment of Lane's brigade the General receiving wounds that proved fatal eight days later.

Dr. Bartlett is professor emeritus of clinical surgery Washington University School of Medicine.

## SURGERY GYNECOLOGY AND OBSTETRICS



THIS WAS JONATHAN JACKSON  
1844 1863

One bullet entered the right hand, two the left arm, the latter cutting the brachial artery and shattering the humerus. The General's horse plunged beneath the limb of a tree which struck the rider in the face but one of his officers caught the reins and the wounded man fell into his arms. Companions took off his blood soaked garments and tried to bandage the wounds while others sought Surgeon General McGuire of the Stone wall brigade who was nearby. Jackson was bleeding, and in great pain supported by officers on

each side, while shells and bullets diving a threw men, officers and riderless horses into complete disorder. He was undismayed, however though bleeding profusely and deathly pale when he issued his last order "Pender must hold out to the last." He begged to be down so a litter was made, but when one of the bearers of it the General pitched to the ground incurring a first serious injury to his chest.

McGuire, who had found him by moonlight coming through the trees met him with an an-

balance. The General was still bleeding profusely though he remained calm self-controlled and expressed sympathy for others. McGuire placed his finger on the left brachial artery and held it there during the ride in the ambulance during which time whiskey and morphine were administered. Two and one half hours after the wounding McGuire made an examination. Then by two o'clock Sunday morning in a hospital Jackson under blankets, again got whiskey and water. A little later chloroform was given after which a bullet was taken from his right hand which had been fractured and his left arm was amputated high entailing a simple quick bloodless circular operation. The other bullet had entered the outside of his forearm just below the elbow to come out the opposite side above the wrist. The few slight face wounds were dressed then the General delegated authority to General Stuart after which he slept several hours.

Monday morning he was free from pain and hopeful some hours later he suffered right chest pain resulting according to the Surgeon General from the litter fall though no lesion was discovered and this pain was gone a few hours later. Tuesday morning he was removed in the ambulance and arrived at the Chandler House about 8:00 p.m. where he died five days later. He ate fairly well after his arrival slept the entire night and on Wednesday was thought to be improving. He felt well was cheerful had his wounds dressed and then asked when he could return to battle. At daylight Thursday however he was in great pain and McGuire found a right pleural pneumonia. *Cripping mercury antimony and opium* were employed. His wife arrived then and nursed him to the end. All wounds were dressed Friday he breathed with difficulty there also was great exhaustion. On Sunday morning May 10 1863 his wife told him that recovery was doubtful he then expressed his wish to be buried in Lexington after stating that he had hoped that some Sunday would be his last day on earth. Then his mind began to wander and he gave murmured army commands, his last words being "Let us cross over the river and rest under the shade of the trees."

The remains were taken to Richmond for a public funeral, then to Lexington for burial. In 1875 a bronze monument was erected to his memory in Richmond it having been paid for wholly by English subscribers who greatly admired this American military genius.

Eighty three years have now elapsed since Jackson's wounding. It is only natural that we surgeons of three generations should entertain a composite opinion of surgical thought as it has developed since that time and speculate on the treatment and prognosis in a like accident as of today. (None of this is to be taken as hypercritical since Hunter McGuire was a distinguished surgeon whose son Stuart I am proud to claim as a friend.)

We must consider hemorrhage early amputation anesthetic asepsis systemic antiseptics and information regarding impending death.

1 Hemorrhage left the Civil War surgeon helpless as far as replacement therapy was concerned indeed its control was limited to pressure cautery ligation or amputation.

2 Today it is considered unlikely that gangrene will follow destruction of the brachial artery particularly if a paravertebral block dilates the collaterals. Surely prolonged observation of the ischemic arm previous to amputation would be justified particularly after profuse bleeding and shock.

3 Chloroform though admittedly dangerous was of course the accepted anesthetic of the period. A form of nerve block today would take its place and at the same time centripetal shock impulses would be prevented from reaching the already damaged nerve centers.

4. The Civil War was over long before the thought or practice of antiseptics or asepsis reached America from its European birthplace. I heard my own father some twenty years later enthuse frequently over the appearance of *laudable pus* after amputations.

5 The pneumonia which was apparently the last straw today could have been easily controlled by sulfonamides. I suppose if not almost certainly by penicillin. Systemic antiseptics had not been dreamed of in 1863.

6 Today we are not given to warning the patient of impending death so one fails to see how the General's chances of recovery were enhanced by frequent depressing messages on this subject from many of the group about him.

#### REFERENCES

- 1 Southern Historical Society Papers (Dr. Hunter McGuire) 1:37 14 154.
- 2 Stonewall Jackson and the Civil War Vol. 2. By Lieutenant Colonel G. F. HENDERSON New York C. B. Loegman, Green & Co. 191.
- 3 Appleton's Cyclopedia of American Biography Vol. 1 3 301 302 New York D. Appleton & Co. 1878.

## REVIEWS OF NEW BOOKS

THE small volume *Cancer of the Scrotum in Relation to Occupation* by Henry puts on record that certain specific agents are, under industrial conditions, the main factors in the production of epithelioma. Cancer of the scrotum contributes more than 8 per cent of all deaths caused annually by cancer of the skin and only 0.35 per cent of all the deaths caused by cancer of all sites.

Percival Potts in 1775 quoted from Ramazzini's book, *De Morbis Artificum* giving him credit for the first reference to chimney sweepers' cancer. He also stated that "cancer of the scrotum and testes is a peculiarly liable to which chimney sweepers are or carcinoma. A high incidence of cancer of the scrotum among industrial workers of certain trades as cotton mule spinners, was observed by Wilson in 1907. Carcinoma or ulceration of the skin occurring in chimney sweepers or workers handling pitch tar or tarry compounds received statutory recognition in 1907 and was added to the 3rd schedule of the Workmen's Compensation Act. Cutaneous epithelioma occurring in workers coming in contact with mineral oil paraffin or their residue was made compensable in 1914.

The Factories Act of 1920 made epitheliomatous ulceration of the skin a reportable disease. From 1920 to 1943 3,333 cases were reported of which 1,355 or 40.6 per cent were scrotal lesions. The percentages of scrotal lesions reported in the following industries were: coke oven workers 47.6 per cent; coal gas workers, 31.6 per cent; tar distillery workers 19.8 per cent; and pitch workers 16.4 per cent. It was further found that 1,906 or 38.8 per cent of 3,333 notifiable cutaneous cases occurred in the cotton trade (cotton mule spinners) resulting from contact with mineral and shale oil. Seven hundred and ninety three or 64.5 per cent of the scrotal lesions were reported in the cotton mule spinner workers.

The mortality rate of 1,638 cases of scrotal malignancy between 1911 and 1938 was 4.2 per million population or 58 per cent. In addition it was found that cutaneous carcinoma following the commencing of occupational work occurred after 49 to 50 years. In the case of cotton mule spinners, the lag period varied from 15 to 35 years, 1 case occurred after 65 years. The average death age in 163 cases was 61.6 years. It was however impossible to make any de-

ductions of value because so many factors influence the death age. The different ages an employee would enter his occupation, the changing of occupation, the unknown carcinogenic substances in new industries make the information obtained from the death age regarding the time it takes for the carcinogenic substances to act most unreliable.

The treatment recommended for scrotal carcinoma was local excision or radiotherapy. Removal of the inguinal glands was recommended as a wise and safe policy because many of the palpable inguinal glands are only inflammatory. Deep therapy seemed not permitting a biopsy. In a series of 155 patients with primary scrotal malignancies, 93 of 60 per cent died of metastases within a month to 4 years with or without operation (some refused surgery).

Some suggestions were made regarding the prevention of carcinogenic substances from reaching the body of the worker. Also quarterly or biannual physical examinations would pick up scrotal cancer cases much earlier. Some workers dislike to report genital sores or lesions. Cleanliness, adequate ventilation, protective clothing and baths were recommended as prophylactic measures. Early treatment offers the best hope of cure.

LESTER IV RYAN

THE contributions of the frontier military surgeon William Beaumont to the physiology of digestion are a source of pride to every American surgeon. He was our first great physiologist and the first to make a contribution of enduring value. His work with Alexis St. Martin is well known and his own records of those classical experiments have been made readily available by a recent reprint. The preface of *William Beaumont's Formative Years* contains two diaries kept by Beaumont, the one regarding his medical observations and experiences and the other excerpts from his general reading and glimpses of his own philosophy. They cover the period immediately preceding his arrival at Mackinac Island and provide an interesting picture of his activities as a military surgeon during the not too glorious War of 1812. The quotations from the medical authors admired by Beaumont provide the reader with a graphic picture of the scientific fare that was available to the backwoods surgeon and scientist as brightly as a result his own contribution shines the more should read this book.

LESTER R. DRAGSTEDT

WILLIAM BEAUMONT'S FORMATIVE YEARS. Two Early Keokuk, Iowa, 1811. With Annotations and an Introductory Essay by GEORGE MILLER M.A. New York: Henry Schuman, 1946.

CANCER OF THE SCROTUM IN RELATION TO OCCUPATION. By HENRY HARRIS, M.A., M.B. (Cambridge), F.R.C.P., D.P.H. (Cambridge). New York, Toronto: Oxford University Press, 1946.

January, 1947

**SURGERY**  
**GYNECOLOGY AND OBSTETRICS**  
*Supplement*

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Detroit, Michigan

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# INTERNATIONAL ABSTRACTS OF SURGERY

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## COLLECTIVE REVIEW

### THE PARATHYROID ADENOMA

A Study of 322 Cases<sup>1</sup>

EDGAR H. NORRIS M.D. F.A.C.S. Detroit, Michigan

**S**URGICAL management of the parathyroid adenoma holds a place among the recent triumphs of modern surgery. Operative removal of the adenoma is the only effective treatment for this lesion and because of the striking metabolic and skeletal effects with which the neoplasm is associated, the surgical results are often dramatic.

The entire history of the parathyroids extends through a relatively brief period and is encompassed by no more than 65 years. In 1880 long after the gross anatomists had completed their charting of the organs and parts of the body the tiny parathyroid glandules were discovered by Sandstrom a Scandinavian histologist. Eleven years later in 1891 Gley was the first to demonstrate that these glandules were both anatomically and physiologically distinct from the thyroid. From the point of view of clinical medicine and surgery parathyroid history is even shorter and a considerable part of the story has been derived from experience gained in dealing with the parathyroid adenoma.

De Santi (1900) and Benjamins (1902) are often credited with having been the first to describe primary tumors of the parathyroid glands how ever in the light of present knowledge their descriptions are not entirely convincing. De Santi did not report on the histology in his case. And the tumor in Benjamins case was as large as a child's head! What is more despite the fact that the tumor in both cases was very large neither

author noted the association of any skeletal changes. Several other observers of about the same period (Kocher 1899 Langhans, 1907 de Quervain 1909) reported cases of cervical tumors that may have risen from the parathyroids, but, again the evidence of origin is not clear.

The more secure history of the parathyroid adenoma began about 40 years ago and during the first 3 decades of the present century scattered reports of some 30 cases appeared in which a parathyroid tumor was found at autopsy. Probably the earliest record of a case that we may today accept as one of a parathyroid adenoma was that presented by Erdheim in 1903. A year later in 1904 Askanazy was the first to associate a parathyroid tumor with skeletal lesions, and thereafter the combined incidence of an enlarged parathyroid and the lesions of osteitis fibrosa generalisata came to be recognized. However it was not until after the first surgical removal of a parathyroid adenoma by Mandl, a Viennese surgeon in 1925 that widespread practical interest in these related maladies was stimulated. Consequently the history of the clinical surgery of parathyroid disease is rather recent and has been crowded into the brief period of the last twenty years.

Since Mandl's communication of 1925 there has been a rapidly growing list of case reports and the majority have come from surgical clinics. Up to the present time more than 300 cases have been reported and the available information regarding parathyroid adenomas is considerable. However

<sup>1</sup>See Appendix.

because no single investigator has had the opportunity to study more than a few cases, it is not surprising that our more accurate ideas have been slow in formulating and that our fundamental and practical knowledge of the parathyroid adenoma has developed gradually. In the present study we have assembled the recorded information and data and have completed a comprehensive analysis that categorically summarizes our knowledge in a manner which may guide us in securing satisfactory answers to those problems which are still unsolved.

#### MATERIALS AND METHODS USED IN THE PRESENT STUDY

Adenomas of the parathyroid glands have been reported since 1903. In Table I, we have brought together data from the case reports that have appeared in the literature during the 43 years from 1903 to 1945 inclusive. Table I includes the original and basic data from which the statistical analyses of this article have been derived.

Because this article is concerned with the parathyroid adenoma only and because at times in the past there has been a tendency to confuse adenomas with hyperplastic states of the glandules, we have criticised each report editorially and have admitted to the tabulation every case that in our judgment could justifiably be included. Even with this degree of critical analysis, as will be pointed out later a few cases are included among the small group of 'multiple adenomas' about which there may be some discussion. These few cases have been dealt with carefully so as not to prejudice the statistical calculations.

Although, of necessity the data have been compiled from a great many sources, and although the records on certain features are incomplete for many of the cases, we are of the opinion that the quantity of data is sufficient to justify the conclusions reached. For the quality of the records we can assume no more responsibility than to suspect their accuracy whenever exaggerated departures from evident tendencies are noted. In order critically to minimize the application of editorial judgment and to place the greater responsibility upon the original records, each problem has been approached mathematically and from several points of view with the use of illustrative tables and charts.

#### STATISTICAL ANALYSIS OF THE RECORDED DATA

*General incidence of the adenoma.* Apparently no exact figures have been published to indicate the incidence of parathyroid adenomas either in groups of individuals or in series of surgical cases.

Of the 322 cases included in Table I, 78.9 per cent of the adenomas were removed at operation and 21.1 per cent were discovered at autopsy (Table II).

*Single and multiple adenomas.* In the total group of 322 cases more than 1 adenoma was found in 20 instances, or in 6.2 per cent of the cases. These may be identified in Table I for a superior 1 (1) has been placed before the serial number of each case of multiple adenomas. Because this group in which more than 1 adenoma was found was small and since in most of the cases features were present that laid them open to question as true adenomas, they will be considered separately in our further statistical calculations. Before this decision was reached, however the effect of the inclusion or deletion of this small group was tested and found to be negligible. Their distribution by decades was much like that for the cases of single adenomas (1 is found in the second decade 1 in the third, 3 in the fourth, 9 in the fifth, 5 in the sixth, and 1 in the seventh). Weights are recorded in only 5 of the 30 cases. Sixteen of the cases (80.0%) of multiple adenomas were in females and 4 in males (20.0%).

In the great majority of cases the parathyroid adenoma was a single lesion that developed in, and therefore involved, only 1 of the parathyroid glandules. A single adenoma was found 302 times in the total group of 322 cases, a relative incidence of 93.8 per cent.

*Location of the adenoma.* The side of the neck in which the adenoma was found is recorded in 251 cases. In 132 (52.6 per cent) the adenoma occurred on the right side and in 119 (47.4 per cent) it was found on the left side of the neck. In 197 cases the location was further defined to indicate involvement of the superior or the inferior glandule (Table III). In 84 cases (42.7 per cent) the adenoma was located in the region of the right lower parathyroid in 81 cases (41.1 per cent) in the region of the left lower parathyroid in 18 cases (9.1 per cent) in the region of the right upper parathyroid and in 14 cases (7.1 per cent) it was located in the region of the left upper parathyroid.

A single adenoma in an aberrant position was found in 30 (10.7%) of 281 cases. In 19 (63.3 per cent) of these 30 cases the adenoma was located in the mediastinum in 9 (50.0 per cent) within the substance of the thyroid gland and in 2 (6.7 per cent) behind the esophagus.

*Weight of the adenoma.* The weight of the single adenoma is recorded in 80 of the total group of 322 cases. These 80 cases are arranged in Table IV. A study of Table IV shows that the weights of the individual tumors varied through an extreme

range. The smallest tumor weighed only 0.4 gm. while the largest attained a weight of 120 gm. The average weight was 12.47 gm and the mean weight for this series was 7.0 gm.

*Size of the adenoma.* The size of single adenomas is recorded with three dimensional measurements in centimeters for 143 cases. Since the majority of these tumors are roughly ellipsoidal in form, their approximate volume in cubic centimeters can be calculated by the application of the formula we used in computing the size of the parathyroids and the lateral thyroids in human embryos and fetuses

(Norris, 1937) The formula is  $\frac{\pi}{6} a b c$ , in which  $a$ ,  $b$  and  $c$  represent the three diameters the results from the application of this formula are recorded in Table V

As may be seen in Table V the estimated volume of the individual tumors in this group of adenomas varied through an extreme range. The volume of the smallest tumor was 0.11 c.c. while that of the largest was 111.3 c.c. The average volume was 9.72 c.c. and the mean volume for this series of 143 adenomas was 3.97 c.c.

*Form and other gross pathological features of the adenoma.* In form adenomas of the parathyroid are not as variable as they are in size and weight. Generally they have the form of an ellipsoidal body with three unequal diameters and in this respect the adenoma resembles a normal parathyroid (Fig. 12). However in the case of the adenoma there is a tendency for the diameters to approach equality and certain of the tumors have been nearly round. Some adenomas are bilobed and others are angular bodies. Probably the average dimensions of the adenomas thus far described may be stated to be approximately 3.2 x 2.1 x 1.7 cm.

As regards their other gross features parathyroid adenomas are apparently rather similar. They are usually moderately soft, smooth of surface, and encapsulated. Through the capsule they are likely to be grayish brown in color. The cut surface tends to be moist and homogeneous in texture and yellowish or reddish brown in color. The depth of the red tone of course depends upon the vascularity of the tumor and at times hemorrhagic areas are present.

*Age incidence.* The age of the patient at the time the adenoma was discovered is stated in 316 of the group of 322 cases. This data is summarized in Table VI.

Parathyroid adenomas have been found in each decade from the second to the eighth inclusive no cases have been reported in children under 10 years of age or in adults over 80. Of the patients

in the second decade (the youngest age group) 5 were 14 years old 2 were 16 4 were 17 4 were 18 and 3 were 19 years old. The oldest patient was operated on at 77 years of age. The maximum incidence occurred in patients between 40 and 50 years of age and the incidence in both the fourth and the sixth decades was high and at approximately the same level. Seventy per cent of the adenomas have been found in patients between 30 and 60 years of age. Of the single adenomas the percentage incidence by decades was as follows: second decade, 6.0 per cent third 13.5 per cent fourth 18.2 per cent fifth 29.5 per cent sixth 21.6 per cent seventh 8.5 per cent and eighth decade 2.7 per cent.

*Sex incidence.* Sex is reported in 317 cases of the 322 in this series.

The predominance of females over males is evident in both groups as shown in Table VII it being in the ratio of approximately 3 to 1 in the group of single adenomas and 4 to 1 in the group of multiple adenomas.

*Incidence of associated osteitis fibrosa generalisata and renal lithiasis and/or calcification.* Observations were recorded regarding the presence or absence of associated skeletal and renal changes in each of 314 cases included in Table I. The incidence of these associated maladies is summarized in Table VIII. It is striking that only 1.5 per cent of 322 cases failed to show a degree of skeletal or renal change of clinical importance.

## DISCUSSION

*Incidence of the adenoma in groups and according to geography age and sex.*

As to its general incidence it may be said that although the parathyroid adenoma is not a common tumor within the present medical generation the primary hyperparathyroidism with which the lesion is associated has become a well defined clinical entity. Despite this fact the malady continues to be recognized rather late in its course.

This is regrettable for as with most diseases the clinical results are better in those cases that come under early management before deformities and irreparable damage have developed. Probably the general incidence of this tumor is greater than is suspected.

As to its incidence in groups it is perhaps just as well for the present that we have no figures to indicate the incidence of parathyroid adenomas either in groups of individuals or in series of surgical cases. This is true because it has been common experience that the incidence of the lesion has risen sharply whenever the threshold of suspicion has been lowered and whenever diagnostic

TABLE I—ADENOMAS OF THE PARATHYROID A SUMMARY OF CASE REPORTS FROM THE LITERATURE<sup>1</sup>

Serial No	Year	Author	Age in Years	Sex	Number of T. nodes	Location of T. nodes	Measurements of Tumors in Centimeters	Weight of T. nodes in Grams	Endocrine Changes	Renal Stoses and/or Calcification	Autopsy or Operation	Remarks
	1903	Erdheim	18	—		RL	5 5 5	—	+		A	
	901	Akasaky	5	F		L	5	—	+	+	A	
3	1905	Habst	—	F		RU	5 5	—			A	In thyroid
	905	MacCallum	26	M		RL		7	—	+	A	
5	906	Wechselbaum	—	M		RL	5 5 5	—			A	
6	906	Wechselbaum	—	F		LU	5 5 5	—			A	
7	907	Schwarzl	48	F		LU	5 5 5	—	+		A	
8	907	von Verelby	45	F		RL	5 5 5	—			A	3 other glands normal
9	1907	von Verelby	50	M		LL	5 5	—			A	
	1913	Malinow	7	F		R	7 7 7	—	+		A	
	913	Patauf	5	F		RL	—	—	+		A	
	915	Harbitz	10	F		L	5 5 5	—	+	+	A	
3	916	Marsch	63	F		RL	7 5	—	+		A	3 other glands normal
14	1916	Schlagensiefel	45	M		LL	Pine	—	+		A	
5	916	Schlagensiefel	6	F		RL	Almond	—	+		A	
6	917	Mayer	26	M		RL		—	+		A	other glands normal
7	9	Fisher and Quencher	40	M		RL	5	—	+		A	
8	918	Hartwich	60	F		L	5	0	+		A	other glands normal
9	1918	Nagelsbach and Wotawa	27	M		—	Flynn's egg	—	+	+	A	
10	918	Sauer		M		LL	Hamlet	—	+	+	A	
	918	Strack	27	F		L	5 5 5	—	+		A	
11	918	Dawson and Struthers	49	M		LL	5 in diameter	—	+		A	
	918	Stenholm	24	F		RL	5	—	+	+	A	5 other glands normal
14	918	Stenholm	51	F		RL	5	—	+	+	A	
5	918	Charvonn		M		—	5	—	+		A	4 other glands normal
16	918	Charvonn	30	F		—	Hamlet	—	+		A	
17	918	Mandl	38	M		LL	5 5	—	+		O	
18	1919	Parron and Castro Freyre	15	M		R	Cherret	—	+		A	
19	919	Fenncke	35	M		LL	—	6	+	+	A	
30	919	Fenncke	59	F		RL	—	5	—		A	
31	919	Geld	54	F		RU	5 6	—	+		O	
32	919	Berr et al	36	F		L	5 in diameter	—	+	+	O	
33	1919	Berr et al	38	M		—	5 in diameter	—	+		O	
34	1919	Byrd et al		M		LL	5 5 5	—	+		O	5 other glands normal
35	919	Eggers	—	F		LL	Hamlet	—	+		O	
36	919	Hunder		F		LL	3 7 5 5	—	+		O	
3	919	Widder and Wedbreck	33	F		—	5 5 5	—	+		O	Extra-normal
38	920	Ask-Upmark	45	M		L	5 5 5	—	+		A	
39	920	Compage	50	F		LL	5	—	+		O	

See key to Table in footnote end of Table

TABLE L—ADENOMAS OF THE PARATHYROID A SUMMARY OF CASE REPORTS FROM THE LITERATURE<sup>1</sup>—Continued

Serial No.	Year	Author	Age in Years	Sex	Number of Tumors	Location of Tumors	Measurements of Tumors in Centimeters	Weight of Tumor in Grams	Fixed, Gauge	Renal Stones and/or Calcification	Anatomy for Operation	Remarks
40	1930	Drennan	63	F		RL	4.5 in diameter	—	+		A	
41	1930	Hecker	—	—		—	Walnut	—	+		O	
42	1930	Leri et al.	31	M		RL	—	—	+	+	O	
43	1930	Penberton	24	F		LL	5 3 3	—	+		O	
44	1930	Rosenbach and Desque	24	F		RL	—	—	+		O	
45	1930	Saenger	26	M		LL	5 4	—	+		O	
46	1930	Wanke	38	F		RL	Walnut	—	+		A	
						RU	Coffee bean					
47	1930	Wanke	41	F		RL	Almond	—	+		O	
48	1930	Zajewski	37	M		RL	4.5 3.0 3	8			A	
49	1931	Allen	34	M		—	—		+		O	
50	1931	Aak Uppmark	43	F		L	4.0	—	+		O	
51	1931	Berner	40	F		L	8 8	7	+		A	
52	1931	Berner	47	F		L	Large	—	+		A	
53	1931	Cooley	4	F		—	—	—	+		O	
54	1931	Coeln	17	M		RU	7 .0	—	+	+	O	
55	1931	Dremer and Hampton	44	F		R	6.5 5 5	33	+	+	O	
						LU	in diameter					
56	1931	Hunter and Turnbull	40	F		RL	8 5 8	—	+	+	A	
57	1931	Hunter and Turnbull	37	F		RU	3 5 9	3	+	+	O	One other large gland seen
58	1931	Hunter and Turnbull	40	F		LL	6.8 8 4	35	+	+	O	
						RU	7.5 5 8	36				
59	1931	Hunter and Turnbull	5	F		RL	3.0 3	—	+	+	O	Parts of one mass
60	1931	Lierre and Muller	4	F	1	RL	3.5 3	—	+		A	
61	1931	May and Lierre	45	M		LL	3 8	8	+	+	O	
62	1931	Quirk and Hunsberger	5	M		LL	7 5	—	+		O	
63	1931	von Redwitz	—	—		RL	Cherry stone	—	+		—	
64	1931	Schouten	55	M		—	—	—	+		—	
65	1931	Schupp	5	F		—	5 7.5 5	—	+		A	3 others normal thyroid
66	1931	Saenger and Boer	35	F		L	Almond	—	+		O	
67	1931	Saenger and Boer	37	M		LL	5 5	—	+		O	
68	1931	Well	44	F		RL	3 6	—	+	+	O	
						R					O	
69	1931	Deyerdick	35	F		L	—	—		+	A	
70	1931	Chelivitz and Otten	5	F	1	RL	3.5 5	—	+		O	
71	1931	Fregoni and Almandri	5	F		R	6	9	+		O	
72	1931	Gandhi and Patel	60	M		RL	—	—	+		O	





TABLE I—ADENOMAS OF THE PARATHYROID A SUMMARY OF CASE REPORTS FROM THE LITERATURE—Continued

Serial No.	Year	Author	Age in Years	Sex	Number of Tumors	Location of Tumors	Measurements of Tumors in Centimeters	Weight of Tumors in Grams	Endotal Change	Renal Stones and/or Calcification	Anatomy for Operation	Remarks
108	1933	Thomson and Smith	4	F		LU	In greatest diameter	—	+		0	
109	1933	Venables	5	F		R	1.5 .5 x 1.	—	+		0	In thyroid
110	1934	Barker	65	F		RL	5 5	—	+	+	0	
111	1934	Cahill		F		RL	Peanut-size	—	+		0	
112	1934	Corya	20	F	1	—	Small nut	—	+		0	
113	1934	Courty and Callens	60	F		RL	Cherry-size	—	+		0	
114	1934	Gottman et al.	34	M		RL	7 6 .0	3.5	+	+	0	
115	1934	Gottman et al.	53	F		RL	5 8	4.5	+	+	0	
116	1934	Gottman et al.	33	F		—	—	—	+		0	
117	1934	Lewis and Trimble	65	F		RL	5	—	+		0	
118	1934	McMahon	40	F		LL	3 5	—	+	+	0	
119	1934	Murphy and Butler	17	M		—	In diameter	—	+		0	Retrosternal
120	1934	Morelle	5	F		R	x 7	—	+		0	
121	1934	Peterson	53	F		LL	Small olive	—	+		0	
122	1934	Ravine and Lyon	53	F		LU	3-4 times norm					
123	1934	Sortsen	74	M		LL	4 greatest diam	—	+		0	
124	1934	Strandgaard	47	F		R	1.7		+	+	0	
125	1934	Tilston	48	F		RL	Walnut	—	+	+	0	
126	1935	Bellin and Gershwil	44	F		—	2.3	—	+	+	0	
127	1935	Brooks	48	F	1	RL	—	—	+		0	
128	1935	Brown	45	F		RL	—	—	+	+	0	
129	1935	Cuthbertson and Mackey	53	F		LL	3.7 5 5	6.7	+		0	
130	1935	Cuthbertson and Mackey	40	F		LL	—	1.8	+		0	Portion of adenoma left in situ
131	1935	Cuthbertson and Mackey	19	F	1	—	—	—	+		0	
132	1935	Gamberini	77	F		R	3.5 5 9	—	+		0	
133	1935	Lahey and Haggert	6	F		LI	3.7 .9	—	+		0	
134	1935	Lahey and Haggert	53	F		RL	Medium sized olive	—	+		0	
135	1935	Lahey and Haggert	74	F	1	R	7 0.5	—	+		0	I thyroid
136	1935	Lahey and Haggert	44	F	1	RL	2.8	—	+		0	
137	1935	Lahey and Haggert	5	F		RL	3	—	+		0	
138	1935	Quirk et al.	38	M		—	3. 2.0 .0	—	+		0	
139	1935	Ross	33	F		LL	Large	—	+	+	0	
140	1935	Rutishauser	63	M		R	—	9	+		0	
141	1935	Valla et al.	32	F	1	L	Grain of corn	—	+		0	
142	1935	Valla et al.	45	F	1	L	Grain of corn	—	+		0	
143	1935	Warren and Morgan	6	F	2	LL	3 .0 .5	—	+		0	
144	1935	Warren and Morgan	1	F		RL	.0 .0	—	+		0	

TABLE I.—ADENOMAS OF THE PARATHYROID A SUMMARY OF CASE REPORTS FROM THE LITERATURE—Continued

Serial No	Year	Author	Age in Years	Sex	Number of Tumors	Location of Tumors	Measurements of Tumors in Centimeters	Weight of Tumors in Grams	Endothelial Changes	Renal Stones and/or Calcification	Asphyxial or Operation	Remarks
145	1915	Warren and Morgan	48	F		RU	7 7 7	—	+		O	In thyroid
146	1915	Warren and Morgan	51	F		RL	8 in great. diam.	—	+		O	
147	1915	Warren and Morgan	5	F		RL	3.5 2.4 2.0	—	+		O	
148	1915	Webb	80	F		RL	4.5 2.5	—	+		O	
40	1916	Cayter Baker and Howard	5	F		—	Small walnut	—	+	+	O	
90	1916	Castleman, Mallory, Churchill & Cope	46	F		R	6.5 5 3.5	53	+		O	
11	1916	Castleman, Mallory, Churchill & Cope	60	F		—	0.5	—	+		O	
5	1916	Castleman, Mallory, Churchill & Cope		F		—	5 0.9	—	+	+	O	
23	1915	Castleman, Mallory, Churchill & Cope	33	F		LL	3	—	+	+	O	
54	1916	Castleman, Mallory, Churchill & Cope	35	M		—	3	—	+	+	O	Mechanism
55	1916	Castleman, Mallory, Churchill & Cope	36	F		—	3 5	—	+		O	Mechanism
56	1916	Castleman, Mallory, Churchill & Cope	44	F		R	8 6	—	+	+	O	
57	1916	Castleman, Mallory, Churchill & Cope	33	M		LL		7	+	+	O	
58	1916	Castleman, Mallory, Churchill & Cope	54	F		LL	3 7 8	—	+	+	O	
59	1916	Castleman, Mallory, Churchill & Cope	53	F		LU	3	2.5	+	+	O	
60	1916	Castleman, Mallory, Churchill & Cope		M		LU				+	O	
61	1916	Castleman, Mallory, Churchill & Cope	3	M		R	2 9	2.2	+	+	O	
62	1916	Castleman, Mallory, Churchill & Cope	10	M		RL	5 0.6	6		+	O	Glands very close
63	1916	Castleman, Mallory, Churchill & Cope	38	F		RL	4.5 3 3	3		+	O	
64	1916	Castleman, Mallory, Churchill & Cope	49	M		RL	3 3	12.7	+		O	
65	1916	Castleman, Mallory, Churchill & Cope	36	F		RU	3 7 3	18		+	O	
						LU	2.0 2 3	3	+	+	O	
						RU	About same as RL					
1406	1916	Castleman, Mallory, Churchill & Cope	33	F		RL	6 3	—		+	O	
57	1916	Castleman, Mallory, Churchill & Cope	41	M		LU	3 7 8	—	+	+	O	3 other glands seen
68	1916	Khons, Wood and Ravella	35	F		LL		—	+		O	
149	1916	Flick and Gibson	66	M		R	1	—	+		O	
170	1916	Ockler and Smyth	17	F		LL	3.7 3 8	11.8	+		O	
7	1916	Ockler and Smyth	3	M		LL	3	6.5	+		O	
7	1916	Hansen	47	F		RU	8 3	—	+	+	O	

TABLE I—ADENOMAS OF THE PARATHYROID A SUMMARY OF CASE REPORTS FROM THE LITERATURE—Continued

Serial No	Year	Author	Age In Years	Sex	Number of Tumors	Location of Tumors	Measurements of Tumors in Centimeters	Weight of Tumors in Grams	Skeletal Changes	Renal Stones and/or Calcification	Autopsy or Operation	Remarks
173	1935	Hanes	44	F	1	RU	4 .0 2.0	—	+	+	O	
174	1936	Jenop	53	F	1	—	4.5 3.2	9.7	+	—	O	In superior mediastinum
175	1936	Jenop	64	F	—	—	4.3 2.0	4	+	—	O	Behind mediastinal sternum
176	1936	Jenop	34	F	1	RL	.0 5 8	—	+	—	O	
177	1936	McClure	5	F	1	—	In diameter	—	+	—	O	In thyroid
178	1936	Mellgren	44	F	1	—	7 1.5 1	—	—	—	A	Accidental finding at autopsy
179	1936	Möller	41	F	1	RL	4 4	5	+	+	O	
180	1936	Moore	34	M	—	LL	5 7.5 .0	—	—	+	O	
181	1936	Neves and Calkins	51	M	—	RL	0.0 in diameter	—	+	—	O	
182	1936	Noble and Borg	35	F	1	L	4.0	—	+	—	O	
183	1936	Payne	40	F	—	LU	Small	—	+	+	A	
184	1936	Riven and Mason	51	F	1	LL	5	—	+	+	O	
185	1936	Slak	53	M	1	R	5 7.5 0.5	—	+	—	O	
186	1936	Snell	47	M	—	RL	6 6 5	—	+	—	O	
187	1936	Westworth and Lingsen	35	F	—	R	2.5 9 2.7	—	+	—	O	
188	1937	Amico	43	F	—	—	Almond	3.5	+	—	O	
189	1937	Bauer and Jung	34	F	—	LU	—	—	+	—	O	
190	1937	Boile	41	F	—	LL	Walnut	—	+	—	O	
191	1937	Brenner	45	F	1	LL	Almond-size	9	+	—	O	
192	1937	Da Idaco	55	M	—	RL	5 in diameter	—	+	+	A	
193	1937	Fahrd	52	F	—	LL	2.5 in diameter	3.85	+	—	O	In mediastinum
194	1937	Fahrd	57	F	—	LL	3 in diameter	12.5	+	—	O	Thyroid tissue attached; weight too great
195	1937	Fahrd	41	F	—	L	2.4 B	—	+	—	O	A In mediastinum B In thyroid lobe
196	1937	Flick and Gibbon	60	M	—	RL	4.0 5 2.0	—	+	—	O	
197	1937	Frank and Hjernö	63	F	—	L	.0 8 6	—	+	—	A	
198	1937	Oomakuro	95	F	—	LL	3.5 1 1.0	—	+	—	O	
199	1937	Gordon-Taylor and Handley	44	F	—	LL	2.1 .2 1.	4	+	—	O	Intrathoracic
200	1937	Grosso	5	F	—	LL	5 .1 0.7	6	+	—	O	
201	1937	Hanes	40	F	—	LL	—	—	+	+	A	
202	1937	Hirsch	43	M	—	RL	6.5 4 .0	24.5	+	+	O	
203	1937	MacKinnon	49	F	—	LL	3.75 1.8	—	+	—	O	
204	1937	Meisel	34	F	1	RU	Pigeon's egg	—	+	—	O	
205	1937	Meisel	3	M	—	LU	Small hen's egg	—	+	—	O	
206	1937	Meisel	4	M	—	RL	Small hen's egg	—	+	—	O	
207	1937	Meolten, Clarke and Haywood	4	F	—	LL	3 1	6	+	—	O	No assay of adenoma
208	1937	Petersen	3	M	—	RL	Chestnut	—	+	—	O	
209	1937	Ross	11	F	—	LL	Large	—	+	—	O	

TABLE I—ADENOMAS OF THE PARATHYROID A SUMMARY OF CASE REPORTS FROM THE LITERATURE<sup>1</sup>—Continued

Serial No.	Year	Author	Age in Years	Sex	Number of Tumors	Location of Tumors	Size of Tumors in Centimeters	Weight of Tumors in Grams	Relative Change	Endocrine Studies and/or Calcitonin	Autopsy or Operation	Remarks
10	17	Schrempf and Hart 12	35	M		RL	—	20	+	+	O	
11	5	Affert and Jensen		F		L	3	20	—	+	O	Extracapsular
	5	Carnot and La Jolle		F		—	—	—	+	+	A	
						L	Large pea	—	+		O	
113	35	F. Scott	40	F		LL	Large pea	—	+		O	
		Gottman and Parson		F		RL	5	—	+	+	O	3 other normal glands present
5	5	Gottman and Parson		F		LL	3 3 3	—	+		O	
16	5	Gottman and Parson		F		LL	3 3	—	+		O	
7	35	Mackenzie	41	F		LL	3 4	—	+		O	
5	35	McQuillan		F		R	—	—			O	Cystic cell, brown, no clinical findings
18	35	McQuillan		F		R	G-1 Ball	—			O	Colloid carcinoma
20	1915	Mathers and Caspell	40	F		LL	3 3	0	+		O	
	1915	Moulinsport and Livers		F		RU	3	—	+		O	
	1918	Mathers and Lichert	3	M		L	Orange	—		+	O	In Epineurium between esophagus and trachea
1	1915	Rabin	35	M		LL	3	1	+		O	
24	38	Sprent	5	F		—	—	—	+		O	
25	1915	W. Shuren		M	(1)	—	3 3 20	20	+	+	O	other enlarged lymphatic nodes
26	1930	Anderson		F		RU	3 3	—	+	+	O	
27	30	Darby and Bruce		F		R	3	—	+		O	
5	1930	Reinle and Herrman		F		RL	—	2.8	+	+	O	
29	1930	Friderichsen	3	F		—	3.5 3	—	+	+	O	Parathyroid
290	30	Gordano	50	M		RL	—	—	+		A	
3	1930	Hansen	40	F		LL	—	—	+	+	A	
3	1930	Hughes	3	F		RL	—	—	+		O	Spherical
33	30	Johnson	3	M		RL	3 4	3.5	+	+	O	Autopsy 5 years after parathyroidectomy
34	1930	Mallory		F		—	—	—	+		O	
35	1930	Oliver	37	F		RL	3.8 3	3.8		+	A	
36	1930	Oliver	30	F		LL	1 1	4		+	A	
37	1930	Scarpa	5	M		LU	6.5	20	+		O	
123	30	Whyte	35	F		—	3.5 3	—	+		O	
30	1930	Arnold	40	M		R	6 3 3	—	+	+	A	Cysts and infarcted areas
30	1930	Reumgartner	38	F		RL	—	20	+		O	
34	1930	Bruckner	5	F		—	—	10.9	+		O	
41	1930	Fakral	37	F		RL	—	—	+		O	
43	1930	Fakral	34	F		LL	—	—	+		O	Spherical
44	30	Hart and Gordano	34	M		R	—	—	+		O	

TABLE I—ADENOMAS OF THE PARATHYROID A SUMMARY OF CASE REPORTS FROM THE LITERATURE—Continued

Serial No	Year	Author	Age in Years	Sex	Number of Tumors	Location of Tumors	Measurements of Tumors Centimeters	Weight of Tumors in Grams	External Changes	Renal Stenosis and/or Calcification	As-topsy or Operation	Remarks
245	1940	Hart and Gardner	53	F	1	LL	4 3	—	+		O	
246	1940	Hart and Gardner	40	F	1	RL	3 1.5 5	7	+	+	O	
247	1940	Hart and Gardner	54	F		RL	5 5 6	—	+	+	O	
248	1940	Hart and Gardner	46	F		RU	.0 8	—		+	O	
249	1940	Hart and Gardner	44	F		RU	4	—		+	O	
250	1940	Hart and Gardner	47	F		RU	6 5	—	+	+	O	
251	1940	Hart and Gardner	40	F		LL	—	—	+	+	A	
252	1940	Hunter	37	F		—	3 5 9	3				
253	1910	Kleiberg	49	M		LL	—	3	+		O	
254	1910	Moser and Petry	63	M		RU	3	0	+		O	
255	94	Noad & Miller		M		LL	5	—	+	+	O	
256	1910	O'Connor & Keenan	43	F		LL	3	—		+	A	
257	1940	Strie	3	F		RU	1 0 8	7	+		O	
258	1940	Smith & Cook	44	F		RL	5	7	+	+	A	
259	1930	Snapper	37	M		L	5	—	+		O	
260	1940	Snapper	44	F		RL	Swallow's egg		+	+	O	
261	1940	Vance, Rudge and Beck	47	F		LL	3 7 3 3	17.0	+		O	
262	84	Bergstrand	40	F		—	—	—	+	+	O	
263	194	Bergstrand	32	F		RU	Walnut	—	+	+	A	
264	04	Chapman	47	F	1	RL	3	—	+		O	
265	1941	Cochrane	30	F		R	Lima bean	—	+	+	O	In thyroid
266	194	Cochrane	30	M		R	Large Olive	7.5	+		O	
267	1941	Cochrane	68	M	1	RL	1.0 1 6	5	+		O	
268	1945	Cope	26	F		—	—	—		+	O	In mediastinum
269	194	Cope	54	F		LL	.8 8 5	4	+	+	O	In mediastinum
270	1941	Cope	50	F		LL	—	—	+	+	O	In mediastinum
271	1941	Couch & Robertson	6	F		L	7.5 5	—	+		O	
272	1941	Couch & Robertson	64	F		RL	3 5	—	+		O	
273	1941	Curtis & Loomis	25	M		L	4.5 5	1	+	+	O	
274	1941	Deak	5	F		LL	Cherry	—	+		O	In mediastinum
275	1941	Downes & Scott	30	M		RL	4	—	+	+	A	
276	1941	Jobe	0	F		L	Dansons plum	—	+		O	
277	1941	Mallory	33	F		—	—	—	+		O	In mediastinum
278	1941	Thornett et al.	69	F	1	RL	2.8 .0 3	—	+		O	
279	1941	Vogt	76	M		—	5.5 5.5 4	—	+		O	
280	1943	Gilletts	34	F		—	4.0	—	+		A	
281	1947	Koyde	33	F		LL	5.5 2.3 1.3		+		O	
282	1948	Warner	6	F		RL	4.8 1.0	—	+	+	A	normal glands found
283	1948	Andre et al.	35	F		LU	Small olive	—	+	+	O	
284	1949	Grobben and Morehead	5	F		RL	10 7 3	—		+	O	

TABLE I—A SUMMARY OF CASE REPORTS FROM THE LITERATURE—Continued

Serial No.	Year	Author	Age in Years	Sex	Number of Tumor	Location of Tumor	Measurement of Tumor in centimeters	Weight of Tumor in grams	Incision and type of drainage	Renal stones and or calcification	Aspirate by needle	Remarks
5	1913	Hanner et al				LC			+		+	
16	1913	M. Hagen		F		RU			+		+	
2	1913	Orr		F		L					+	
		Ross		F		RL						
5	1913	Schwartz	70	F		LL					+	
109	1913	Shofar & al		F							+	1 mm. last scan
19		Shofar & al		F							+	1 mm. last scan
19	1914	Shofar & al		F		RL					+	
103		Shofar & C. S.		F		LL					+	
12		Shofar et al		F		LL					+	
193	1914	Alexander et al		M		RL			+		+	
196	1914	Alexander et al		F		RL					+	
19	1914	Alexander et al		F		LL					+	
19	1914	Alexander et al		F		LL					+	
19	1914	Alexander et al		F							+	
190	1914	Alexander et al		M					+		+	
194	1914	Alexander et al		F		L			+	+	+	In medication
192	1914	Coffey	64	F		RL					+	In medication
193	1914	Cope		M		RL					+	
19	1914	Cope		F							+	Pale myophal cells about es. ly
193	1914	Faulk		F		LL					+	
196	1914	Geddes and Sparks		F		LL					+	Very brief in the course of 3 weeks
197	1914	Nickels		M		RL	11 cm.				+	
198	1914	Nickels		M		LL	Small basel		+		+	
199	1914	Nickels		F		RL	Wedge		+		+	
19	1914	Volz and Small	1	F		LL					+	
19	1915	Dunsmuir and J. J.		F		RL			+	+	+	
19	1915	Flank		F		RL					+	
19	1915	Flank	15	F		RU			+	+	+	
19	1915	Flank	1	F							+	
19	1915	Flank	37	F				1	+		+	
196	1915	Flank	40	F					+		+	
197	1915	Flank	19	M		RL		20	+		+	
198	1915	McClore and Lam	5	M		R	3 5 7	3	+	+	+	
199	1915	McClore and Lam	9	M		LL	5			+	+	
196	1915	McClore and Lam		F		LL				+	+	
197	1915	McClore and Lam	5	F		R				+	+	
19	1915	Wardle	15	F				5	+	+	+	

Key to abbreviations and signs in Table I: — indicates no data given; A, autopsy; F, female; M, male; O, operation; RU, right upper parathyroid; RL, right lower parathyroid; LU, left upper parathyroid; LL, left lower parathyroid. Blistered changes and renal stones and or calcification. + indicates the presence of changes. Blank space indicates no mention of changes. Indicates author remarked the absence of changes.

APPENDIX TO TABLE I<sup>1</sup>

Serial No.	Year	Author	Age in Years	Sex	Number of Tumors	Location of Tumors	Measurements of Tumors in Centimeters	Weight of Tumors in Grams	Statistical Group	Renal Stones and/or Calcification	Autopsy or Operation	Remarks
323	1945	Nickel	23	M	1		Small cherry					
324	1945	Hansen	35	M		RL	In diameter		+	+	O	
325	1945	Poste and Christie	24	M		RL	3 in diameter	77	?	+	O	Bones carefully examined by ray showed doubtful slight osteoporosis.
326	1945	Bierman	44	F		LL			+	+	O	
327	1945	Madory	29	M		LU			+	+	O	
328	1945	McDonald	40	F		R	3 in diameter		+	+	O	
329	1945	Mockig et al	62	M		LL	1.0 0.5 0.5		+	+	O	In mediastinum.
330	1945	Norris	21	M		LL	3.0 7 5	39	+		O	
331	1945	Norris	23	M		LL		7	+	+	O	
332	1945	Norris	48	F			5 4 8				O	
333	1945	Norris	7	M		LU	6 6		+	+	O	Infarction of adenoma.
334	1945	Norris	23	F		R	3 5		O		O	Oxyphal adenoma, only lymph node was cervical swelling
335	1945	Rogers	35	M		RI	3.0 5 7	4	+	+	A	
336	1945	Voort	42	M		L		687	+		O	

<sup>1</sup>Cases of parathyroid adenoma discovered after the statistical analyses of the 3 cases included in Table I had been concluded.

acumen has become more keen. It is probable that figures collected a decade hence may express more accurately the actual incidence of the lesion.

With regard to the incidence at autopsy and at operation it may be pointed out that during the period of about 20 years after Askanazy described the association of an enlarged parathyroid with skeletal lesions, 26 adenomas were reported as postmortem findings. Following the first surgical removal of an adenoma by Mandl in 1925 the clinical picture of primary hyperparathyroidism became better defined, interest was stimulated and, so far as the number and source of the reported cases is concerned, the statistical incidence of the tumor was altered greatly (Table II). Thus, in the period of over two decades from 1903 to 1925 96.3 per cent of the adenomas were autopsy specimens and only 3.7 per cent were removed at operation whereas in the 10 years from 1926 to 1935 more than 80 per cent of the reported cases came from surgical clinics and less than 20 per cent from the postmortem room and in the decade from 1936 to 1945 approximately 88 per cent of the reported tumors were operative specimens while only about 12 per cent were discovered at autopsy. These figures become the more significant when account is taken of the fact that during the latter period (1936 to 1945) on the average, 50 per cent more cases were operated on each year

than came to surgery during each year of the earlier period. Although the number of cases of parathyroid adenoma reported in the literature probably represents but a fraction of the true incidence, such records as we have suggest that in the future still more cases will be recognized and that a greater number will be given the benefit of earlier surgery.

As to the geographic incidence it may be stated that considerable numbers of cases have been reported from particular clinics, but this must not be taken as evidence to support the contention that the incidence of parathyroid adenomas is influenced by geography (Wildner and Howell 1936 Cope 1944). What is true however is the indisputable fact that this tumor has been recognized more commonly in those places where men are diagnostically alert to the problems presented by this cryptic malady.

Our information regarding the age incidence of parathyroid adenomas is based upon data that record the age of the patient at the time the tumor was discovered at operation or at autopsy. The scattergram and frequency curves shown in figure 1 emphasize two points. Taking into consideration the entire group of 295 cases, the maximum incidence occurred in patients 45 years of age with a large accumulation on either side of this age for 70 per cent of the adenomas were found



## INTERNATIONAL ABSTRACTS OF SURGERY

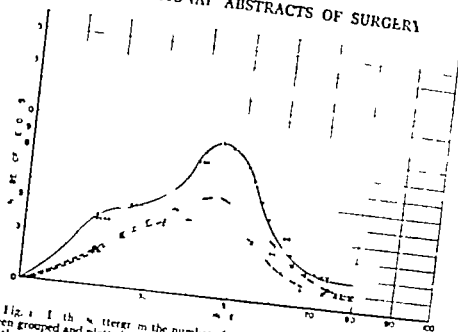


Fig. 1. The scattergram in the number of adenoma found at each year of life has been grouped and plotted as the upper one drawn. Note that this curve has a peak at 45 years. The other two curves, in broken lines, have been taken from Figures 2 and 3 and have been drawn into Figure 1 for earlier comparison. (Total of 205 adenomas.)

TABLE II — ADENOMAS FOUND AT AUTOPSY AND AT OPERATION

Period of age	No. of cases	Total no.	Age at death	Operation	Per cent age
0-10	1	1	10	1	1
10-20	1	1	20	1	1
20-30	1	1	30	1	1
30-40	1	1	40	1	1
40-50	1	1	50	1	1
50-60	1	1	60	1	1
60-70	1	1	70	1	1
70-80	1	1	80	1	1
80-90	1	1	90	1	1
90-100	1	1	100	1	1
Total	10	10		10	10

in patients between 30 and 60 years of age. Figure 1 also illustrates that nearly twice as many cases were discovered in the years of late childhood and early adult life as were observed within the seventh and eighth decades.

We were interested to learn whether the better understanding of hyperparathyroidism that has existed during the last decade would reflect in an alteration of the age incidence curve.

In this end the 162 cases reported from 1936 to 1945 were studied separately and were plotted in the scattergram marked Figure 2 and a frequency curve was drawn in. Comparison of this curve with the one shown for the entire group in Figure 1 shows that the high peak of middle life has been replaced by a broader curve. Continuing this comparison another difference is apparent although in the smaller group more cases continue to appear in the early years of life than in the declining decades, there is no longer evidence of an exaggerated concentration of cases in the third decade.

To analyze further the occurrence of this disease in relation to age the 22 cases discovered at autopsy and reported between 1916 and 1945 were deleted. The 140 remaining cases were plotted in Figure 3. The curve drawn in Figure 3 has a peak; it is characterized by a limb that ascends rather steeply during the early adult years to reach a broad plateau that extends through the middle decades and by a limb of gradual descent after the fiftieth year. The curve of Figure 3 indicates a much more even distribution of the cases through-

TABLE III — LOCATION OF THE ADENOMA

Location	Number of cases	Percentage
Right Lower	81	4.7
Left Lower	8	4
Right Upper	4	0.1
Left Upper	4	7.1
Total	97	100.0
Right	3	5.6
Left	9	47.4
In aberrant positions	9	0.7
In mediastinum	30	61.3
In the thyroid	9	10.0
Retrosophageal	9	6.7
Location not stated	4	2.7
More than one adenoma	20	6

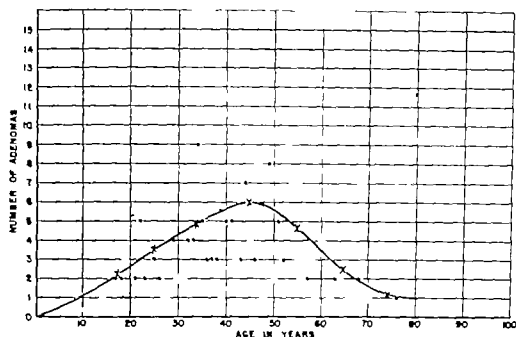


Fig. 2. In this scattergram the number of adenomas found at each year of life have been grouped and plotted as a dot. The frequency curve of this figure also appears as the middle curve in Figure 1. (162 cases reported 1936-1945)

the life span than appeared in Figures 1 and 2. It seems likely that the curve in Figure 3 based as it is upon corrected data expresses more accurately the age distribution of parathyroid adenomas than do the curves shown in Figures 1 and 2. For reader comparison the curves from Figures 2 and 3 have been drawn in broken lines in the scattergram marked figure 1.

From the standpoint of the improving standards of clinical medicine the findings just related are most complimentary. This statistical analysis appears to demonstrate the operation of two most desirable tendencies: (1) that the duration of cases of primary hyperparathyroidism has been reduced and (2) that during recent years there has been an earlier recognition of cases both of

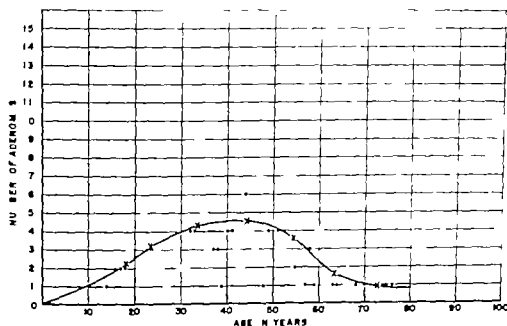


Fig. 3. In this scattergram the number of adenomas found at each year of life have been grouped and plotted as a dot. The frequency curve of this figure also appears as the lowest curve in Figure 1. (140 cases reported 1936-1945; 22 adenomas discovered at autopsy have been deleted.)

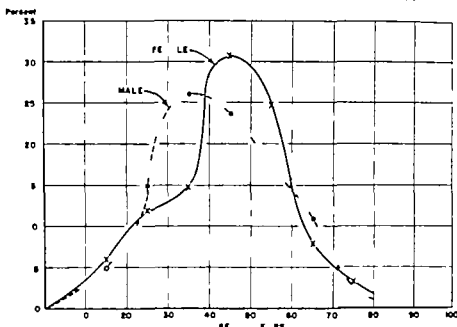


Fig. 4. The curve drawn in a solid line indicates the distribution of adenomas in the group of 317 females; note the presence of two phases in the ascending limb and the location of the peak at 45 years. The curve drawn in a broken line indicates the distribution of adenomas in the group of 80 males; note the relative simplicity of this curve and that its peak is located at about 35 years.

these tendencies appear to be direct results of a better and a more widespread understanding of the disease and its diagnostic criteria.

The sex incidence as may be seen in Table VII is such that adenomas of the parathyroid have been found 3 times as frequently in females as in males. For this significant sex difference no satisfactory explanation is found in the literature. In Figure 4 we have approached the problem by the construction of curves showing the percentage distribution in decades of 397 cases according to sex.

In both sexes adenomas begin to be recognized at about the age of puberty. Among males these tumors have been found with constantly increasing frequency through the third decade and this maximum incidence is attained in the fourth decade. Among females, adenomas have been found with constantly diminishing frequency from the fifth decade throughout the remainder of life (Figure 4).

As may be seen in Figure 4 the distribution of the cases among females is somewhat different from that among the males, starting at puberty the curve rises less abruptly for some 20 years and then ascends steeply to a maximum in the fifth decade. Throughout the later decades the incidence in females decreases constantly and precipitously.

From this analysis 4 conclusions seem justified. On the basis of sex there is a difference in the age distribution of parathyroid adenomas. The maximum incidence occurs a decade earlier in males than in females. The maximum incidence among females is greater than that among males. The ascending limb of the curve for females shows two phases since these two phases extend through and correspond to the childbearing period, it is possible that they may have been influenced or perhaps determined by pregnancy or by lactation.

*Single and multiple adenomas.* In the answer to the query whether true adenomas of the parathyroid are ever multiple, will be found much of fundamental and practical importance. Only 30 cases have been reported as examples of the parathyroid adenoma in which a tumor was found in more than one glandule. These cases are too few to have great statistical significance as a group. However since their distribution according to age and according to sex is much the same as obtains for the group of single adenomas, the fact that we have chosen to omit them from combined consideration with the much larger group of single tumors has not appreciably altered the conclusions reached. Indeed, if any observation argues strongly that the group of multiple tumors are true adenomas, it certainly is the fact that age and sex distribution of the two groups is so similar.

It is well known that certain conditions such as severe chronic renal insufficiency, are often associated with hypertrophy of all of the parathyroids. In such instances the parathyroid tumefaction is due to a parenchymal hyperplasia that is secondary to the underlying disease. This is therefore a secondary hyperplasia of the glandules and a condition that must be carefully distinguished from the primary hyperplasia (neoplasia) of the true adenoma. This thesis was established largely by the excellent studies of Albright and his coworkers and their published work did not appear until 1938. It so happens that of the 20 cases of multiple adenomas, only 2 have been reported since 1938!

If we study the basic data recorded for these 20 cases more carefully several points become evident. One case (Table I Serial No 75) had 4 enlarged glands, 2 that were very large and 2 that were said to be enlarged but the size was not given. In another case (Table I, Serial No 225) 3 enlarged glands were reported 1 which was definitely enlarged, was removed at operation and the 2 other enlarged glands, the measurements of which were not given, were found at autopsy. Three large glands were also found in the case recorded in Table I as Serial No 315 these were later interpreted as representing primary hyperplasia of the 'wasserhelle' cells. In 3 of the remaining 17 cases (Table I, Serial Nos. 69, 102, 210) no absolute measurements of the glands are recorded, and in another 3 (Table I Serial Nos. 165, 166, 243) the size of the second gland was such that it could fall within normal limits. In 2 cases (Table I Serial Nos 59, 162) the tumors may have been more or less separate parts of one mass. There remain 9 cases (Table I, Serial Nos. 47, 56, 74, 77, 85, 122, 183, 195, 213) for each of which the data recorded are too incomplete to permit utilization of the cases as a group for deciding an issue such as that involved in the present problem.

Finally it needs to be pointed out that among this entire group of 20 cases there were 12 in which advanced renal disease was recognized. Since secondary hyperplasia of the parathyroids is not infrequently associated with high degrees of chronic renal insufficiency the burden of proof must rest with each investigator to demonstrate the absence of renal or other previous disease in all of those cases of multiple enlargements of the parathyroid glands that are thought to be adenomas.

Only one conclusion seems justifiable although it is possible that more than 1 adenoma may develop in 2 or more glands in the same case at the same time, up to the present time the literature

TABLE IV — INDIVIDUAL WEIGHTS OF 80 ADENOMAS

Number	Serial No. from Table I	Weight in grams	Number	Serial No. from Table I	Weight in grams	Number	Serial No. from Table I	Weight in grams
	109	4	8	87	4	55	81	.8
	100	6	79	54	4	56	77.5	1.3
3	7	9	30	296	4	57	75	4
4	9	9	3	83	4.3	58	64	7
5	0		3	5	4.3	59	10	8
6	57	3	33	8	4.9	60	70	1.8
7	00	1	34	30	5.0	6	200	
8	5	3	35	9	5.0	6	53	3
9	16	4	50	7	6.5	63	2.8	3
	70	5	37	30	6.7	64	58	13.5
	6	8	35	5	7	65	38	13.5
	24		39	3	7	66	94	3.5
5	18		40	57	7	67	3	5
	100		4	146	7	68	30	6
3	60		4	57	7	69	161	7
6	76		45	35	7.0	70	74	0.7
7	194		44	121	7	7	3.7	10
8	303	4	45	66	7.5	7	103	14.5
9	86	5	46	5	7.8	73	167	5.0
10	107	6	47	45	8.0	74	59	16
	3	2.0	48	40	9	75	140	10
	14	3.5	49	54	9	76	64	37
3	33	3.5	50	49		77	85	53
4	25	3.8	5	144	10	78	50	51
5	59	1.35	5	30	9	79	36	
10	23	1.85	53	34	9	80	37	10
17	99	4	54	5.5				

has contained few convincing reports of multiple adenomas of the parathyroids that may be accepted without question.

*Location of the adenoma.* In 1937 we published the results of an investigation of the topographic anatomy of the parathyroid glands in 93 human embryos and fetuses. The range of variability in the position of the glandules was established, and the reasons for the topographic variations were elucidated (Norris 1937). For the surgeon an exact knowledge of the embryogenesis of these glandules is important in order that he may understand the locations in which tumors of the parathyroids are to be sought. Because of their significance in this connection certain of the illustrations from our earlier study (Norris, 1937) have

TABLE V — ESTIMATED VOLUME IN CUBIC CENTIMETERS OF 143 ADENOMAS

Number	Serial No from Table I	Estimated Volume in	Weight in Grams	Number	Serial No from Table I	Estimated Volume in c.	Weight in Grams	Number	Serial No from Table I	Estimated Volume in	Weight in Grams
	31			49	27	2.38		97	32	6.67	
	80	3		50	207	29	6	98	43	6.74	
3	9	5		51	6	24	8	99	3	6.25	7
	5	8		5	5	54	4.5	200	29	7.33	61
3	53	20		52	70	57		91	44	7.95	20
6	78	17		54	2	24		10	6	2.20	
7	160	9		55	7	25		23	291	8.28	
8	84	20		56	20	25		24	57	8.85	7
	63	20		57	59	26		25	48	8.89	2
	50	50		5		28		106	12	9.27	
	67	20			5	28		107	57	9.33	7
		53		60	01	3.8		108		9.54	
3	200	6	6	6	20	3.8	2.85	200	64	9.51	11.7
	5	6		6		3.8			17	20.20	
5	7	7		6	224	3.8			00	20.60	
6	7	77		64	20	3			99	20.60	
17	92	8		65	8	3.17		3	169	20.60	
8	53	70		66	63	3.18		4	90	20.60	
	109	00	1	67		3.60		5	60	23	
20	129	04		68	24	3.65		116	73	28	
	68	00		69	278	3.85		7	173	27	3
	3			70	55	3.04		8		28	
	38			7	20	06		9	204	13.55	
	5					3.97		20	121	13.54	
5	70		5	7	7.8				26	5.96	7
26	70	77		7	20				28	14.15	13.5
7	7	24		7	08	26		3	22	3.90	
26	45	24		70	7	4.5			79	26.47	11.6
26	37	7		77	90	48		15	204	7.55	37
20		48		8	20	66		26	26	17.65	
	8	48		79	133			27	209	17.66	
	32	37		80		77		8	26	18.84	17
3	87	20		8	43	77		20	267	20.87	25
14	3	1.64	3	8	20			20	20	27.58	21.5
25	3	64	3	8	20	3.5		2	37	27	
20	145	00		81	94	3.20			204	28.27	
17	70	25		82	14	3.20		3		28.29	
18	10	80		84	55	5.20		34	20	28	
29	05	05		87	12	3.20	7	55	20	37.4	20
20	16	98		88	187	2.47		26	202	20	
41	80	90	5	89	287	3.58	4	37	8	43.1	
4	00	00		90	200	3.57		124	25	1.61	21
43	3		2.5	91	66	3.78		20	20	20.28	53
44		3		92	22	6	4.3	20	270	6.15	
45	27	16		94	54	6.20		14	180	95.20	200
46	27	16		94	17	6.20	6.8	14	17	20.26	20
4	14	20	2.5	95	26	29		1	254	20	
4	80			96							

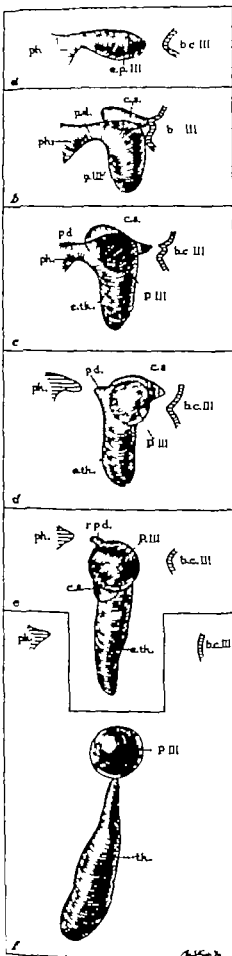
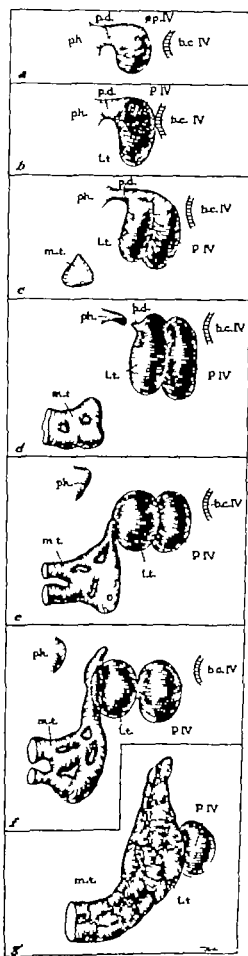


Fig. 5. Left, A schematic interpretation of the morphogenesis of the third branchial pouch and its derivatives. For detailed description of units see text of article by Norris, 1937 a and b, preprimordial stage c, early primordial stage d, early primordial complex stage e, late branchial complex stage f late branchial complex stage, (definitive form stage not included) b.c.III, third branchial cleft (ectoderm) c.a., cervical sinus (ectoderm) e.th., entodermal thymus, e.p.III, third entodermal branchial pouch p.III parathyroid III p.d. pharyngobranchial duct ph, pharynx r.p.d., remnant of pharyngobranchial duct th thymus.

Fig. 6. Right, A schematic interpretation of the morphogenesis of the fourth branchial pouch and its derivatives. The median thyroid has also been included. For detailed description of units see text of article by Norris, 1937 a, Preprimordial stage b and c, early primordial stage d, branchial complex stage e, fusion stage f isolation stage (definitive form stage not included) In the diagram the stages represented are named by a combination of the terms applied in the study of the lateral thyroid and parathyroid IV b.c., fourth branchial cleft (ectoderm) e.p.IV, fourth entodermal branchial pouch Lt., lateral thyroid m.t., median thyroid p.IV parathyroid IV p.d., pharyngobranchial duct, ph., pharynx r.p.d., remnant of pharyngobranchial duct.



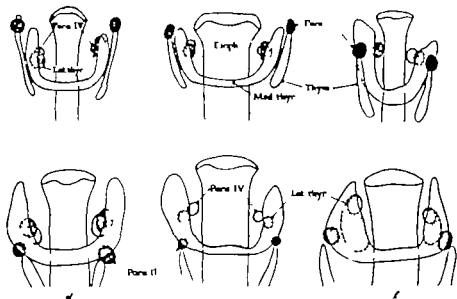


Fig. 7 An arrangement of drawings based upon selected graphic reconstructions to show the usual changing relations of the derivatives of the third and fourth branchial pouches during the branchial complex stage. All of the drawings represent anterior views. The central structure in outline represents the esophagus; the U-shaped figure in outline, the median thyroid; the elongated barlike bodies in outline, the thyroids. Parathyroid III is shown in solid black (diagonals where it lies behind the thyroid); parathyroid IV in simple outline; lateral thyroid, in coarse stipple (finer stipple when it lies behind or within the median thyroid lobe). (a) Graphic reconstruction of pharyngeal region of 5.0 mm. embryo. (30.) (b) Graphic reconstruction of pharyngeal region of 16.0 mm. embryo. (30.) (c) Graphic reconstruction of pharyngeal region of 7.0 mm. embryo. (30.) Note that parathyroid III has descended so that it lies in approximately the same plane as parathyroid IV (30.) (d) Graphic reconstruction of pharyngeal region of 6.0 mm. embryo. Parathyroid III has descended to the level of its usual definitive position. (33.) (e) Graphic reconstruction of pharyngeal region of 30.0 mm. embryo. This figure represents the end of the branchial complex stage and shows the parathyroids nearly isolated and in their usual definitive positions. (30.) (f) Graphic reconstruction of pharyngeal region of 24.0 mm. embryo. This figure shows the very striking growth that has taken place in the lateral thyroids and the resultant altered form of the lateral lobes of the thyroid gland. Compare the outline form of the median thyroid in this figure with the outline form of the same body in a, b, c, d, e. (X30.)

been reproduced in this article (Figures 5, 6, 7, 8, 9, 10, 11). These figures are described and explained in the individual legends. A surgeon should not consider himself competent to operate for a parathyroid adenoma unless he has a thorough knowledge of the embryology of the human pharynx and its derivatives. To determine the site of the tumor is the first problem of the surgeon as he enters the neck to treat hyperparathyroidism and, almost entirely, the various possible sites in which the tumor may be situated are determined by the mechanics of genetics in the cervical region of the individual.

Adenomas of the parathyroid glands are about equally frequent on the right and on the left side of the neck (Table III). In the series of 351 cases, 53.6 per cent (132) of the adenomas were found on the right side, and 47.4 per cent (119) were dis-

covered on the left side of the neck. However when the frequency of adenomatous involvement of the superior and inferior glandules is considered, a remarkable difference becomes apparent (Table III).

In the group of 197 cases, 83.8 per cent (165) of the adenomas were found in the region of the inferior glandule, while only 16.2 per cent (32) were located in the region of the superior glandule. Here again the distribution of the cases in which the adenoma was found in the inferior and superior positions is about equal when they are divided into right and left groups. Thus 43.7 per cent (84) of the adenomas were located in the right inferior position and 41.1 per cent (81) were found in the left inferior position, 9.1 per cent (18) were located in the right superior position, and 7.1 per cent (14) were found in the left superior position.

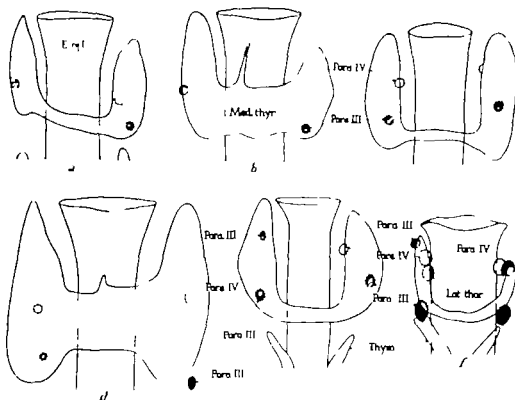


Fig. 8. An arrangement of drawings based upon selected graphic reconstructions to show variations in the more usual definitive relations of the parathyroids and certain anomalies. All drawings represent anterior views. The central structure in outline represents the esophagus, the bilobed body in outline, the definitive thyroid, the barlike bodies in outline, the thymus. Parathyroid III is shown in solid black (diagonals where it lies behind the thyroid), parathyroid IV in simple outline (broken line where it lies behind the thyroid), lateral thyroid, in coarse stipple (finer stipple when it lies behind the median thyroid lobe). (a) Graphic reconstruction from cervical region of 60.0 mm. fetus. ( $\times 10$ ) (b) Graphic reconstruction from cervical region of 66.0 mm. fetus. ( $\times 10$ ) (c) Graphic reconstruction from cervical region of 83.0 mm. fetus. ( $\times 10$ ) (d) Graphic reconstruction from cervical region of 83.0 mm. fetus. ( $\times 10$ ) (e) Graphic reconstruction from cervical region of 65.0 mm. fetus. Note presence and location of accessory parathyroid III. ( $\times 10$ ) (f) Graphic reconstruction from pharyngeal region of 22.0 mm. embryo. Note presence and location of accessory parathyroid III. In this figure the lateral thyroid has fused with, but has not been incorporated by the median thyroid. ( $\times 30$ )

In view of the extent of the migration of the inferior parathyroid that goes on normally during embryogenesis, it is not surprising that adenomas are found in aberrant positions (Figs. 5, 6, 7, 8, 9). In the series of 281 cases the tumor was found in an abnormal situation in 30 cases (10.7 per cent). In this group of 30 cases the tumor was found in the mediastinum in 63.3 per cent, imbedded in the thyroid in 30.0 per cent, and behind the esophagus in 6.7 per cent of the instances. The adenomas discovered in the mediastinum are there because the glandule from which the tumor arose was drawn down into the thorax by the ascending thymus.

The tumors which were imbedded in the normal thyroid grew in parathyroids that had been surrounded by the expanding thyroid during fetal life (Figs. 10 and 11).

These observations have practical value for the operating surgeon. Since the average size of a parathyroid adenoma is small, and since the extensive dissection in search of the tumor demands the utmost care, a scientific plan should guide the cervical exploration. On the basis of the frequency with which adenomas have been found in certain locations a formula to guide the surgeon's approach may be suggested. First the region of the right lower thyroid pole should be explored, then that of the left lower thyroid pole, then the region of the right superior glandule and, finally, the usual location of the left superior parathyroid should be exposed. In seeking an adenoma in the region of the superior glandule it must be remembered that superior in this instance does not necessarily correspond to the upper pole of the thyroid gland, but more nearly to the midlevel of



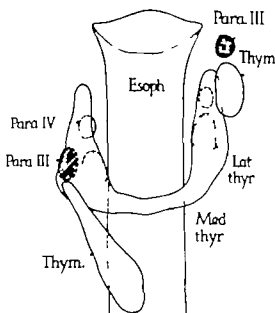


Fig 9 Drawing of a graphic reconstruction from the pharyngeal region of a 24 mm embryo. A tensor view of the anomalous undescended third branchial complex on the left side which contrasts strikingly with the normal condition on the right side. Note the right median thyroid lobes at places where lateral thyroid bodies have been incorporated. The central structure in outline represents the esophagus the U shaped body in outline the median thyroid the barlike and ovaloid bodies in outline, the right and left thymus, respectively. Parathyroid III is shown in solid black (diagonal lines where it lies behind the thyroid) parathyroid IV in simple outline (broken line where it lies behind the thyroid) lateral thyroid in fine stipple for it has been incorporated within the median thyroid. (X 20.)

the lateral thyroid lobe. As the dissection progresses in each of these fields the contours of the thyroid had best be carefully scrutinized in order that a tumor unbedded in the substance of the thyroid may not be overlooked. Finally in the cervical exploration the tracheoesophageal angle the retroesophageal space, and the carotid sheath on each side remain for inspection. Ultimately when the cervical exploration has been fruitless, the surgeon must open the mediastinum. Excellent descriptions of the technique of parathyroid surgery are found in articles by Churchill and Cope (1934 and 1936) and by Cope (1941).

*Weight size form and other gross pathological features of the adenoma.* The site of the tumor is the first problem, and the size of the adenoma be-

comes the second problem of the operating surgeon. Most adenomas of the parathyroid are relatively small soft, encapsulated tumors, they are too small, in the majority of cases, to produce local symptoms that the patient will recognize, or signs that the physician may discern in his physical examination of the neck. However it may be well to call attention to the fact that in a few cases the patient may complain of a swelling in the neck, dysphagia or the like.

Previously we have pointed out the wide variability in the size of these lesions. The smallest adenomas have been very tiny bodies while the largest have attained truly exceptional proportions. Indeed, as may be seen in Tables IV and V the 10 largest tumors in our series were of sufficient size to account for a wide disparity between the average and the mean values of weight and volume. Of course, the larger tumors will cause the surgeon no difficulty in his exploration. Therefore, from the practical point of view and in dealing with the majority of cases, it will be best for the surgeon to have in mind the mean values. For the most part he will be searching for a tumor whose weight will approach 7.0 gm. whose volume will approximate 4 or 5 cc, and whose diameters may be expected to vary from a mean of about 3.2 by 2.1 by 1.7 cm.

Pains were taken to estimate the volume of the 143 adenomas for each of which 3 diametric measurements were given. This was done because suitable data for this calculation were available for nearly twice as many tumors as were included in the group that had been weighed. Forty-four tumors had been both weighed and measured and it was interesting to note the close degree of correspondence between the weight and the estimated volume in the majority of these cases (Table V). In only 6 cases (13.6 per cent) was the discrepancy between the recorded weight and the estimated volume too great to be readily accounted for.

In our series the smallest adenoma weighed 0.4 gm. while the largest weighed 120.0 gm., and the mean weight was 7.0 gm. The biological and clinical significance of these figures may be seen in Table IV.

If a normal parathyroid gland weighs approximately 0.035 gm. then under normal conditions

TABLE VI.—DISTRIBUTION OF ADENOMAS BY DECADE

Age in Years	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	Total
Number of Single Adenomas		18	40	11	85	65	1	8		208
Number of Multiple Adenomas				1	9	8				18

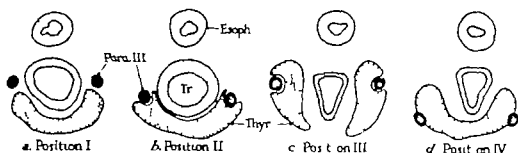


Fig. 10 Group of diagrams representing cross sections through thyroid region to indicate variations in position of parathyroid III. These four diagrams correspond to the four position groups described in the article by Norris, 1937. Parathyroid III is shown in solid black, definitive thyroid in coarse stipple, esophagus trachea (or larynx) in fine stipple.

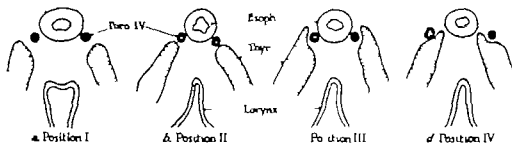


Fig. 11 Group of diagrams representing cross sections through thyroid region to indicate variations in position of parathyroid IV. These four diagrams correspond to the four position groups described in the article by Norris, 1937. Parathyroid IV is shown in solid black, definitive thyroid, in coarse stipple, esophagus and larynx, in fine stipple.

the combined weight of all the parathyroid tissue would be about 0.14 gm. Thus, the smallest adenoma of 0.4 gm. was more than 10 times as large as a normal glandule and approximately 3 times the mass represented by the total parathyroid tissue of the body. This small tumor was associated with a striking clinical picture in which both skeletal and renal changes were prominent.

The largest tumor with its weight of 120.0 gm. was nearly 3,500 times as large as a normal glandule and approximately 850 times greater than the mass of all the parathyroid tissue of the body. Adenomas of 7.0 gm. representing the mean weight of the tumors in our series, show an hypertrophy of nearly 200 times and 50 times, respectively, the size of a normal glandule and the total parathyroid tissue of the body.

As Castleman and Mallory (1935) pointed out, if this new formed glandular tissue functioned in proportion to its size, some individuals would die of parathyroid poisoning like that so easily produced in animals with parathormone unless some compensating mechanism were brought into play. Using the blood calcium levels these same authors thought they could demonstrate a roughly quantitative relation between the size of tumor and degree of hyperfunction. However they stated that as the size of the tumor in

creases the proportional effect of unit weight on the blood calcium becomes rapidly less and less.

In Figure 12 the characteristic form of an adenoma is shown in comparison to the size and form of a normal parathyroid glandule. Although the adenoma shown in this illustration may be considered typical, not a few adenomas have been much more irregular in form. Some have been irregularly bilobed or nearly separated into two distinct masses; it is certain of such cases that may have been misinterpreted as examples of multiple adenomas. From the practical point of view, however, the knowledge that lobulated tumors exist should cause the surgeon to search carefully in the vicinity from which an adenoma has been removed, if a partially detached lobule or a portion of such a tumor is not removed, the clinical result would be spoiled or possibly a second operation would be necessary.

Through the capsule the tumor has a grayish brown color. On the cut surface tones of yellowish brown are mixed with shades of red that depend upon the richness of the vascularity. Most adenomas are soft and have a texture similar to that of the normal spleen. However in some the presence of sufficient stromal tissue in the form of septal bands may considerably increase the consistency. Deposits of calcium in the capsule or in



Fig. Photograph of the parathyroid adenoma removed from a patient suffering from generalized osteitis fibrosa. The adenoma weighed 3.9 gm. Note the bilobed form of the adenoma. The small object to the left is a normal parathyroid removed from the same patient.

the connective tissue septa have been observed. Hemorrhage from the thin walled vessels is certainly the most frequent complicating feature. It is probable that the cystlike spaces so commonly described are posthemorrhagic phenomena. Areas of necrosis are not commonly reported in adenomas of the parathyroid.

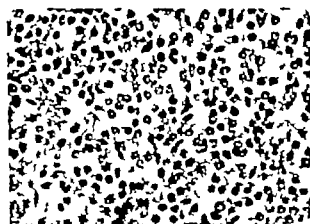


Fig. 13. Photomicrograph of an area from the adenoma shown in Figure . Note the monotonous character of the histological picture. From field 1, field the structure was practically the same. All of the cells are dense cells, only an occasional primordial or small vesicular cell is seen. ( $\times 400$ )

We have reported 1 case in which there was infarction of an adenoma, associated with the signs and symptoms of tetany (Norris, 1946). The cause of this vascular accident was not determined.

**Histology and cytology of the adenoma.** The structural makeup of a parathyroid adenoma is subject to variability within rather wide limits. Most characteristically the parenchyma of this tumor is arranged in irregular blocks or masses of epithelial cells. These blocks or masses are closely related and are separated from each other by an extremely delicate connective tissue stroma through which a rich network of capillaries and sinusoids runs (Figs. 13 and 14). However not a few adenomas exhibit a mixed and much more complex architecture. In some adenomas follicular structures of varying size are conspicuous (Figs. 16, 17 and 18) and in others irregular cystlike spaces are seen. Indeed in certain adenomas follicular and cystic structures may predominate, with solid portions (Figs. 13 and 14) making up a relatively minor part of the tumor.

Probably the microscopic identification of a parathyroid adenoma depends more upon the recognition of cells characteristic of the parathyroid than it does upon a characteristically typical structural pattern. In the adenomas the size cellular types are to be found as are represented in the parenchyma of normal parathyroids (Norris, 1947) and the cells tend to be polyhedral bodies outlined by very distinct cell walls (Figs. 13, 14, 15 and 16).

In 1898 Welsh, after examining the parathyroid glands from 40 human cadavers at autopsy published a description of the histology of the



Fig. 4. Photomicrograph of an area typical of the greater part of a parathyroid adenoma. Note the delicate vascular stroma that separates the epithelial masses. Nearly all of the cells are vesicular cells; only an occasional primordial or dense cell is seen. ( $\times 400$ )

normal gland and he recognized certain distinctly different types of cells. Subsequent authors, in writing their studies have introduced other terms as suited their convenience until now the terminology applicable to the cells of the parathyroid has become regrettably confused. This confusion is particularly unfortunate from the standpoint of our present interest because there is probably no better material for the study and delineation of the functions of the cellular elements of the parathyroid than that provided by a group of functionally active adenomas. However little progress along this line can be made until a uniform and thoroughly understood terminology has been adopted. In a recent article based upon the study of 1665 human parathyroids, we have recommended a terminology for the parenchymal cytological elements of these glandules and it is hoped that the use of it may lead to an understanding of the functional attributes of the different cells (Norris 1947). When we have more information on this subject it is likely that we will be able to recognize a more constant relationship between the cytological picture of an adenoma and the associated clinical and laboratory findings. May we venture to suggest that when such a relationship can be demonstrated it probably will be much more direct constant and significant than is the relationship between the size of the adenoma and the associated clinical state? We are wont to answer this rhetorical query in the affirmative because all of the cytological types I have described (primordial cells vesicular cells clear cells dense cells dark cells, and oxyphil cells) have been found in adenomas and in many tumors particular cells have predominated almost

to the exclusion of others while in other tumors the cells have been mixed in varying proportions and include all manner of transitional forms. We are in need of more cases of primary hyperparathyroidism for which the greatest detail in the clinical history and findings have been recorded before the adenoma is removed, if a closer relationship between the cytology and functional state is to be established.

On the basis of cellular constitution the oxyphil adenoma (a tumor consisting entirely of oxyphil cells) is probably the rarest form of parathyroid adenoma (Fig 16). Very few such tumors have been described (Hunter and Turnbull, 1931, McQuillan 1938 Cope 1944 Norris 1946). In fact, oxyphil adenomas are so unusual that some authors have contended against their existence. Care must always be exercised of course not to mistake for adenomas, those large islands of oxyphil cells that are commonly found in the normal glands of adults (Chown 1937).

The cells of certain adenomas manifest a considerable degree of pleomorphism and in some the presence of mitoses is a conspicuous finding. Indeed some adenomas show pictures that simulate invasion of their capsules by the parenchymal elements such a picture has been interpreted by us and by others as signifying only the enclosure of peripheral cords between overlying layers of the capsule. On the other hand, such observations (cellular pleomorphism mitoses and capsular invasion?) have led certain authors to designate particular tumors as grade 1 carcinomas (Snell 1936 Alexander *et al* 1944). From the knowledge we now possess of the parathyroid adenoma I can see small advantage in so doing indeed the recog-



Fig. 15. Photomicrograph of an area from a parathyroid adenoma. Nearly all of the cells are small clear cells some large clear cells are present. (X400)

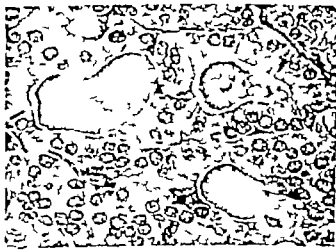


Fig. 16. Photomicrograph of a selected area in the adenoma pictured in Figure 14 to illustrate an unusual structural pattern. Note the colloid filled parathyroid follicles. Most of the cells are columnar dense cells. (X400)

## INTERNATIONAL ABSTRACTS OF SURGERY

TABLE VII.—DISTRIBUTION OF ADENOMAS ACCORDING TO SEX

	Male		Female	
	Number of Cases	Percentage	Number of Cases	Percentage
Single Adenomas	80	27	7	73
Multiple Adenomas	80	16	80	

nition of grade 1 carcinoma seems rather disadvantageous and confusing since these tumors do not invade extensively or metastasize nor do they behave as malignant tumors in their other characteristics. It seems preferable to regard the parathyroid adenoma as a benign tumor by definition to give up any desire to recognize a grade 1 degree of malignancy for this lesion and to reserve

TABLE VIII.—INCIDENCE OF OSTEITIS FIBROSA GENERALISATA AND RENAL LITHIASIS AND/OR CALCIFICATION IN ASSOCIATION WITH A PARATHYROID ADENOMA

Associated skeletal and/or renal disease	Number of Cases	Percent of Total (No.)
Osteitis fibrosa generalisata alone	19	59.3
Renal lithiasis and/or renal calcification alone	7	5.3
Associated skeletal and renal lesions	101	31.4
No skeletal or renal lesions	5	1.3
No record	4	1.5
Total	323	100

the term carcinoma for those much rarer neoplasms of the parathyroid that exhibit indubitable evidence of their malignant nature.

Histological evidence supports the concept that the parathyroid adenoma develops as a result of a



Figs. 7 and 8. Photomicrographs of two areas from the same parathyroid adenoma to show varieties of histological architecture. Left, illustrates the follicular structure and the arrangement of parenchymal cords in loose lace-like pattern. N to the clearly faintly stained col-

loid in the follicles and between the cords. (X 100.) Right, illustrates a pattern made up of irregular cystic follicular structures.

In the lower right hand corner an area of more nearly solid structure is seen. (X 100.)

localized proliferative process within one glandule. Especially in the smaller adenomas a rim of normal parathyroid tissue has been seen persisting over one surface of the tumor (Castleman and Mallory 1935). In sections from larger tumors such remnants of normal parenchyma are less easily found because of the very size of the growth and in the larger tumors the normal glandular tissue may have been caused to atrophy by the growth of the adenoma.

*Clinical duration and growth of the adenoma.* From the foregoing pages one may surmise that exact knowledge regarding the growth of this tumor and its clinical duration would be scant. This is indeed the case. However the literature contains many observations that throw light upon the problem what is more much may now be deduced from the combined use of the data and findings we have just reviewed. For evident reasons it is important that we have precise information concerning the general biologic aspects of this neoplasm without such information there is little hope for further improvement in the clinical management of the serious conditions of which the adenoma is provocative.

In 1934 Albright, Aub and Bauer reported a case in which there was reason to believe from the symptoms that the adenoma had existed for 30 years. At the other extreme a few cases are recorded in which there were no symptoms at all the tumor having been discovered accidentally as the result of suspicion aroused by altered blood findings in the course of an examination for other purposes. Apparently very few patients in whom an adenoma has been identified have presented themselves with symptoms extending through a period so brief as 1 year. Some patients have recognized symptoms for less than 2 years but by far the majority have histories with symptoms ascribable to the adenoma that have extended through many years prior to the diagnostic recognition of the responsible lesion. Very many patients have described symptoms that extended through a decade or even 15 or more years. There is the case of the famous Captain Martell, this man was known to have had hyperparathyroidism for 13 years and he underwent 7 operations before the adenoma was found in the anterior mediastinum. Probably it may be concluded from the reported cases that the average duration of symptoms has been from 5 to 7 years.

All of this convinces us of two things. In the first place the disease state with which a parathyroid adenoma is associated is cryptic at its onset and insidious in its progression. Secondly it must again be emphasized that reports in the

literature record the date at which the adenoma was finally discovered—a date in the majority of instances that is years after the time at which the tumor originated and began to produce its effects. With this latter conclusion in mind it will be well for us to reconsider our figures on the age incidence of the adenoma. If this is done while we at the same time have in mind the data on the weight, the size and the histology of adenomas we may extend our knowledge regarding the growth tendencies of this neoplasm.

As is shown in Table VI and in Figure 1 the age of the youngest patients at the time the adenoma was discovered was 14 years. Since it is likely that on the average these adenomas had been present for some years we may believe that they had their origin during the first decade or even during the period of early childhood. Similar reasoning applied in an effort to establish the age at the time of onset will displace the entire incidence curve (Figure 1) to the left; the age of onset for the maximum number of cases would then be nearer 10, 15 or 20 years than at 45 years as shown in Figure 1. Further support for this conclusion comes from a review of Figure 2; it will be seen that the incidence has been modified through inclusion of only the more recently reported cases—cases that in all probability were identified nearer the time of onset than the cases discovered during earlier periods. Likewise emphatic support is given by the curve shown in Figure 3—a curve that has been altered by omitting the terminal cases in which the tumor was found at autopsy.

This approach toward correction of data on the age incidence of the adenoma in an effort to determine the time of onset has further significance if we wish to relate the onset of parathyroid adenoma



Fig 19. Photomicrograph of a typical area in an oxyphil adenoma. Note the mitotic figure. (X350)



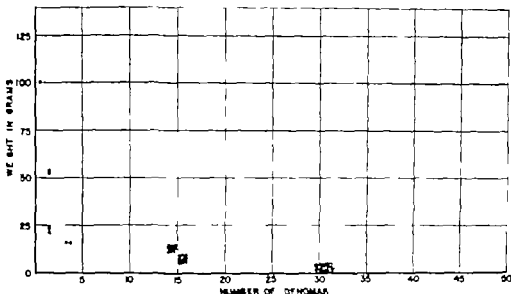


Fig 21. In this scattergram 80 adenomas have been assembled into groups that differed by 5 gm. in weight, and distributed on the chart according to this weight grouping and according to the number of adenomas in each group.

tionship of cell types to function and more concerning the endocrine relation of the tumor to the general physiology of the body.

In summary of this analysis several conclusions seem warranted. The cryptic nature of primary hyperparathyroidism makes it impossible to determine the exact time of onset however such knowledge as we have of the incidence and growth tendencies of this tumor seems to indicate that it may originate in a particular individual at any time from childhood to old age. Furthermore the insidiousness with which the malady progresses imposes difficulties in judging of the duration of the disease prior to recognition of the adenoma, although subject to acute clinical crises the disease is essentially chronic and slowly progressive. As the result of a wider dissemination of more accurate knowledge of the disease and its diagnostic problems, more cases of hyperparathyroidism have been recognized during the last decade than in the years that preceded. However when the cases reported between 1936 and 1945 were segregated, the weights and volumes produced scattergrams quite similar to those shown in Figures 20 and 22. Indeed as may be seen in Figure 22 the largest adenoma thus far reported occurred in an individual 25 years of age. It therefore appears that certain adenomas grow more rapidly than others (perhaps periodically) and that their size is not wholly dependent upon duration. Certainly the reports in the literature substantiate the conclusion that as the tumor increases in size its clinical effects are proportionately less.

*Pathological physiology of the adenoma* In the last few years considerable progress has been made in the understanding of both the normal and the pathological physiology of the parathyroid glands. A recent article by Pope and Aub (1944) presents a comprehensive review of this progress.

As we have learned the parathyroid adenoma is a benign neoplasm which in practically all, if not in all, instances affects the body's economy through the excess of parathyroid hormone generated in the tumor. The parathyroid adenoma is therefore an endocrinologically active tumor and the diseased state produced by the presence of the adenoma is the direct result of an oversupply of the hormone. So far as we know the secretion generated by the adenoma is the same as that elaborated by normal parathyroids, consequently the effects produced in the body result from the continued activity of an abnormally large amount of the secretion. In this connection it should be pointed out that there is need for more reports on the bioassay of adenomas (Moolten, Clarke and Haywood, 1937; Rutishauser, 1941). Assays of more adenomas would seem to offer the best objective approach to the problem. However a note of caution may be sounded in the first place there are possible sources of error and, secondly, the findings from assays are not necessarily indicative of the behavior or of the fate of the hormone in the body.

In studying the altered physiology produced by the adenoma we become interested in the subject of mineral metabolism and its control by the endocrine glands. The recent literature contains a



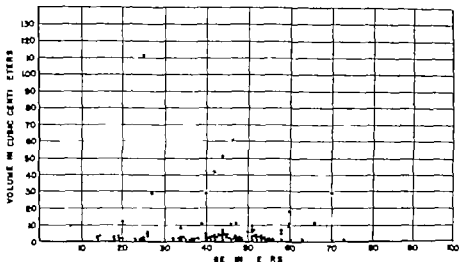


Fig. In this scattergram the individual estimated volume in cubic centimeters of 140 adenomas is plotted as dot. Nearly twice as many cases were available for the construction of this chart as appear in Figure 20. Note that the adenoma having the greatest volume occurred in an individual 25 years of age. In general, this scattergram confirms the evidence recorded in Figure 20.

number of excellent reviews in this field. Since the comprehensive review of calcium and phosphorus metabolism by Schmidt and Greenberg in 1935 other studies have appeared concerned with the same topic and with the chemistry of calcification and the physiology of bone, by Greenberg (1939) Cohn, Cohn, and Aub (1942) Logan (1940) MacLean (1943) Guest and Rapoport (1941) and by MacLean (1941). In 1942 Campbell and Turner reviewed the literature on the relation of the endocrine glands to calcium metabolism, and studies on special aspects of this problem have appeared by Albright (1941) Anderson (1939) Bodansky and Duff (1939) MacLean (1941) and by Silberberg and Silberberg (1943).

Such information as we have indicates that the parathyroids can function in the absence of the anterior lobe of the pituitary gland. If there is an endocrine relationship between these two organs it is not so direct or so close as in the case with certain other ductless glands and the pituitary (Campbell and Turner 1942).

The terminal results from the action of the parathyroid hormone are well known; however the exact manner in which the hormone affects these results remains a matter of conjecture. There are two theories regarding the action of the parathyroid hormone and for each there is considerable support in the nature of experimental evidence. The theory of Collip (1932) holds that the chief action of the parathyroid hormone is directly on the solution of calcium salts from bone. On the other hand the theory of Albright (1929) postu-

lates the chief action of the parathyroid hormone to be that of promoting the renal excretion of phosphate.

The hormone acts to increase the excretion of calcium if insufficient calcium is being absorbed from the intestine. Decalcification of the bones will result. Perhaps those clinical cases that show no skeletal decalcification may find their explanation in the protection that comes from a diet rich in calcium. Why certain patients manifest a form of generalized osteoporosis and why others develop the bizarre picture of osteitis fibrosa cystica is not understood; possibly the latter condition develops in those patients in whom the loss of calcium is very rapid.

The increased output of calcium by the kidney results in supersaturation of the urine with this element. The calcium precipitates out as a phosphate salt (alkaline urine) or as calcium oxalate (acid urine) and calculi may be formed anywhere in the urinary tract. If the precipitation occurs in the lumens of the renal tubules, casts of calcium phosphate are formed. Not infrequently calcium is deposited in the renal parenchyma, which produces calcification of the kidney and a gradual impairment of renal function. Since it appears that on the whole, those cases of hyperparathyroidism that develop renal complications are milder than those with extensive osseous involvement, and since calcification of the kidney may develop early in the malady, renal calcification may progress to lethal proportions before the underlying condition is

recognized. Cope (1944) has very clearly described the ensuing picture.

The development of renal impairment alters the characteristics of the disordered metabolism. With progressive renal calcification or nephritis from ascending sepsis the kidney fails to excrete the excess calcium with which it is burdened by the overactive parathyroid glands. The excess, however, is excreted by the large bowel and the calcium level of the blood remains as before. If renal impairment continues there may be less calcium than normal in the urine.

With impairment the kidney also fails to excrete phosphate, chloride, and nonprotein nitrogen. The levels of these three substances rise in the blood. The phosphate may rise from its abnormal, low level to normal or even above. When it is above normal it may tend to depress the elevated calcium. When retention of these substances occurs the urine has a fixed low specific gravity usually without albumin. The kidney function, as judged by the phenolsulfonphthalein excretion may be but little depressed. And it is in this manner that a fatal degree of renal insufficiency may become associated with an otherwise relatively mild case of hyperparathyroidism (Mayer 1941).

*Clinical complications of the adenoma.* We have seen how the disease condition provoked by a parathyroid adenoma is an entity known as primary hyperparathyroidism, the result of the continued presence of an excess of the parathyroid hormone. As this state endures through months and even years of time certain complicating changes develop in the body in varying frequency and in varying degrees of intensity. The chief complications involve the elements of the skeletal system and the upper urinary tract. Indeed changes are so common in these anatomic systems that by many they have come to be thought of as the disease condition itself, in our series of 322 cases, only 1.5 per cent of the adenomas failed to produce any clinically recognizable skeletal and/or renal changes (Table VIII).

The figures in Table VIII indicate that the skeletal and renal changes may occur in particular patients either alone or together. In the present series of cases clinically recognizable changes in the bones were found in 90 per cent while the urinary tract showed involvement in only 36 per cent of the cases. The effects of the hyperparathyroidism were confined to the osseous parts alone in 60 per cent of the cases, to the urinary tract alone in only about 5 per cent and in particular patients there were changes in both the skeletal and renal tissues in a little over 30 per

cent of the cases. In addition to these common complications a few authors have described the occurrence of metastatic calcification in soft tissues other than those of the kidney.

Cope (1944) believes that complications affecting the urinary tract are more common in hyperparathyroidism than are those affecting the skeleton. He also states that renal complications are more likely to be associated with milder states of hyperparathyroidism and that the bony changes tend to be more prominent in the severer forms of the disease. Albright, Baird, Cope and Bloomberg (1934) assume that the degree of the bone changes is related to the duration of the disease rather than to its severity.

The renal complications are the direct result of the high concentration of calcium in the urine. Calcium may be precipitated out from the urine in any part of the urinary tract from the renal tubules to the bladder with the formation of casts or stones. Not infrequently the precipitation of calcium occurs in the parenchyma of the kidney itself. No matter where it occurs the precipitation leads to greater or lesser degrees of disturbance of renal function; many patients have been operated upon for calculi before the underlying condition was recognized.

The osseous changes are due to the removal of abnormal amounts of calcium from the bones. At times this results in the picture of a diffuse osteoporosis and in other cases the bizarre picture of *osteitis fibrosa cystica* is produced. The bones become softened and fragile so that deformities and pathological fractures occur. These pathological changes (Figs. 23 and 24) have been experimentally reproduced in animals (Yaffe 1933).

It is of interest to know that, according to Denninger (1931) *osteitis fibrosa generalisata* existed in America in prehistoric times. Lesions interpreted to be those of this condition were found in the skeleton of a primitive American Indian that was discovered in Northern Illinois.

*Clinical features associated with the adenoma.* *primary hyperparathyroidism.* The clinical state associated with the adenoma is known as primary hyperparathyroidism. It is called primary because the adenoma is thought of as an autonomous neoplasm and the term 'primary' further distinguishes the effects produced by this tumor from other conditions in which enlargement and overactivity of the parathyroids result as secondary effects due to certain preexisting diseases (chronic renal insufficiency, rickets, etc.). By definition therefore, primary hyperparathyroidism is the clinical condition associated with and provoked by the presence of a parathyroid adenoma.

in which the signs and symptoms are engendered by the excess of parathyroid hormone secreted by this tumor

Primary hyperparathyroidism may be discovered at any period of life from midchildhood to old age. The youngest patient from whom an adenoma has been removed was less than 14 years old at the time of her operation and symptoms had been present since the age of 9 (Anspach and Clifton, 1939). The oldest patient was 77 years of age at the time of her operation (Gamberini, 1935). The maximum incidence is between 30 and 60 years.

Primary hyperparathyroidism is 3 times more frequent in females than in males.

The average duration of the symptoms prior to the discovery of the adenoma has ranged from 5 to 7 years, and the persistence of symptoms through such a long period attests the cryptic nature of the malady. The literature records 1 case in which there is reason to believe that the symptoms had existed for 39 years (Albright, Aub and Bauer, 1934).

Because, on the average, a parathyroid adenoma remains small it relatively rarely produces mechanical symptoms. Occasionally it may cause dysphagia or a feeling of fullness in the neck. Probably in no more than 10 per cent of the cases has the adenoma been palpable, or has it displaced the thyroid so that distortion of the cervical contours was noticeable. A few adenomas, in aberrant positions, have been visualized in roentgenograms of the chest.

Lassitude, asthenia, and fatigue are usually complained of and result from the muscular hypotonia that is caused by the associated hypercalcemia. Occasionally the increased excretion of calcium may produce polyuria and polydipsia. Loss of weight, and at times vaguely connected gastrointestinal symptoms, such as impaired appetite, constipation, indigestion, nausea, and vomiting may be mentioned. Among their chief symptoms some patients list pain in the extremities or pain over other skeletal parts, and a few have noted loss of height and the development of kyphosis.

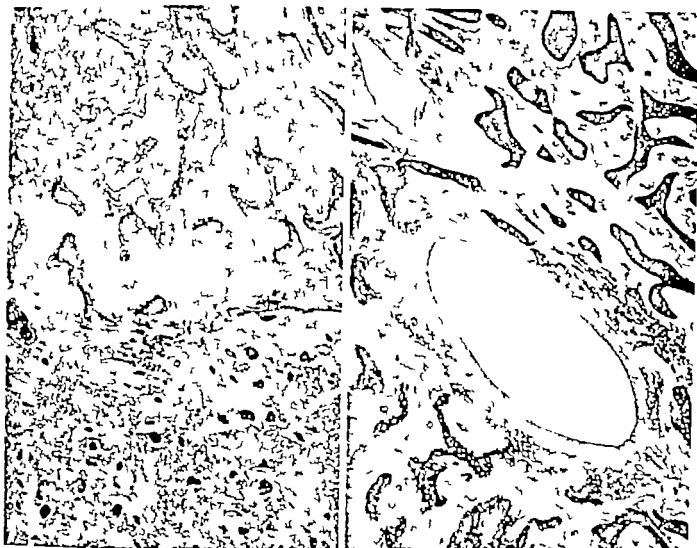
This recitation serves to emphasize the fact that primary hyperparathyroidism has no specific symptoms. Indeed, the very lack of specific symptoms has made the malady clinically unrecognizable except in rare instances, until its complications have become evident. The differential diagnosis in the incipient period will always be difficult and the early recognition of cases will depend almost wholly upon the enthusiasm and vigilance of the physician.

Hypercalcemia and hypophosphatemia are the two most prominent laboratory findings. Generally the blood serum calcium value will be between 11 and 16 mgm. per cent and the phosphorus value between 2 and 4 mgm. per cent, as the concentration of calcium increases in the serum, the phosphorus level is depressed. Hypercalciuria is commonly demonstrable. Studies of the serum phosphatase have not yielded such constant or dependable results, although in many cases the concentration has been elevated. Consequently any patient with indefinite complaints, with hypercalciuria, and with blood which contains an excess of calcium and a diminished amount of phosphorus should be re-examined and his condition investigated until hyperparathyroidism has been excluded.

The clinical course of primary hyperparathyroidism is characterized by its insidious onset and by its cryptic, chronic progression. The course is likely to be interrupted by such seemingly unrelated incidents as renal colics, the passage of renal calculi, spontaneous fracture of the bones, the development of postural deformities, or the appearance of tumorlike swellings on the skeletal parts. All of the latter when recognized for their true nature are the more dramatic indications of complications that develop in cases of primary hyperparathyroidism.

At times the course may be interrupted by crises during which the patient suffers from acute poisoning by the parathyroid hormone. Crises of this type are sometimes referred to as acute hyperparathyroidism. Exemplary cases have been described by Dawson and Struthers (1923), Hanes (1939), Oliver (1939), Smith and Cooke (1940), and by Alexander *et al.* (1944). In such attacks the patient exhibits restlessness, tachycardia, and prostration and may succumb. Rogers (1946) described a case in which uncontrollable vomiting preceded death. On the whole patients with primary hyperparathyroidism remain ambulatory, are disturbed by a variety of indefinite, non-specific symptoms, and progress slowly through periods of disability due to exaggerated distress from complications, to a state of chronic invalidism. This tragic course can be interrupted only by the diagnostic recognition of the condition and by the removal of the adenoma.

So prominent are the complications of primary hyperparathyroidism that they have often been regarded as the disease itself and many times therapy has been directed toward them without recognition of the underlying responsible lesion. The most conspicuous complications involve the skeleton and the kidney.



Figs. 23 and 24. Two photomicrographs from biopsies taken from the humeri of 2 patients, each suffering from the effects of a parathyroid adenoma. These figures illustrate the skeletal lesion known as osteitis fibrosa generalisata. The replacement of the marrow spaces by fibrous tissue is

well shown. In the lower part of Figure 23 numerous giant cells are scattered through the fibrous tissue. In the upper part of Figure 23 a tiny cyst is present. Near the center of Figure 24 a large cyst is seen and just above and to the right a considerable accumulation of pigment. (X 50.)

We have already seen how 90 per cent of the reported cases have shown clinically recognizable involvement of the osseous tissues. The skeletal lesion in primary hyperparathyroidism is called osteitis fibrosa generalisata a disease that manifests itself in two forms. The more common form is described by the term osteitis fibrosa cystica, because of the cystlike areas of rarefaction that appear in the bones. Very many of the bones may be affected, or the lesions may be sparsely and irregularly scattered through the skeleton. The less common form shows a diffuse decalcification of the skeletal parts and is spoken of as the diffuse osteoporotic form; the bones become flexible and rubbery in advanced stages of this condition. Although these two forms of osteitis fibrosa generalisata are recognizable, it is quite common to find evidence of each form in the same case.

Despite the fact that in our series of cases only 36 per cent showed involvement of the urinary tract Cope (1944) states that the commonest complication of hyperparathyroidism is precipitation of calcium in the urinary tract. Doubtless this apparent discrepancy is due to several facts: first, many of the cases reported in the literature developed through long periods of time; second, a better knowledge concerning the association of renal lesions has come in recent years; and finally, probably greater attention has been paid to the renal function in hyperparathyroidism at the Massachusetts General Hospital than in many other places.

The urinary system is affected in four ways in hyperparathyroidism: the excretion of calcium in the urine tends to be increased; calcium casts may form in the renal tubules; there may be cal-

TABLE V.—CLINICAL STAGES OF PRIMARY HYPERPARATHYROIDISM

Stage I	Period of Incubation	Brief history of lassitude and fatigue associated with hypercalcaemia, hypophosphataemia and hypercalcaemia. No demonstrable findings by means of roentgenograms in bones or kidney.
Stage II	Period of Early Complications	Longer history of lassitude, fatigue, and perhaps polyuria, polydipsia, and indigestion. History of one or two bouts of renal colic. History of pains in the extremities. Possibly one spontaneous fracture. Possibly history of bony growth on bony part. Roentgenograms may demonstrate renal calculus or moderately well-developed picture of osteitis fibrosa generalisata. Hypercalcaemia, hypophosphataemia and hypercalcaemia.
Stage III	Period of Advanced Complications	Long period of debility with loss of weight. Long continued history of renal colic, polyuria, and polydipsia. Roentgenograms demonstrate renal calculus and/or calculosis. Long continued history of pains in extremities and one or two bouts of renal colic. History of osteitis fibrosa generalisata. Possibly one spontaneous fracture. Skeletal deformities. Skeletal deformities. Roentgenograms show widespread and extensive evidence of osteitis fibrosa generalisata. Hypercalcaemia, hypophosphataemia, and hypercalcaemia. Possibly albuminuria.
Stage IV	Period of Irreversible and Lethal Damage	Prolonged period of debility through many years, with loss of weight and malnutrition. Prolonged history of bony pain and renal colic. Albuminuria, low fixed specific gravity in the urine, nitrogen retention in the blood with evidence of marked renal insufficiency. History of many spontaneous fractures. Skeletal deformities. Roentgenograms demonstrate extensive deposits of calcium in the kidneys with renal calculus also skeletal deformities and widespread, extensive evidence of osteitis fibrosa generalisata. Only moderate hypercalcaemia, hypophosphataemia, and hypocalcaemia (due to renal failure).

cium deposits in the renal parenchyma and the formation of urinary calculi is common.

Many authors have attempted to classify the cases of primary hyperparathyroidism into clinical groups, depending for the most part upon the presence of findings in the bones or in the kidney. Such efforts seem to exaggerate the importance of prominent complications, and they do little to indicate the true nature of the disease. In our opinion it is preferable for us, as clinicians, to have a comprehensive, practical knowledge of hyperparathyroidism and its complications that will lead us early and directly to the offending adenoma. At least for the present there seem to be no good reasons to recognize clinical types. On the other hand, some advantage may come from the recognition of clinical stages in the progress of the disease especially if such a subdivision tends to aid in the earlier identification of sufferers. An arbitrary subdivision of primary hyperparathyroidism into four clinical stages is proposed in Table V.

The differential diagnosis of primary hyperparathyroidism has been presented in many articles, such as those of Fox and Taglia (1943) and Flink (1945).

**Therapy.** The only effective treatment for primary hyperparathyroidism is the surgical removal of the etiologically associated parathyroid adenoma. The majority of surgeons have performed total extirpation of the adenoma in a single operation with results that have been on the whole, gratifying. Cope (1944) however recommends an occasional subtotal resection of the adenoma in the presence of extensive bone disease. This author also recommends a two stage operation for cases in which the adenoma, not discovered during the initial cervical exploration, must be sought in the mediastinum.

Roentgen therapy for the parathyroid adenoma has been ineffectual. From the structure of the

tumor this negative effect would probably accord with the judgment of most pathologists. Reports in the literature of cases benefited by roentgenotherapy include insufficient data on the calcium and phosphorus metabolism to assume that the clinical improvement may not have been due to diet alone.

Thus far the medical management of primary hyperparathyroidism has been unsatisfactory. Although a high calcium diet may influence recalcification of bones in the presence of an active adenoma the kidney damage is likely to be accelerated by the increased intake of calcium.

**Postoperative course and results from surgical management.** Although no statistics are available on extensive series of cases, one obtains the impression from the literature that the immediate postoperative mortality from the removal of parathyroid adenomas has not been high. However as many authors have pointed out (Churchill, 1936; Cope, 1941; Moehlig and Ulich, 1946) the technical and anatomical features of the operation are such that the task should be undertaken only by especially qualified surgeons. A satisfactory exploration for and the removal of a parathyroid adenoma demand knowledge, experience, and technical skill of a type not necessarily possessed by surgeons expert in dealing with diseases of the thyroid gland. It must be borne in mind that the problems of parathyroid surgery are not alone those of the regional anatomy of the neck but are specifically peculiar to the embryology, anatomy and physiology of the parathyroid glands. The principles and technique of the surgery of the parathyroids are beautifully and thoroughly presented in articles by Churchill (1936) and Cope (1941).

In the management of cases of primary hyperparathyroidism the surgeon needs the close collaboration of an experienced internist. It is of the

utmost importance that the preoperative diagnosis be firmly established and that the surgeon be convinced of the accuracy of the diagnosis. The surgeon needs this fortification because the accuracy of diagnosis in this disease cannot be disrupted by a single exploratory operation. Furthermore, the surgeon needs this assurance for he must do a most meticulous and thorough dissection to find a small adenoma and at the same time, he must identify and carefully preserve the normal parathyroids.

Within the first few hours after the removal of the adenoma a precipitous fall in the blood serum calcium level regularly occurs therefore the danger of postoperative tetany is always imminent. Churchill and Cope (1936), Cope (1941) and Albright with his associates (1937) have demonstrated that the higher the levels of serum phosphatase preoperatively the greater the likelihood of postoperative tetany. Consequently if the preoperative phosphatase level is high postoperative tetany should be looked for and treated as soon as its premonitory symptoms appear (Flink 1945).

Many patients have noted a remarkable improvement in their subjective well being even in the immediate postoperative period. Of course the organic improvement is likely to be best in those cases in which the complications of hyperparathyroidism are least developed. In general the late postoperative results have been good, but as they are unpredictable in particular cases only a guarded prognosis can be given. Voltz and Smull (1944) presented a case in which despite any evidence of the continuance or recurrence of hyperparathyroidism, there was failure of recalcification of the bones 5 years following the removal of the adenoma. Discouraging results of this type in which the bones fail to recalcify even in the face of normal serum calcium levels, may be attributed to arrested osteoblastic activity (Gutman and Parsons, 1938; Voltz and Smull 1944). On the other hand, Sprunt (1938) reported a case that had a long history and extensive skeletal involvement in which there was nearly complete recalcification of the bones by the eighth postoperative month. Fortunately many cases have responded similarly well, and it is to be expected that as more patients come earlier to surgery more will obtain better results.

The parathyroid adenoma in medicine of the future. It cannot be doubted but that in the future fewer cases of parathyroid adenoma will be allowed to endure through such long periods as in the past. More cases will be recognized early in their course and will be removed before extreme

complications have developed. The shortened duration of the disease should favor the recording of more accurate and more detailed clinical histories and this will aid in fixing the time of onset. Such data will be invaluable in refining our knowledge of the growth potentialities of the adenoma. Preoperatively it is hoped that careful laboratory studies will be made repeatedly and through a long enough period so that they will throw more light upon the disturbed physiology. These studies are much needed in order that it may be decided whether a quantitative relation exists between the disturbed mineral metabolism and the size and histological structure of the tumor. Postoperatively the tumor should be accurately weighed in grams and measured in centimeters. After the gross description has been recorded and portions selected for microscopic study, the remainder of the adenoma should be subjected to bio-assay.

It is desirable that all cases of primary hyperparathyroidism be published the more complete data to be presented in the reports of the next decade will go far in answering the unsolved problems attached to this malady. Finally it should be emphasized that a thoroughgoing knowledge of the parathyroid adenoma will not only be valuable from the point of view of understanding this particular tumor but it is likely that accurate and detailed knowledge of the parathyroid adenoma may shed light upon problems connected with other endocrinologically active tumors and possibly even upon the abstruse problems of neoplasia in general.

#### SUMMARY

1 Surgical management of the parathyroid adenoma holds a place among the triumphs of modern surgery.

2 Operative removal of the parathyroid adenoma is the only effective treatment of this lesion and the associated primary hyperparathyroidism.

3 Historically the clinical surgery of parathyroid disease is recent and has been crowded into the brief period of the last 20 years.

4 Although the parathyroid adenoma is not a common tumor its general incidence is probably greater than is suspected.

5 During the 43 years from 1903 to 1945 reports of 322 cases of parathyroid adenoma have appeared in the literature.

6 No exact figures are available to indicate the incidence of parathyroid adenomas, either in groups of individuals or in series of surgical cases.

7 In approximately 80 per cent of the cases reported prior to 1936 the adenomas were removed

at operation and in 30 per cent they were discovered at autopsy. Better knowledge of primary hyperparathyroidism has altered these figures. In the decade from 1936 to 1945 nearly 90 per cent were removed surgically and only about 10 per cent were found at autopsy.

8. There is no evidence to support the concept that the incidence of the parathyroid adenoma is influenced by geography.

9. The exact time of origin of a parathyroid adenoma is difficult to establish. However analysis of the available data indicates that this tumor may originate at any time from midchildhood to old age.

10. Parathyroid adenomas have been found in each decade from the second to the eighth inclusive. For our total group the maximum incidence is in the fifth decade and 70 per cent of the adenomas were discovered in patients between 30 and 60 years of age.

11. The sex incidence of the parathyroid adenoma shows a preponderance in females over males in the ratio of approximately 3 to 1.

12. On the basis of sex there is a difference in the age distribution of parathyroid adenomas; the maximum incidence occurs a decade earlier in males than in females, and there is a qualitative difference in the age-sex distribution curves (Fig. 4).

13. Multiple adenomas were described in 20 instances, or in 6.3 per cent of the reported cases.

14. The question of multiple adenomas is discussed and the possibility of confusing supposed examples with cases of secondary hyperplasia of the glandules is pointed out. It is concluded that, up to the present time, the evidence for the existence of true multiple adenomas is meager.

15. In the great majority of cases the parathyroid adenoma is a single lesion that develops in, and therefore involves only 1 of the parathyroid glandules.

16. As the neck is entered to treat hyperparathyroidism, the first problem of the surgeon is to determine the site of the adenoma.

17. Adenomas of the parathyroid glands are about equally frequent on the right and left sides of the neck, but when the incidence of involvement of the inferior and superior glands is considered a great difference is apparent.

18. Fifty-one and six tenths per cent of the adenomas occurred on the right side and 47.4 per cent on the left side of the neck.

19. Forty-two and seven tenths per cent of the adenomas were located in the region of the right lower parathyroid. 41.1 per cent, in the region of the left lower; 9.1 per cent, in the region of the

right upper and 7.1 per cent were located in the region of the left upper parathyroid.

20. In 10.7 per cent of the cases the adenoma was found in an aberrant position, in 63.3 per cent of this group it was in the mediastinum, in 30 per cent, within the substance of the thyroid gland, and in 6.7 per cent, it was behind the esophagus.

21. On the basis of this data on the location of the adenoma, a formula for the scientific, surgical approach to an adenoma is suggested (page 13, Table V).

22. The size of the adenoma is the second problem of the operating surgeon.

23. The weights of individual adenomas have varied through an extreme range; the smallest weighed 0.4 gm. while the largest attained a weight of 130 gm. The average weight was 12.7 gm. and the mean weight 7.0 gm.

24. For the most part the surgeon will be searching for a tumor with a weight approaching 7.0 grams, a volume approximating 4 or 5 cc., and with diameters which may vary from a mean of about 3.2 by 2.1 by 1.7 cm.

25. The smallest adenoma was more than 10 times the size of a normal parathyroid gland, while the largest adenoma was 3,500 times as large as a normal glandule.

26. By means of the blood calcium levels, it has been possible to demonstrate a roughly quantitative relationship between the size of the tumor and the degree of hyperfunction. However as the size of the adenoma increases the proportional effect of unit weight on the blood calcium becomes rapidly less and less.

27. Bio-assays of parathyroid adenomas indicate that these tumors contain a hormone that is similar to, if not identical with, that produced by the normal gland.

28. Most parathyroid adenomas are yellowish brown or reddish brown in color, moderately soft, encapsulated, and with smooth surfaces. Although some are bilobed, most of them are ellipsoidal in form.

29. Histologically the parathyroid adenoma is recognized because of its fairly typical structural pattern, but more particularly because of the presence of characteristic parathyroid cells.

30. All of the 6 types of parenchymal cytological elements found in normal glandules (Norman, 1947) may be found in adenomas of the parathyroid; these may be present in varying proportions in particular tumors.

31. An adenoma made up entirely of oxyphil cells (oxyphil adenoma) is a rare and probably special form of tumor.

32 The literature records a case in which there is reason to believe the adenoma had existed for 39 years.

33 Few patients have recognized symptoms ascribable to the adenoma for a period less than 1 year.

34 It is probable that the average duration of symptoms has been from 5 to 7 years prior to the recognition of the adenoma.

35 There is evidence to support the concepts that adenomas may exhibit a periodicity in their growth and that there are differing inherent growth tendencies in particular adenomas.

36 It appears that the incidence of parathyroid adenomas rises as the keenness of diagnostic acumen increases. During the years of the past decade more and more cases have been given the benefit of earlier surgery and fewer cases have been left to be discovered at autopsy.

37 It is recommended that confusion be avoided by confining the use of the term carcinoma to those very rare tumors of the parathyroid that exhibit indubitable evidence of their malignant nature.

38 The parathyroid adenoma is a benign endocrinologically active neoplasm which in practically all, if not in all, instances affects the bodily economy through the excess of parathyroid hormone generated by the tumor.

39 The terminal results from the action of the parathyroid hormone are well known however the exact manner in which the hormone affects these results remains a matter of conjecture.

40 The clinical disease provoked by a parathyroid adenoma is known as primary hyperparathyroidism.

41 Primary hyperparathyroidism is characterized by its insidious onset and by its cryptic chronic progression. There are no specific symptoms.

42 Few cases of primary hyperparathyroidism are recognized prior to the appearance of complications that involve either the skeletal the urinary or both of these anatomic systems.

43 The skeletal involvement in primary hyperparathyroidism (called osteitis fibrosa generalisata) is common and takes one of two forms osteitis fibrosa cystica and diffuse osteoporosis.

44 The roentgen findings of osteitis fibrosa generalisata are characteristic.

45 Osteitis fibrosa generalisata may lead to the development of deformities and spontaneous fractures, and commonly produces pain, of which the patient complains in the bones and joints.

46 Following removal of the adenoma there has been a spectacular and complete recalcifica-

tion of the bones in some cases, while in others there has been little postoperative reformation of the skeletal parts.

47 The renal complications of primary hyperparathyroidism are due to hypercalcaemia, and to the precipitation of calcium salts in the renal parenchyma or in the renal tubules and excretory passages.

48 Clinically the cases of primary hyperparathyroidism showing renal complications are likely to be less severe than those in which the osseous changes are more prominent.

49 Apparently more and more parathyroid adenomas have been discovered during recent years in urological clinics.

50 The clinical course of primary hyperparathyroidism is likely to be interrupted by such incidents as the appearance of skeletal deformities, spontaneous fractures renal colics, and the passage of renal calculi.

51 Untreated cases of primary hyperparathyroidism progress to invalidism and death from renal insufficiency malnutrition or other intercurrent malady.

52 Apparently no advantage is gained from the classification of cases of primary hyperparathyroidism into clinical groups.

53 It is recommended that four clinical stages of primary hyperparathyroidism be recognized (1) period of inception (2) period of early complications (3) period of advanced complications (4) period of irreparable and lethal damage.

54 The only effective treatment for primary hyperparathyroidism is the surgical removal of the etiologically associated adenoma.

55 The problems of parathyroid surgery are not alone those of the regional anatomy of the neck but are specifically peculiar to the embryology anatomy and physiology of the parathyroid glands.

56 At least for the next decade all cases of parathyroid adenoma should be reported. To be most useful the published reports will contain accurate and detailed clinical histories and findings, repeated laboratory studies, weights and measurements of the tumor careful histological and cytologic descriptions, and bio-assays of the adenomas.

## REFERENCES

- 1 ABEL, A. L. THOMSON G. and HAWKLEY L. M. *Lancet*, Lond. 1933, 2 525-529.
- 2 ALBRIGHT F. *J. Am. M. Ass.*, 1941 117 527-533.
- 3 ALBRIGHT F., AUS J. C., and BAUER, W. *J. Am. M. Ass.*, 1934, 102 1276-1287.
- 4 ALBRIGHT, F., and ELLSWORTH, R. *J. Clin. Invest.* 1929, 7 183-201.



- 5 ALBRIGHT, F., SULKOWITZ, H. W. and BLOOMBERG, E. *Am. J. M. Sc.*, 1937, 93 800-813
- 6 Idem. *Arch. Int. M.*, 1938, 62 90-215.
- 7 ALEXANDER, H. B. and PEMBERTON, J. D. *et al. Am. J. Surg.* 1944, 65 137-188.
- 8 ALLAM, F. N. *Proc. Mayo Clin.*, 1931, 6 684-689.
- 9 ALLOTT, E. N. and JENKINS, J. *Lancet, Lond.*, 1938, 1 600-6
- 10 AMICO, D. *Riv. chir. Nap.* 1937, 6 -71.
- ANDERSON, W. A. D. *Arch. Path., Chic.*, 1939, 27 753-778.
- 12 Idem. *Endocrinology* 1939, 24 372-378.
- 13 ANDER, H. M., SCHWARTZ, E. W. and VAN SOLKEMA, A. J. *Michigan M. Soc.*, 1943, 42 195-97
- 14 ANDRACH, W. E., and CLIFTON, W. M. *Am. J. Dis. Child.*, 1939, 58 340-357
5. ARMSTRONG, H. G. *Bull. Acad. M. Toronto*, 1938, 5 10.
- 16 ARNOLD, W. *Virchows Arch.* 1940, 206 4 7-66.
- 17 ASKANASY, M. *Trub. Path.-anat. Inst. Arb.* 1902, 4 393-42
8. ASK UPKAMP, E. *Acta med. scand.*, 1939, 74 284-313.
- 19 Idem. *Acta chir. scand.*, 93 68 55-573.
- 20 BARKER, L. F. J. *Bone Surg.*, 1934, 16 435-440.
- 21 BARKER, V. L. and BRIDGES, O. *Arch. Surg.* 1939, 39 205-23.
- BARR, D. P., BULGER, H. A., and DIXON, H. H. J. *Am. M. Ass.*, 1939, 9 951-952.
- 23 BAUER, J. and JUNG, A. *Rev. chir. Par.* 1937, 75 284-295.
- 24 BACHMANN, C. J. *West. J. Surg.* 1940, 48 324-326.
- 5 BELLIN, D. E., and GERSCHWITZ, B. S. *Am. J. M. Sc.* 1935, 90 519-53
- 26 BENJAMIN, C. E. *Beltr. path. Anat.* 1903, 3 143-182.
- 7 BEROSTRAND, H. *Acta chir. scand.*, 1941, 83 25-40.
- 28 BERNDT, D. *Virchows Arch.*, 93 282 680-702
- 29 BETHURINK, C. W. *Ned. tchr. geneesk.*, 1932, 76 3380-3391.
- 30 BECKEL, G. *Helvet. med. acta*, 1943, 2 76-277
- 31 BODANIKY, M. and DUFF, V. B. J. *Am. M. Ass.*, 1939, 12 3-230.
- 32 BOLLE, K. *Ueber einen epithelkoerperchen-tumor bei ostitis fibrosa generalisata (Recklinghausen)* Thesis, Koelnburg, 1937
- 33 BOTD, J. D. MICHAM, J. E., and STRAUSS, G. J. *Am. M. Ass.*, 1939, 93 684-688.
- 34 BRIDGLER, H. R., and HERRMAN, W. G. *Am. J. Roentg.* 1939, 4 601-602.
- 35 BROOKER, R. *Proc. R. Soc. M. Lond.* 1935, 28 366-368.
- 36 BROWN, A. E. *Proc. Mayo Clin.*, 1935, 0 4 7-424.
- 37 BRUNNER, W. *Arch. klin. Chir.* 1937, 88 330-352.
- 38 Ibid., 1940, 90 420-438.
- 39 CAHILL, J. A. *Med. Ann. District of Columbia*, 1934, 3 275-278.
- 40 CAMPBELL, I. L., and TURNER, C. W. *Res. Bull. No. 352* 34 p. *Univ. Missouri Coll. Agr. Columbia, Missouri*, 1942
- 4 CARNOT, P. and LAPITTE, A. *Bull. Soc. med. Hôp. Paris*, 1938, 3rd ser. 44 426-436
- 42 CARTER, L. P., BAKER, B. M., and HOWARD, J. E. T. *Am. Im. Physicians*, 1936, 51 5-20.
- 43 CASTLEMAN, B. and MALLORY, T. B. *Am. J. Path.*, 1935, 7
- 44 CH. UYL, V. J. *De l'osteite fibro-gliodique type Recklinghausen. Thèse pour Le Doctorat en Médecine. Paris Masson (Cie)* 95
- 45 CHAPMAN, H. S. *West. J. Surg.* 1941, 49 386-397
- 46 CHIRKOV, O., and OLSEN, H. C. *Acta chir. scand.* 1932, 71 172-204.
- 47 CROW, B. *Canad. M. Ass. J.* 1937, 37 5-12
- 48 CHURCHILL, E. D. *Ann. Surg.* 1934, 60 606-6
- 49 Idem. *Surgical Treatment of Parathyroid Tumors Associated with Hyperparathyroidism. In Pack, C. T. & Livingston, E. M., ed. "Treatment of Cancer"* 67-686. New York Hoeber, 1940.
- 50 CHURCHILL, E. D. and COPE, O. *Ann. Surg.*, 1935, 104 9-35
- 51 Idem. *Surg. Gyn. Obst.*, 1934, 58 255-271.
- 52 COBURN, D. E. *Am. J. Surg.* 1944, 68 252-258.
- 53 COCHRANE, R. C. *N. England J. M.*, 1944, 224 977-978.
- 54 COHEN, H., and KELLY, R. E. *Brit. J. Surg.*, 1933, 10 472-478.
- 55 COHEN, W. E., COHEN, E. T. and AUB, J. C. *Annal. Rev. Biochem.*, 1942, 4 5-440.
- 56 COLLIP, J. B. *Medicine, Balt.*, 1936, 5 1-57
- 57 COMPTON, E. L. *Surg. Gyn. Obst.*, 1939, 50 783-794
- 58 COOLY, T. B. *Am. J. Dis. Children*, 1931, 41 641-693
- 59 COPE, O. *Ann. Surg.*, 1941, 114 706-733
- 60 Idem. *Surgery* 1944, 16 73-83.
- 61 COPPELLO, O., and BARLARD, P. M. *Bol. Soc. de Buenos Aires*, 1932, 6 607-62.
- 62 COXIN, G. *Presse méd.*, 1934, 42-63.
- 63 COXIN, C. F. *Guy's Hosp. Rep., Lond.*, 1931, 81 207-38.
- 64 COOCH, J. H., and ROBERTSON, H. F. *Surg. Gyn. Obst.*, 1941, 73 165-174.
- 65 COOKEY, L., and CALLENDER, J. *Bull. Soc. nat. Chir. Par.* 1934, 60 777-783.
- 66 CURTIS, C. S., and LOOMIS, E. G. *N. England J. M.*, 1941, 25 370-371
- 67 CUTCHENSON, D. P. and MACKAY, W. A. *Glasgow M. J.* 1935, 5 240-292.
- 68 DAVIDSON, O. W. J. *Urol. Balt.*, 1937, 37 35-4
- 69 DAWSON, J. W. and STRUTHERS, J. W. *Edinburgh M. J.* 1921, 20 42-559.
- 70 DECK, W. *Zbl. Chir.* 1941, 68 794-796.
- 71 DEHMEGER, H. S. *Arch. Path.*, 1931, 1 930-94
- 72 DE QUERVAIN, F. *Dent. Zchr. Chir.* 1902, 60 314-352.
- 73 DE SANTIL. *Internat. Zbl. Laryng. Rhinol.*, 1900, 16 546-547
- 74 DEWEES, R. S., and ZINN, L. *Cleveland Clin. Q.* 1945, 12 6-18.
- 75 DOWNS, R. S., and SCOTT, V. *Arch. Int. M.*, 1941, 67 658-664.
- 76 DRENNAN, A. M. J. *Path. Bact., Lond.*, 1939, 33 65-70.
- 77 DRESSER, R., and HAMPTON, A. O. *Am. J. Roentg.* 193, 25 739-748.
- 78 DYKE, S. C., WALKER, R. M. and FREEMAN, L. *Lancet, Lond.*, 1933, 530-532
- 79 ECKHART, Cited by F. Mandl. *Zbl. Chir.* 1929, 55 739-745.
- 80 EDMIST, R. C., FRASER, F. R., DOWHILL, T. P. and R. M., HARRIS, C. F. and DAVIDSON, J. A. *Brit. J. Surg.*, 1933, 20 479-507
- 81 ELSON, K. A., WOOD, F. C., and RAYNER, I. S. *Am. J. M. Sc.*, 1936, 9 49-55.
- 82 EMMING, J. *Beltr. path. Anat.*, 1903, 33 153-196.
- 83 FARRAR, G. S. *Canad. M. Ass. J.* 1937, 37 1-16.
- 84 Idem. *Tr. West. Surg. Ass.*, 1937, 47 484-496.
- 85 Idem. *T. Am. Ass. Study Goffer* 1940, 52-262.
- 86 FAWCETT, A. W. *Brit. M. J.* 1938, 233.
- 87 FISCHER, B. Cited by Guenther B. *Frankf. Zchr. Path.* 1912, 3 294-38.

83. FLICK, J. B. and GIBSON, J. H. JR. *Bull. Ayer Clin Lab.*, 1917, 3, 73-78.
84. FLICK, J. B. *Med. Clin. N. America*, 1945, 29, 389-404.
85. FOLDS, G. S. *J. Urol.*, Balt., 1944, 52, 180-183.
86. FOX, N. and TAOLOIA, V. *Arch. Otolaryng.*, Chic. 1913, 37, 377-390.
87. FRANKS, S., and HJERREILD, N. *Hospitalstudende*, 1937, 80, 1117-1130.
88. FRIMMERSEN, C. *Lancet*, Lond. 1939, 1, 85-86 also *Ugeskr. laeger* 1939, 101, 200-211.
89. FROCONI, C., and ALEMBARDI, R. *Policlinico* 1932, (sec. chir.) 39, 1765-1776.
90. GAMBRIERI, C. *Endocr. pat. cost.*, Bologna, 1935, 10, 547-557.
91. GAUDIER, H., and PATORE, G. *Bull. Soc. chir. Paris*, 1938, 58, 1154-1157.
92. GILLETTE, N. W. *Gillette Clin. Q.* 1943-1943, 1, 16-19.
93. GIORDANO, A. *Endocr. pat. cost.*, Bologna, 1939, 14, 125-152.
94. GLEY, E. C. *rend. Soc. biol.*, 1891, 43, 250.
95. GOLD, E. *Milit. Grenzgeb. Med. Chir.* 1928, 41, 63-82.
96. GOLDMAN, D. and SAFADIN, A. *Ohio M. J.* 1944, 40, 437-439.
97. GOLDMAN, L., and SMYTH, F. S. *Ann. Surg.* 1936, 104, 971-981.
98. GONZAKOV, G. A. *Vest. Khir.*, 1937, 54, 109-110.
99. GORDON-TAYLOR, G., and HANDLEY, R. S. *Brit. J. Surg.*, 1937, 25, 6-16.
100. GORDON-TAYLOR, G., and WILKES, P. *Brit. J. Surg.* 1937, 19, 606-618.
101. GRASSO, R. *Policlinico*, (sec. chir.) 1937, 44, 304-312.
102. GREENBERG, D. M. *Annual Rev. Biochem.* 1939, 8, 269-300.
103. GROLLMAN, A., and MORCHEAD, R. P. *North Carolina M. J.*, 1943, 4, 524-536.
104. GUST, G. M., and RAPAPORT, S. *Physiol. Rev.* 1941, 21, 410-437.
105. GUTMAN, A. B. and PARSON, W. B. *Ann. Int. M.* 1938, 12, 15-31.
106. GUTMAN, A. B. SWENSON, P. C. and PARSONS, W. B. *J. Am. M. Ass.* 1934, 103, 87-94.
107. HART, J. R. *Surg. Clin. N. America*, 1933, 13, 1365-1378.
108. HARTMAN, C. J. *N. York State J. M.*, 1938, 38, 1449-1453.
109. HANES, F. M. *Internat. Clin.*, 1936, 4, 80-85.
110. Idem. *Am. J. M. Sc.* 1939, 197, 85-90.
111. Idem. *North Carolina M. J.*, 1945, 6, 507-515.
112. HANKE, H. *Arch. Klin. Chir.*, 1932, 172, 306-402.
113. HARNITZ, F. *J. Med. Res.*, 1915, 27, 361-375.
114. HART, D. and GARDNER, C. E. *Jr. South. Surgeon*, 1940, 9, 41-58.
115. HARTWICH, A. *Virchows Arch.* 1922, 236, 61-116.
116. HAYES, J. M. *Minnesota M. J.*, 1938, 21, 74-76.
117. HICKER, Zbl. Chir. 1930, 57, 2804.
118. HELLESTROM, J. *Acta chir. scand.* 1932, 69, 237-304.
119. HERMETO JÚNIOR, S. *Rev. cir. S. Paulo*, 1943-1943, 8, 217-246.
120. HIRSCH, H. *Am. J. Roentg.* 1937, 38, 457-464.
121. HONDER, R. S., HARRIS, R. G. S. and HERRLICH, J. D. *Med. J. Australia*, 1943, 1, 221.
122. HUGHES, J. F. *Med. J. Australia*, 1939, 3, 830-835.
123. HULST, J. P. L. *Zbl. allg. Path.* 1905, 16, 103-105.
124. HUNTER, D. *Proc. R. Soc. M. Lond.* 1929, 23, 227-234.
125. Idem. *Med. Press*, 1940, 204, 432-435.
126. HUNTER, D. and TURNBULL, H. M. *Brit. J. Surg.*, 1931, 19, 203-284.
127. HUSELAIN, J. *Beitr. klin. Chir.* 1930, 169, 276-298.
128. JAFFE, H. *Arch. Path.*, 1933, 16, 63, 236.
129. JAFFE, W. J. *J. Irish J. M. Sc.* 1936, 6th ser. pp. 50-91.
130. JOBE, M. C. *Rocky Mountain M. J.* 1941, 38, 121-126.
131. JOHNSON, J. W. *Jr. Am. J. Path.*, 1939, 15, 111-126.
132. KEYNES, G., and TAYLOR, H. *Brit. J. Surg.*, 1933, 21, 20-28.
133. KHORRAMA, P. A. *Khn. med. Moskva*, 1933, 11, 1238-1243.
134. KLEIMBERG, S. *Am. J. Surg.*, 1940, 50, 358-362.
135. KLEINSHOF, N. C. and KOKOFF, G. F. *J. Clin. Endocr.* 1943, 3, 351-352.
136. KOCHER, T. *Virchows Arch.*, 1899, 115, 532-556.
137. LAKE, R. and GREENE, J. A. *J. Clin. Endocr.* 1943, 3, 408-412.
138. LAHEY, F. H. and HAGGART, G. E. *Surg. Gyn. Obst.* 1935, 60, 1033-1051.
139. LANGRISH, T. *Virchows Arch.*, 1907, 189, 60-152.
140. LEM, A., LAVAY, F. LIEVRE, J. A., and WELLS, J. *Bull. Soc. méd. hôp. Paris*, 1939, 54, 1881-1891.
141. LEWIS, D. and TRIMBLE, I. R. *Deut. Zsch. Chir.* 1934, 242, 315-320.
142. LIEVRE, J. A. and MULLER, P. *Bull. Soc. méd. hôp. Paris*, 1931, 47, 5-1522.
143. LOOAN, M. A. *Physiol. Rev.* 1940, 20, 522-560.
144. MACCALLUM, W. G. *Bull. Johns Hopkins Hosp.*, 1905, 16, 87-89.
145. McCLEURE, R. D. *Arch. Surg.*, 1936, 33, 808-824.
146. McCLEURE, R. D. and LAM, C. R. *Ann. Surg.* 1945, 121, 454-469.
147. McDONALD, C. C. *Texas J. M.*, 1946, 41, 468-471.
148. MACKENZIE, K. *Austral. N. Zealand J. Surg.*, 1938, 7, 256-257.
149. MACLEAN, F. C. *J. Am. M. Ass.*, 1941, 117, 609-619.
150. Idem. *Annual Rev. Physiol.*, 1943, 5, 70-104.
151. Idem. In EVANS, E. A., Jr. ed. *The Biological Action of Vitamin D*. Chicago Univ. of Chicago Press, 1942, pp. 185-201.
152. McLEAN, A. *Tr. Am. Ther. Soc.*, 1934, 34, 176-192.
153. McQUILLAN, A. S. *Ann. Surg.* 1938, 108, 464-468.
154. MALLORY, T. B. *N. England J. M.* 1941, 225, 106-107.
155. Idem. 1946, 234, 125-127.
156. MANDL, F. *Wchn. Klin. Wsch.*, 1925, 38, 1343-1344.
157. Idem. *Deut. Zsch. Chir.* 1933, 240, 362-375.
158. MARCHEL, R. *Frankf. Zsch. Path.* 1916, 19, 159-171.
159. MATHERS, R. P., and CAPELL, D. F. *J. Lar. Otol. Lond.*, 1938, 53, 656-667.
160. MAY, E. and LIEVRE, J. A. *Bull. Soc. méd. hôp. Paris*, 1931, 47, 1808-1819.
161. MAYN, S., Jr. *Bull. Johns Hopkins Hosp.*, 1941, 68, 319-328.
162. MELER, M. *Frankf. Zsch. Path.*, 1937, 51, 104, 130.
163. MELLORE, J. *Acta path. microb. scand.*, 1943, 20, 693-734.
164. Idem. *Uppsala ldk. fören. förh.* 1936, 42, 35-46.
165. MERTZ, A. A. *Illinois M. J.*, 1932, 62, 468-472.
166. MEYER, O. *Frankf. Zsch. Path.* 1917, 20, 115-159.
167. MILLER, E. S. and EVANS, L. R. *N. England J. M.* 1942, 227, 949-952.
168. MINCKRETT, T. W., and BUTLER, R. W. *Brit. J. Surg.* 1934, 21, 500-506.
169. MORRIS, R. C., and UCH, H. W. *Am. J. Surg.* 1946, 71, 381-386.

175. Idem. Harper Hosp. Bull., Detr. 1944, 2: 41-49.
176. MONTGOMERY, Arch. klin. Chir. 1913, 101: 333-368.
177. MÖLLER, W. Acta chir. scand., 936, 78: 183-204.
178. MOULTON, S. E., CLARK, F. M. and HAYWOOD, H. J. Am. M. Ass., 1937, 108: 111-112.
179. MOORE, T. D. Memphis M. J. 1936, 11: 37-38.
180. MORELLE, J. J. chir. ann. Soc. belge chir. 1934, 31: 29, 35-397.
181. Ibid. 1934, 33: 3: 178-188.
182. MORROW, J. J. Internat. Clin., 1933, 3: 18-26.
183. MOULOUQUET, P. and LEBLANC, J. A. Bull. Soc. med. hôp. Paris, 938, 54: 764-766.
84. Idem. J. chir. Par. 1939, 53: 16-75.
85. MOZER, J. J. and PARRY, K. Rev. méd. Suisse rom., 1940, 60: 2: 5-23.
186. NADOKLEBRACH and WESTHUSEN. Deut. med. Wochr. 1922, 48: 1599.
187. NEVES, C., and PEREIRA CALDAS, J. Lisboa med., 1936, 13: 423-446.
188. NICKELS, J. Arch. klin. Chir., 1944, 205: 488-495.
89. NOAD, K. B., and MILLER, I. D. Austral. N. Zealand J. Surg., 1940, 10: 198-204.
90. NOBLE, J. F. and BORO, J. F. Arch. Int. M., 936, 58: 846-850.
91. NOBLE, T. F. J. Bone Surg., 932, 4: 8: 185.
92. NOSENKIN, A. H., and EICHENKAT, K. N. York State J. Med., 1938, 38: 856-858.
93. NOHRIS, E. H. Anat. Record, 1947. In press.
94. Idem. Arch. Path., 946, 4: 26-273.
95. Idem. Washington Pub. No. 479. Contr. Embryol. Carnegie Inst., 1937, 26: 247-294.
96. Ibid. Pub. No. 496. 1938, 27: 91-207.
97. O'CONNOR, V. J. and KEARNEY, J. J. Arch. Path., Chic., 1940, 30: 837.
98. OLIVER, W. A. Lancet, Lond. 939, 2: 240-244.
199. OPPENHEIMER, B. A. J. Mount Sinai Hosp. N. York, 940-941, 7: 7-29.
200. ORR, I. M. Brit. J. Surg., 1948-1949, 30: 375-377.
201. PALTAUF, R. Zbl. allg. Path., 9: 3, 24: 959-961.
202. PEREIRA, H., and CASTO PEREIRA, L. C. rend. Soc. Med. 1936, 95: 590-592.
203. PATERSON, D. C. Proc. Connecticut M. Soc., 1934, 142: 3: 4-215.
204. PAYNE, R. Proc. R. Soc. M., Lond., 1936, 29: 1128-1130.
205. PEMBERTON, J. DE J. and GEDDER, K. B. Ann. Surg. 939, 9: 202-2.
206. PENECKE, R. Zbl. allg. Path., 1936, 37: 335.
207. PETERSEN, J. P. Ned. tidskr. Geneesk., 937, 8: 2215-2231.
208. POPE, A., and AUB, J. C. N. England J. M. 1944, 30: 698-707.
209. QUICK, A. J. and HUNTERLOKER, A., JR. J. Am. M. Ass., 93: 96: 745-751.
10. QUICK, A. J., HUNTERLOKER, A., ELLISON, E. L., and HUDSON, H. J. Am. M. Ass., 935, 104: 2245-2249.
11. RAHM, H. Zbl. Chir., 938, 65: 2027-2028.
12. RANKIN, F. W. and PRICESTLEY, J. T. Am. J. Surg., 933, 20: 298-314.
213. RAYNA, A., and LYON, S. Presse méd., 1934, 1: 12-1024.
14. REDWITZ, E. VON. Zbl. f. Chir. 193, 58: 240.
5. RENAUD, M., PETIT MARIE, G. and FAYOT, M. Bull. Soc. méd. hôp. Paris, 1938, 48: 1107-1110.
16. RICK, C. O. Minnesota M., 943, 20: 1092.
17. RIVEN, E. S., and MASON, M. F. Ann. I. t. M., 936, 9: 578-587.
8. RO. DROX, W. L. Bull. Acad. M., Toronto, 940-941, 14: 10-.
19. ROOFER, H. M. J. Am. M. Ass., 946, 30: 2-28.
220. ROSENDALE, R. S. Am. J. Path. 937, 8: 743-771.
221. ROSENTHAL and DROUZE. Verh. Ges. Verdauungs., 1939, 9: 213-224.
222. ROSE, K. Austral. N. Zealand J. Surg. 1935, 4: 407-413.
223. ROTHE, C. A. Brit. J. Surg., 1942, 30: 69-75.
224. RULAKOV, A., and SAKAYAN, R. G. Sov. kln. 1937, 18: 212-228.
225. RUTSHAUER, E. Schweiz. med. Wochr., 1941, 71: 189.
226. Idem. Virchows Arch. 1935, 294: 370-386.
227. SAINTON, P. and MILLOT, J. L. Ann. anat. path. Par. 933, 1: 8: 5-818.
228. SANDSTROM, L. Upsala Läk. Foren. Förel. 126, 3: 44-470.
229. SAUER, H. Deutsche Zsch. Chir., 1932, 170: 95-129.
30. SCHLAGENHAUTER. Mensch. med. Wochr. 1918, 67: 56.
231. SCHLEISSNER, H., and GOLD, E. Klin. Wochr., 1933, 12: 784-787.
32. SCHMIDT, C. L. A., and GRADENBERG, D. M. Physiol. Rev. 935, 15: 207-234.
233. SCHMIDT, A. Mensch. med. Wochr., 1907, 34: 494-497.
234. SCHOUTEN, D. E. Ned. tidskr. Geneesk., 1937, 75: 252-255.
35. SCHRAMPT, A. Acta med. scand., 1943, 5: 199-213.
236. SCHRAMPT, A., and HARKITT, H. F. Acta chir. scand. 937, 80: 199-208.
237. SCHUFF, H. Deut. Zsch. Chir. 193, 233: 95-128.
238. SCHWENK, C., and EISEN, T. Ugrsk. leger, 1933, 95: 1259-1264.
239. SHARPE, H. S. Canad. M. Ass. J., 939, 40: 167-169.
240. SHOFER, N. S., HARRIS, E. H., and REBER, E. M. J. Tennessee M. Ass., 943, 56: 97-10.
241. SILVERBERG, M., and SILVERBERG, R. Arch. Path. Chic., 943, 56: 5: 2-534.
242. SIRE, I. E. N. York State J. M., 1940, 40: 1788-1796.
243. SIRE, J. N. Wisconsin M. J., 936, 35: 41.
244. SMITH, F. B. and COOKE, R. T. Lancet, Lond. 1940, 3: 650-65.
245. SMARPER, I. Arch. Int. M., 939, 46: 506-513.
246. Idem. Acta med. scand., 940, 3: 331-340.
247. SMARPER, I., and BOEVE, H. J. Dent. Arch. klin. Med., 193, 170: 37-386.
248. SKELL, A. M. Proc. Mayo Clin., 936, 1: 613-616.
249. SOFFER, L. J. and COHEN, C. Arch. Int. M., 1943, 71: 630-649.
30. SORENGER, A. Acta chir. scand. 1934, 74: 485-492.
251. SPURNT, T. P. Ann. Int. M., 938, 1: 121-127.
32. STERNBERG, T. Pathologisch-anatomische Studien über die Osteodystrophia fibrosa (synonymus: Ostia fibrosa von Recklinghausen) Upsala. Abhandl. und Wiksell, 924.
33. STRANDGAARD, H. Hospitalvidende, 934, 77: 387-393.
254. STRAUSS, B. Frankf. Zsch. Path., 1922, 26: 3: 8-124.
255. STRUTHERS, J. W. T. Med. Chir. Soc. Edinburgh, 1937-38, 12: 308, 37-44.
256. THOMAS, G., and SMITH, L. West. J. Surg. 1935, 41: 78-82.
257. THOMSON, D. L., and COLLIER, J. B. Physiol. Rev. 1934, 3: 309-385.
38. THORP, B., JENKINS, W. F. and HAWKES, R. J. M. Am. Georgia, 941, 30: 223-227.
259. TELESTON, W. Proc. Connecticut M. Soc., 934, 142: 97-220.
260. VALLE, J. OTTOLENGHI, C. E., and GONZALEZ, J. C. L. Rev. ortop. traumat., B. Air., 935, 5: 91-113.
261. VANCE, J. ROOGE, J. and BRICK, L. W. South M. J. 940, 33: 38-35.

262. VENABLE, J F Guy's Hosp. Rep., Lond 1933, 83 124-199.
263. VERHEYEN T von Virchows Arch., 1907 187 80 105.
264. VOLT, F Zbl. Chir., 1941, 68 890-893
265. VOLZ, C P., and SMULL, K. Ann. Int. M., 1944, 21 329-332.
266. VUORI, A. Duodecim, 1946, 62 66-75
267. WANKER, R. Deutsche Zschr Chir., 1930, 228 210-213.
268. WARREN S., and MORGAN J R. E Arch. Path 1935, 20 823-836
269. WAREBURN, W W California M 1938 48 240-244
270. WEBB, R. C. Minnesota M., 1935 18 664-669
271. WEICHSELBAUM, A. Verh. deut. path. Ges., 1906, 10 83-85.
272. WEIL, M. P., LANGLOIS, L. and DRAGOMIRESCO, M Bull. Soc. méd. hôp. Paris, 1931 47 1929-1937
273. Welch D A. J Anat. Physiol. 1898, 32 292-307
274. WESTWORTH, E. T., and LONGMAN L. R. Radiology 1936, 27 365-367
275. WERNER, A. A. South. M. J 1942 35 671-676.
276. WHITE, D N Zealand M J, 1939, 38 394-397
277. WICHMANN F W Deutsche Zschr Chir., 1932, 235 619-634
278. WILDER, R. M. Endocrinology 1929, 13 231-244.
279. WILDER, R. M., CAMP J D ROBERTSON H. E., and ADAMS, M Proc. Staff meeting, Mayo Clin 1932 7 597-606.
280. WILDER, R. M. and HOWELL, L. P J Am. M Ass., 1936 106 427-431
281. WINDHOLZ, F Radiology, 1945 44 14-22
282. WOODSIDE, M A., and FOULDS, G S. Ontario M Rev., 1944, 11 93-96.
283. ZAJEWLOSCHIN M. N Frankf Zschr Path. 1930 40 132-138.

# ABSTRACTS OF CURRENT LITERATURE

## SURGERY OF THE HEAD AND NECK

### HEAD

**Bazzoli, L.:** The Pathology and Clinical Symptoms of the Tumors of the Salivary Glands (Patologia clinica dei tumori delle ghiandole salivari) *Arch ital. chir.* 1945 67 3

In this monograph the author reviews the gross and microscopic pathology of tumors of the salivary glands various theories of their origin their classification clinical symptoms and therapy.

His own material consists of 43 cases, 34 benign and 9 malignant. After extirpation of a benign tumor the resulting fistula promptly healed following roentgen treatment. The remaining cases of benign tumors terminated in uneventful recovery.

The author believes that preoperative roentgen irradiation, improved surgical technique and the postoperative application of large doses of x rays greatly improved the prognosis of malignant tumors of the salivary glands. Surgical treatment occupies the main place in our armamentarium for the treatment of malignant tumors of the salivary glands.

**JOSEPH K. NARAT, M.D.**

**Pricolo, V.:** Bilateral Mixed Tumors of the Submaxillary Gland (Tumore misto bilaterale della ghiandola sottomassillare) *T. med. Milano*, 1946 3 32.

A man of 74 who had no family and no previous history of any importance reported that 2 months before coming to the clinic a swelling had appeared in the left maxillary region and a few days later the right submaxillary region began to swell also. The tumors increased in size until on admission the one on the left was the size of a large pear and the one on the right was considerably smaller—about the size of a pigeon's egg. The patient was in moderately good general condition.

Operation was performed in October 1944. Both tumors were encapsulated but the left one was so intimately adherent to the anterior belly of the digastric muscle that a part of the muscle had to be removed. The patient was discharged November 23, 1944, after he had been given roentgen treatment.

The tumors did not show any remnants of the salivary glands. The neighboring lymph glands were not enlarged. The histological findings in the 2 tumors were the same. The tumor cells were massed together in the lower part and in the upper part they were connected forming cords which passed into an intercellular mucous tissue and gave the typical picture of mixed salivary gland tumor.

The different theories that have been advanced to explain the origin of these tumors are discussed. The author himself believes that the theory of inclusion

of epitheliomesenchymal rests in the glands during embryonic life and their later development under the action of some unknown stimulus is the correct one. It is the only one that explains the bilaterality of the tumors the fact that they developed at the same time on both sides and the identical histological picture on the two sides. **AUDREY G. MORRIS, M.D.**

### EYE

**Gundersen, T.:** Observations on the Voosius Ring *Am. J. Ophth.* 1946, 29 837

Voosius who first described this ring in 1903 identified two forms—a colored one which he considered to be derived from the pars ciliaris iridis, and a more colorless one which he attributed to degenerative changes in the epithelium of the lens capsule and possibly in the anterior cortical layers of the lens.

In 1918 Heise and Vogt showed that the ring was not an opacity in the lens or lens capsule but a thin ring of deposit on the former.

Severe trauma and intraocular hemorrhage are the most constant factors in the etiology of the Voosius ring. Heise believes that hemorrhage is more important than trauma. Intraocular hemorrhage is one or more of these—retina, vitreous, or aqueous—present in all 19 cases of this series. Senile and presenile eyes seem to be immune to the formation of a Voosius ring. Gundersen states that the existence of a nontraumatic Voosius ring has never been proved.

All cases in this series occurred in American soldiers between the ages of 19 and 30 years as a result of battle injury. Intraocular hemorrhage was found in every eye. Extensive vitreous or retinal hemorrhage was absent in only 4 cases. The size of the ring was constant in all cases—between 2.55 and 2.75 mm. in diameter.

Gundersen concludes that the ring does not consist of iris pigment left behind on the lens capsule as a result of an injury but that during the interchange of fluids through the anterior lens capsule, blood pigments from the aqueous are deposited in characteristic fashion.

**JOSEPH K. NARAT, M.D.**

**Vail, D.:** The Scleral Resection (Eyeball Shortening) Operation. *Am. J. Ophth.*, 1946, 29 185.

The author discusses scleral resection, or the eyeball shortening operation. This procedure was introduced in 1903 by Mueller for the treatment of retinal detachment in myopia. He resected an oval piece of sclera from 8 to 10 mm. in width and from 18 to 20 mm. long from the temporal side of the eyeball.

One hundred and twenty-one cases of scleral resection for detachment have been collected from the

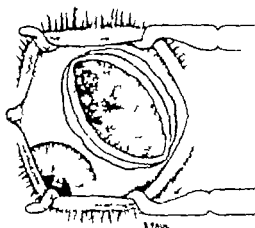


Fig. 1 (Vall) The scleral resection operation. Diagrammatic appearance and position of the staphyloma.

literature, 25 of the retinas being successfully reattached and 31 being partially or temporarily reattached. In other words cures were obtained in about 20 per cent of the cases which is remarkably good. Lindner modified Mueller's technique in 1933. He operated 23 times on 12 eyes most of which were myopic. The best results were obtained in detachment in aphakic eyes and in those cases in which a piece of sclera from the entire circumference of the eyeball was removed in 2 stages.

Vall performed a scleral resection on an only eye which was aphakic and on which 2 previous diathermy operations had been unsuccessful. The retina was reattached and vision restored to 20/70. A scleral resection was done 3 times on the only eye of a young man who had a complete detachment but no real improvement followed.

The author reports a case of Fischel's in which de-termination brought about a cure. A young man 30

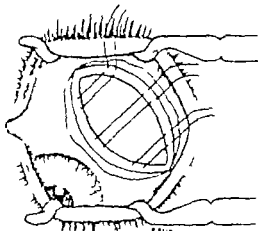


Fig. 3 (Vall) Diagrammatic drawing of position of sutures.

years of age had undergone needling of congenital cataracts innumerable times. One eye was finally lost. For a retinal detachment in the aphakic eye first a Lindner undermining operation and then a diathermy coagulation were performed. At a third operation an unexpected perforation occurred. Finally at the fourth operation eyeball shortening operation of the whole lower half of the eyeball was done. A 3 mm wide crescent was removed, and this was followed by diathermy coagulation. This yielded 6/200 vision and a normal visual field which still prevails 4 years later.

It is concluded that scleral resection is feasible and offers some hope of success in detachment of the retina. It is less hazardous than removal of a clear lens in cases of high myopia.

The operation is also useful for anterior (intercalary) staphyloma and equatorial staphyloma of the sclera. The author cured a case of the latter associated with retinal detachment by excision in a manner similar to the eyeball shortening operation described by Lindner (Fig. 1). The staphyloma measured 12 by 15 mm and began 6 or 7 mm from the limbus between the tendons of the superior and lateral recti muscles. Two double armed sutures were inserted

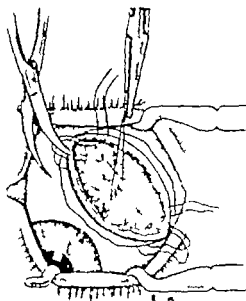


Fig. 2 (Vall) Showing the value of the fixation

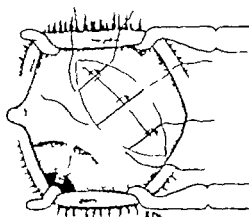


Fig. 4 (Vall) Showing closure of the wounds.

# SURGERY OF THE NERVOUS SYSTEM

## BRAIN AND ITS COVERINGS CRANIAL NERVES

Lofstrom, J. E., Webster, J. E., and Schneider R. C.: The Early Pneumoencephalographic Findings following Penetrating Wounds of the Brain. *Radiol* 37 1946, 47-51

In a group of 356 patients with penetrating wounds of the head treated at the 36th General Hospital, 23 pneumoencephalographic studies were performed and comprise the basis of this report. A qualitative estimate of the amount of cerebral tissue lost and the size of the calvarial defect was made and correlated with the ventricular size. Although a quantitative correlation could not be found it was noted that ipsilateral ventricular dilatation occurred with loss of cerebral tissue and that the dilatation was usually greater in cases with extensive brain loss. In cases in which there was a large amount of brain loss there was also a dilatation of the contralateral ventricle. An interesting finding was a completely normal ventricular conformation in a case with considerable loss of cerebral tissue.

No correlation could be found—at least in the early period—between ventricular distortions and the size of the bony defect. Also it was noted that closure of the dura was apparently not an important factor.

It is postulated that the mechanism of the ventricular dilatation in these cases is on the basis of hydrodynamic compensation. As the cerebral swelling subsides the ventricles dilate as a result of the positive pressure of the cerebrospinal fluid. Although cerebral atrophy, cicatrix, and arachnoid abnormality may result in the progression of ventricular dilatation the former factors could not play an important part in these early changes during the first few months. Acute and chronic basilar meningitis with a partial block may likewise play a part in subsequent diffuse ventricular enlargement.

JACK I. WOOD, M.D.

## SPINAL CORD AND ITS COVERINGS

Pala, C.: Modularity Compression by Neurinomas in the Course of Recklinghausen's Disease (Compression midollari da neurinomi nel morbo di Recklinghausen). *Arch. Ital. Chir.* 1945 67, 173

Two cases in which Recklinghausen's disease involved the spinal cord are reported by the author. In the first case a paraplegic condition and in the second a paraparetic condition were the results of the invasion of the spinal cord. The diagnosis was confirmed in both cases by biopsy. If the sensory and motor syndromes in the course of Recklinghausen's disease cannot be explained by the presence of peripheral neurofibromas a suspicion of the invasion of the spinal cord is justified and

myelographic studies are indicated. The results of such studies may be negative in the presence of a radicular syndrome, for which paravertebral neurinomas are responsible. JOSEPH K. NARAT, M.D.

## PERIPHERAL NERVES

White, J. C.: Painful Injuries of the Nerves and Their Surgical Treatment. *Am. J. Surg.* 1946, 73: 463.

This article considers many of the factors involved in nerve injuries. It reviews old, tried, and unsatisfactory procedures used for such injuries, and presents new techniques in order to crystallize a concept of treatment for the future. Underlying pathological factors leading to painful injuries of the nerves, and as faulty regeneration, sepsis and scar formation, are noted while the theories relating to the etiology of burning pain are discussed in detail. Various types of pain including painful neuromas, caustic, and phantom limb are discussed with regard to their etiology and the factors having a direct influence on them.

The author wishes to stress several important general facts in the treatment of the aforementioned conditions. When pain is permitted to become chronic the cerebral cortex may become so involved in its projection that no peripheral operative procedure is of value. Likewise, it is particularly important in these cases to bear in mind that any ill-advised operation will only make the patient worse. A gradual accumulation of experience since World War I has shown that the following procedures are of no value: (1) repeated resections of neuromas, (2) neurectomies or interruptions of the nerve trunks at higher levels, (3) reamputations for the relief of pain (unless the stump is poorly constructed mechanically), (4) periaxillary sympathetomy, (5) intrathecal injection of alcohol, and (6) posterior rhizotomy.

In their stead two simple procedures are advocated, namely single resection of a painful neuroma, or regional sympathetomy. In the former it is suggested that the fresh nerve stump might be treated more effectively by injecting 30 per cent formalin or 1 per cent aqueous solution of gentian violet instead of alcohol. Boldrey's suggestion of drawing the nerve end through a drill hole of a neighboring bone is presented, as well as Spurling's technique of covering the end of the nerve from which the neuroma has been resected, with a snugly fitting cuff of sheet tantalum. All of these are simple procedures and are theoretically sound methods which deserve careful trial but as yet the follow-up time has been too short to give an evaluation of the results.

The second operation which is discussed is regional sympathetomy either by repeated chemical block or by surgery. When pain is relieved during a

period of procaine block but reappears on the absorption of the drug; there is a good chance that surgical sympathectomy will bring about lasting results. If there is severe pain in an injured nerve it is much better to perform this procedure after a successful procaine block, and postpone any necessary local repair until later. There is a better than even chance that the pain will be relieved and any abnormal peripheral circulation and sweating will be corrected. It is noted that occasionally the distress of painful phantom symptoms can be relieved by sympathectomy but the phantom symptom itself remains.

If these relatively simple procedures are unsuccessful the case should be reviewed by a psychiatrist before resort is made to the more mutilating operations on the central nervous system. Interruption of the lateral spinothalamic tract can relieve pain in a stump but there is some doubt as to whether the marked phantom phenomenon can be alleviated by this procedure. No relief can be expected if the pain is indelibly stamped in the cortex. As a test it appears that spinal anesthesia offers the best chance of ruling out pain of central origin after injury to the lower extremity while procaine block can accomplish the same in the case of arm pain.

If pain is definitely of central origin associated with phantom symptoms, extirpation of the post-central convolution may be attempted. Or as the procedure of final choice, a frontal leucotomy may be performed for elimination of the patient's intractable pain. Both of the latter operations are still purely experimental and prolonged research is necessary prior to an accurate assessment of their value.

The author presents 27 service cases from the United States Naval Hospitals at Chelsea and St. Albans, and 13 civilian cases from the Massachusetts General Hospital, Boston, to demonstrate the results of the procedures which he has discussed.

RICHARD C. SCHNEIDER, M.D.

**Sunderland S.: Course and Rate of Regeneration of Motor Fibers following Lesions of the Radial Nerve. *Arch. Neurol. Psychiat. Chic.* 1946 56 133**

As a result of observations on 63 cases of lesions of the radial nerve in a series of 301 consecutive cases of peripheral nerve injuries studied at the One Hundred and Fifteenth Australian General Hospital and the Repatriation Clinic, Melbourne, Australia, the author presents his views on the course and rate of regeneration of motor fibers following complete interruption of conduction in the nerve. Actually only 31 cases met his criteria.

In the majority of cases spontaneous regeneration proceeded either to completion or to a degree which contraindicated exploration of the nerve, and attention is called to the fact that this may account for the beneficial results often incorrectly attributed to neurolysis when the latter had been performed prematurely. When the condition of the nerve was not known and exploration was indicated satisfac-

tory suture could be performed in less than half of the cases (5). Most of the irreparable situations were gunshot wounds associated with fractures of the humerus. The material is carefully described; criteria are stated, and methods of investigation are outlined.

It is stressed that when a nerve regenerates the order of recovery of motor function is usually but not necessarily that in which the motor branches leave the nerve. The reasons for variation from this order of reinnervation are discussed. A comparison of observed and deduced pathological conditions of the nerve and the onset of recovery in muscle suggests that the appearance of the nerve at injury is a fairly reliable guide to the probable duration of the regenerative process. However this is not necessarily a guide to the condition of the individual fibers for neurapraxia may occur in apparently severe injuries and axonotmesis in nerves which appear normal.

A method of estimating the rate of regeneration of motor axons in peripheral nerves is presented and emphasis is placed on the fact that it deals only with the growth of functionally mature fibers since the criterion is the progression of return of function. The advantage of this method is that it is not necessary to have a knowledge of the level of the injury and of the delay occurring at that site prior to the onset of regeneration. In addition by selecting muscles innervated at different levels the rate of regeneration of nerve can be estimated separately over different segments and one is able to calculate the degree of variation in the rate of progression of regeneration. From the results it is concluded that the mean rate of regeneration over the proximal portions of the nerve is greater than that over the distal portions and that as the regeneration progresses it does so at a diminished rate. In a study of 3 cases of regeneration after suture, the rate in the proximal segment was 1.2 mm. per day and in the distal segment 0.6 mm. per day. In the cases of axonotmesis the mean rate was 1.9 mm. per day in the proximal segment and 0.8 mm. per day in the distal segment which indicated that as regeneration continues it tends to approach the same mean rate as in nerve suture cases. From the data included it would seem that the duration of the initial delay is a measure of the severity of the nerve injury.

The course of regeneration following the onset of recovery may be expressed in terms of the time required to innervate the entire nerve pattern as measured by onset of recovery in the first and last muscles to recover. Factors influencing the time of reinnervation are: (1) variations in linear extent of the pattern; (2) variations in severity of the injury with regard to the area of cross section of nerve involved; and (3) variations in individual rates of regeneration.

In lesions of a minimal degree (axonotmesis) an initial delay of 10 weeks may be expected whereas in more severe injuries such as those after suture or those associated with fractures or other complica-



tions a delay of about 4 months may be expected. When the level of the lesion is known the time required for regenerating axons to reach the brachioradialis or extensor carpi radialis longus may be estimated at 1.9 mm. per day.

The maximum latent period observed before spontaneous regeneration was 10 months, but this was unusual. It is suggested that by adding 12 to 23 weeks, according to the type and severity of injury and to the date of onset of recovery in the first muscle to recover it is possible to calculate the approximate time when voluntary contraction may be expected in the last muscle to be reinnervated.

RICHARD C. SCHNEIDER, M.D.

### SYMPATHETIC NERVES

De Souza Pereira, A.: Blocking of the Splanchnic Nerves and the First Lumbar Sympathetic Ganglion. *Arch Surg* 1946, 53, 33.

The author advocates blocking of the splanchnic nerves and first lumbar sympathetic ganglion for various conditions. It is considered a useful procedure in determining the possible results of contemplated operative measures directed at the sympathetic nervous system, and a means of avoiding possible operative failures.

The various methods of injection of the splanchnic nerves are discussed, and the author proposes his own method of blocking the nerve by the posterior approach. X-rays, anatomical sections, and diagrammatic drawings placed upon the patients' backs are used to demonstrate the location for injection.

A discussion of the clinical indications includes (1) cardiospasm, (2) visceral pain, (3) peptic ulcer, (4) paralytic ileus, (5) megacolon, (6) hypertension, and (7) postoperative condition following abdominal operations.

HOWARD A. BROWN, M.D.

### MISCELLANEOUS

Turnbull, F.: Surgical Relief of Pain in Cancer. *Cancer* 1946, 35, 241.

In this short, somewhat philosophical article, the author is impressed by the necessity of stopping even in part if not wholly the pain which is the lot of the cancer patient. He admits, as any neurosurgeon will, that the problem is a very difficult one, and that this difficulty lies largely in our insufficient understanding of the various mechanisms of pain in the various pain producing lesions. He would use the term unmanageable rather than intractable in describing the pain, believing that it indicates or therapeutic problem.

Realizing the shortcomings of the most accurately performed cordotomy in certain patients, the author contends that cordotomy is, nevertheless, one of the most valuable means at hand of making comfortable many patients who would otherwise be doomed to a terminal existence of heavy debilitating sedation or agonizing pain. He also makes the wise observation that many such patients, having passed at length through the hands of several specialists, including the neurosurgeon, are best off when returned to the final care of their own family doctor.

JOSEPH M. MURPHY, M.D.

# SURGERY OF THE THORAX

## CHEST WALL AND BREAST

Lester C. W.: *The Surgical Treatment of Funnel Chest*. Ann Surg., 1946 123 1003

Funnel chest which is a funnel shaped deformity of the anterior chest wall as the name implies has been recognized for many years under many names such as pectus excavatum trichterbrust and chondrosteron to name a few. Nevertheless the underlying pathological condition was not discovered nor a satisfactory operation devised until Brown demonstrated that the deformity was due to a short central tendon of the diaphragm and described a satisfactory surgical treatment. There is an extensive literature on the subject admirably reviewed by Ochsner and DeBakey which starts with an article by Baubinus written in 1594. Since Brown's article appeared Sweet has reported his experience with 2 cases. The author is now adding a series of 8 cases, the first of which was operated upon 2 years ago and the most recent, 4 months ago.

When the deformity is fully developed it is characterized by a deep conical depression of the anterior chest wall the apex of which is at the xiphoid. The sternum shows the greatest displacement. The manubrium is at approximately the normal level but from this point the sternum curves sharply backward until the xiphoid approaches the vertebral bodies. Some cases have been described in which the xiphoid was practically in contact with the bodies of the vertebrae and in the author's first case the distance separating them was only 1 cm. The apex of the depression may be in the midline but it is often to the right of it which makes an asymmetrical funnel. The ribs and costal cartilages attached to the sternum are proportionately involved in the deformity. The ribs tend to flare out laterally and to turn downward and backward at their sternal ends. This is particularly noticeable in the upper ribs and gives a barrel shape on roentgenological examination. The vertebral column is bent forward into an exaggerated dorsal curve. This with the chest deformity, produces an extreme example of the round shouldered hollow chested individual, further heightened by the fact that he is also thin and underdeveloped.

The effect of the deformity on the thoracic viscera is that of compression. The lung volume is decreased in proportion to the deformity but seldom to a critical level. The effect on the heart is proportionate to the pressure on it and not necessarily to the degree of deformity. There is frequently a systolic heart murmur considered to be functional.

Usually the depression of the sternum pushes the heart into the left hemithorax but there may be considerable displacement before the pressure affects the heart action. On the other hand, if the heart is prevented from being displaced a moderate depression of the sternum can produce limitation of the heart

action. The pressure effect is characterized by dyspnea and palpitation on exertion which may be so great that the patient is practically bedridden. Furthermore, as with other cardiac defects in infancy and childhood the nutrition is poor and the physical development retarded. In spite of this the oxygen saturation of the arterial blood appears to be normal. Often there is a psychologic feeling of inferiority—among the boys when they appear unclothed before their fellows especially when associated with physical limitations and among the girls when they appear in bathing suits or low necked gowns.

The movement of the thorax during respiration especially in the vicinity of the deformity is characteristic of paradoxical respiration. During inspiration the sternum moves backward and the entire funnel deepens while during expiration the movement is in the opposite direction. In other words the movements of the thorax are the reverse of the normal respiratory movements. The explanation of this was discovered by Brown who noted that the central tendon of the diaphragm was unusually short so that contraction of the muscle exerted a pull on the xiphoid and on the costal cartilages of the costal arch drawing them backward whereas a normal diaphragm by flattening its dome would allow the sternum and ribs to swing out and increase the volume of the chest. This pull on the sternum produces a deformity which is reversible at first i.e. in early infancy but when exerted over a long period of time it makes the deformity permanent unless corrected.

The permanent deformity is maintained also by the substernal ligament. This is a continuation of the linea alba of the abdomen up along the under surface of the sternum to the suprasternal notch. It is a dense fibrous band closely adherent to the sternum and involved in the attachment of the diaphragm to the xiphoid. In the established case this ligament can maintain the deformity even after the overlying sternum has been resected. Furthermore it seems to have an abnormal importance in dealing with the correction of the deformity.

The cause of the deformity is generally considered to be congenital and hereditary. In many cases some other member of the family can be found who has a similar funnel chest and not infrequently several members of the family show the deformity.

The symptoms and signs described are not seen in all cases of funnel chest. When they are present operative correction is indicated. Should the patient with obvious funnel chest be without symptoms nothing is to be gained by operation unless the deformity is increasing or the psychologic state suffers as a result from it. Then even in the absence of symptoms the author believes operation to be justified. The surgical treatment is of two types: the first and more simple is for the early stages of the deformity in infancy and is contrived to release the

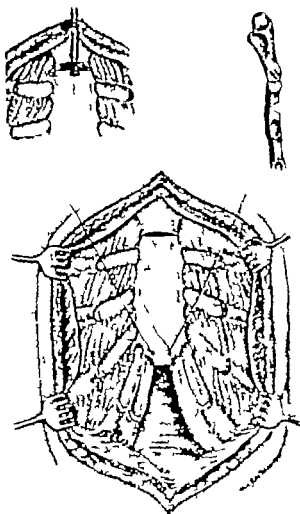


Fig. 1 (Lester) The radical operation. The outer table of the sternum has been cut transversely just below the second rib (edge osteotomy indicated in inserts) and silver wire has been threaded through drill holes in the lower end of the sternum.

pull of the diaphragm on the sternum and costal arch, the second is designed to correct a deformity which has been established and must not only release the diaphragmatic pull, but also correct the bony deformity which has resulted from this pull.

The author then describes the operative procedure and gives a series of 8 cases with complete studies thereof. He summarizes his article by the following statements:

Funnel chest is a deformity of the sternum characterized by a funnel-shaped depression of the sternum with the apex at the xiphoid. It is caused by a short central tendon of the diaphragm which pulls backward on the xiphoid during inspiration. It may produce pressure on the heart causing palpitation, dyspnea on exertion (sometimes extreme) and chronic malnutrition and underdevelopment. In infancy

when the deformity is in a reversible stage a simple operation suffices to correct it. Later when the deformity has become fixed, a much more extensive operation is necessary. Operation results in a high percentage of satisfactory results.

PAUL MERRILL, M.D.

Wade, P.: Untreated Carcinoma of the Breast. *Brit. J. Radiol.* 1946 9 572.

Twenty-seven cases of untreated carcinoma of the breast are analyzed. The survival rates of approximately 827 cases are collected from various sources. Seven hundred and fifty-seven of the cases are classed according to the age of the patients. A comparison is made between the survival rates in 177 treated advanced cases and the results of palliative treatment in 301 other cases. Factors influencing the mean duration of life are discussed. The duration of the untreated disease is not proved to have a definite relation to the age of the patient although the cases recorded show a slight increase in duration of the disease in the middle age groups. There is a wider variation in duration in the younger age groups, but the duration in the older age groups deviates less from the mean duration. Long durations, such as from 20 to 30 years, are unlikely in an age group having a normal expectation of life that is shorter than this period. The treatment of selected advanced cases increases the duration of life and raises the survival rate at all periods. Therefore, treatment enables the patients to regain a percentage of their normal expectation of life, which they would not have had were the disease to remain untreated. The later history of a group of treated and untreated patients should relate to the state of the disease at any given period, and to the duration of life compared with that of an individual of the same age but not known to be suffering from the disease.

EMIL C. ROBINSON, M.D.

Halberstaedter L., and Hochman A. Artificial Menopause and Cancer of the Breast. *J. Am. M. Ass.* 1946 3 80.

Between May 1938 and January 1945 the authors induced artificial menopause by irradiation of the ovaries in 60 women with cancer of the breast. The tumors were classified according to Stenhal as those of Stage I—with no evidence of lymph node metastases at operation; those of Stage II—with microscopic evidence of metastases to the axillary lymph nodes without evidence of involvement of the neighboring tissues and organs; and those of Stage III—with involvement of the adjacent or distant tissues or organs.

Only 60 of 393 women with carcinoma of the breast seen during the period of study were irradiated to produce an artificial menopause. As a rule the artificial menopause was induced when metastases could be identified.

Improvement occurred in 56 per cent of the women in this series. The authors are more liberal in their use of the word improvement. They con-

under it proper to report a case as improved if there is alleviation of the symptoms whereas most authors report cases as improved if regression of the metastatic infiltration can be shown objectively.

Metastases to the bone responded particularly well to the induction of the artificial menopause improvement occurring in 69 per cent of the cases metastases to the pleura and lung reacted favorably in 50 per cent of the cases, metastases to the skin and local recurrence reacted less favorably and metastases to the lymph nodes showed little response. Brain and liver metastases showed no response.

Six of eight patients who had ovarian sterilization as a preventive measure are alive and there is no clinical evidence of metastases.

The best chances of improvement resulting from ovarian sterilization are found in those cases of cancer of the breast in which the tumor cells are euplastic and typical, the so-called adenocarcinomas. The chances of improvement are far fewer in the cases in which the cells are anaplastic and atypical the so-called carcinomas simplex.

Improvement following irradiation of the ovaries is temporary lasting from  $\frac{1}{2}$  year to 2 years in the authors series. This is probably due to the fact that sterilization by irradiation or surgery does not completely stop the flow of ovarian hormones in the body.

EARL O LATIMER, M D

Adair F E. and Herrmann J B: The Use of Testosterone Propionate in the Treatment of Advanced Carcinoma of the Breast. *Ann Surg.*, 1946 123 1023

Many investigators have demonstrated that the administration of estrogenic hormones has produced mammary carcinoma in mice. An attempt to counteract this carcinogenic effect of estrogens by means of androgens was a logical sequence. This principle of inhibiting the activity of gonadal hormones of one sex by the administration of gonadal hormones of the opposite sex has been employed in recent years in the treatment of cancer.

Encouraging results have been obtained in the treatment of prostatic cancer by estrogens. There are, however, surprisingly few reports on the use of androgens in the treatment of human carcinoma. In 1939, Ulrich and Loser described favorable changes in patients with advanced carcinoma of the breast coincident with the administration of testosterone propionate. More recently other authors have published similar findings.

The authors report a series of 11 cases with the following summary and conclusions.

1 No toxic effects were noted in individuals with normal serum calcium levels each of whom received several thousand milligrams of testosterone propionate over a period of 3 months.

2 Four patients (one with soft part and 3 with osseous metastases) manifested remarkable improvement.

3 Evidence of improvement was the regression of the primary lesion and soft part metastases in 1 case

and an increase in calcification in areas of osseous metastasis in 3 cases.

4 Disappearance of pain coincided with the osteoblastic changes.

5 In 2 of the cases that exhibited deposition of calcium in the bone metastases there was a coincident elevation of the serum alkaline phosphatase.

6 Four patients did not respond to therapy and 3 others are still under treatment without clinical evidence of improvement. On microscopic study metastatic nodules from 2 of the latter group revealed hydropic changes.

7 One patient with an initial hypercalcemia associated with osseous metastases manifested a further rise in serum calcium associated with toxic manifestations in consequence of testosterone therapy. This emphasizes the importance of blood chemical studies in patients receiving this treatment.

8 We believe that testosterone propionate in large doses may in certain instances exert a favorable influence on advanced carcinoma of the female breast.

9 The number of cases studied is too small to gauge the frequency of this favorable reaction. From our limited experience the beneficial effects are unpredictable and uncertain. Likewise the duration of the favorable response and the amount of testosterone propionate necessary to maintain this improved status is as yet unknown.

PAUL MERRILL, M D

## TRACHEA LUNGS, AND PLEURA

West J P: Chest Wounds in Battle Casualties. *Ann Surg* 1946 123 986

The author's report deals with 206 battle wounds involving a thoracic cavity. The wounds of the chest cavity are classified under four headings and are discussed separately.

Eighty-seven penetrating wounds of the chest did not require thoracotomy. These patients had relatively minor wounds involving the chest cavity and received no treatment other than aspiration and debridement of the chest wall wounds. Three of these patients had a hemopneumothorax. There was one death in the group—that of a soldier admitted to the hospital with a clostridial infection in a compound fracture of the arm. Death was thought to be caused by the toxemia of the clostridial infection although autopsy revealed extensive intrapleural hemorrhage. Forty-six patients were admitted with penetrating wounds and required thoracotomy. Thirty-five patients were admitted with sucking wounds of the chest and 38 patients had a combined thoraco-abdominal wound.

There were 17 deaths in the entire series and the author comments upon the results as follows.

Of the 87 patients with penetrating wounds not requiring thoracotomy there was only 1 death, a mortality of 1.1 per cent. Of the 46 patients with penetrating wounds requiring thoracotomy there were 4 deaths a mortality of 8.7 per cent. Of the 35 patients with sucking wounds, there were 4 deaths a mortality of 11.4 per cent. Of the 38 patients with thoraco-

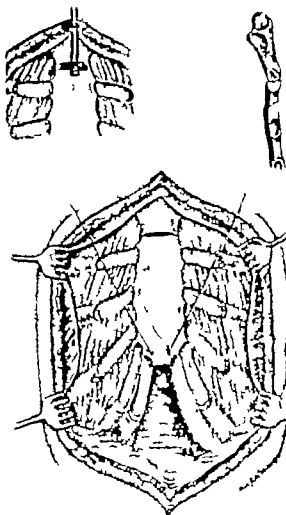


Fig. (Lester) The radical operation. The outer table of the sternum has been cut transversely just below the second rib (wedge osteotomy indicated in inserts) and silver wire has been threaded through drill holes in the lower end of the sternum.

pull of the diaphragm on the sternum and costal arch, the second is designed to correct a deformity which has been established and must not only release the diaphragmatic pull, but also correct the bony deformity which has resulted from this pull.

The author then describes the operative procedure and gives a series of 8 cases with complete studies thereof. He summarizes his article by the following statements:

Funnel chest is a deformity of the sternum characterized by a funnel shaped depression of the sternum with the apex at the xiphoid. It is caused by a short central tendon of the diaphragm which pulls backward on the xiphoid during inspiration. It may produce pressure on the heart causing palpitation, dyspnea on exertion (sometimes extreme) and chronic malnutrition and underdevelopment. In infancy

when the deformity is in a reversible stage a simple operation suffices to correct it. Later when the deformity has become fixed, a much more extensive operation is necessary. Operation results in a high percentage of satisfactory results.

PAUL MINDELL, M.D.

Wade, P.: Untreated Carcinoma of the Breast. *Brit. J. Radiol.* 1946 19: 172

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FRANK C. ROSENTHAL, M.D.

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abdominal wounds, 8 died, a mortality of 81 per cent. It will be observed that the total mortality in this series is approximately half that of the previous series.

In the two series combined, there is a total of 361 thoracic cases, which represents 3.6 per cent of the 10,700 battle casualties treated in the Second Evacuation Hospital between July 1, 1944 and March 1, 1945. The total mortality for the combined series of 361 cases was 43, or 11.5 per cent. Twelve patients with chest wounds who died in the shock ward before operation are not included in these figures.

The following conclusions are based upon the total experience to date:

1. Small penetrating wounds of the chest cavity are best treated by aspiration alone.

2. Penetrating wounds of the chest cavity require a limited thoracotomy (1) when the skin incision necessary for debridement of the chest wall wound causes sucking, (2) when there is extensive damage to the chest wall and roentgenographic evidence suggests severe lung damage, (3) in the presence of progressive bleeding, and (4) when large easily removable foreign bodies are present.

3. In treating sucking wounds of the chest the wound should be enlarged enough to allow suture of a laceration of the lung, removal of foreign bodies and evacuation of blood clots as well as a complete debridement of the chest wall wound.

4. In many cases thoracoabdominal wounds can be dealt with through a thoracotomy incision alone. In other cases the major injury is in the lower abdomen. These patients require celiotomy after treatment of the chest wound. PAUL MERRILL, M.D.

Samson, P. C. and Brewer L. A., III: Principles of Improving Inadequate Tracheobronchial Drainage following Trauma to the Chest. *J. Thorac. Surg.* 1946, 5: 62.

De Takats showed experimentally that thoracic wall trauma resulted in bronchial spasm and increased bronchosecretory activity. The tracheobronchial tree of patients with thoracic wounds is filled with tenacious mucous and purulent secretions. Because of the prevalence of bronchitis in soldiers under combat conditions particularly during the winter months, purulent bronchial exudate often antedates injury. Bloody or mucoid sputum which becomes purulent indicates developing infection. Fluid in the pleural cavity may give bronchial symptoms primarily especially in the presence of a bronchopleural fistula. Necrotic mucosa debris, and membranous exudate from burns of the lower airway and from the local action of certain poison gases may cause widespread tracheobronchial obstruction within a few days after injury.

Present in thoracic injuries are factors which disturb clearing of the tracheobronchial tree by effective cough. Among these are thoracic wall pain, diaphragmatic injury or paresis (reflex?) abdominal ileus, fluid in the pleural cavity and paradoxically movable chest wall from multiple rib fractures.

Signs and symptoms are easily recognizable. There is constant inefficient "wet" cough with a persistent rattling or gurgling element. Only superficial secretions are raised. Bronchial rales with a wheezing high pitched dry quality which may often be heard at the bedside are commonest. There may be sonorous rales. The patient appears to be having an asthmatic attack. Dyspnea usually means a diffuse partial bronchial obstruction with anoxia. Instant bronchial breathing changes in latency and location with a forced cough signifying patchy lobular atelectasis, which if allowed to persist, becomes pneumonitis.

Roentgenograms should be taken in at least two planes. Intrapulmonary bleeding per se will not cause cardiac or mediastinal shift. Shadows are likely to be round or oval with small loculated air pockets, and must be differentiated from shadows caused by atelectasis and from chest wall contusions and pleural lesions.

Important initial steps in treatment are thoracentesis, gastric and intestinal decompression, intercostal or paravertebral block and inhalations of 100 per cent carbon dioxide (rebreathing into a paper bag may be substituted). If there is continued evidence of blockage, mechanical aspiration of the tracheobronchial lumen by catheter or bronchoscopy is resorted to without delay. A simple technique for tracheal toilet with an endotracheal catheter which may be done at the bedside is discussed in detail. An unusually flaccid epiglottis is the only condition which prevents passage of the catheter and that is extremely rare.

Bronchoscopic aspiration is a more efficient procedure than catheter suction. Since it is done under direct vision, both stem bronchi will be aspirated in a more efficient manner. The use of curved section tips allows more adequate drainage of the smaller bronchi. Further increase in the airway is provided by mucosal shrinkage with pontocaine (or cocaine) and epinephrine. The sicker the patient the more immediate is the necessity for bronchoscopy and it is mandatory if an unconscious patient has aspirated vomitus.

In conclusion the authors state that (1) bronchial obstruction may be present in patients with chest injuries as a result of retained fluid substances in the pulmonary tree, and (2) that persistent bronchial obstruction is an important factor in the development of pulmonary atelectasis and pneumonitis following thoracic trauma.

The principles of improving inadequate tracheobronchial drainage are discussed. Illustrative cases are presented. LYNN JOHNSON, M.D.

Berg, S.: Combined Intrapleural and Extrapleural Pneumothorax (Pneumothorax Mixte). *Acta med. scand.*, 1946, Supp. 170, p. 403.

Following the introduction of cauterization of adhesions according to the Jacobaeus method it became possible to extend the limits of pneumothorax treatment and achieve an effective collapse of the lung in

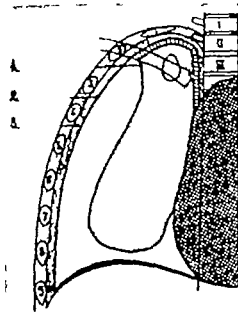


Fig. 1

Fig. 1 (Berg) Incomplete pneumothorax with adherent apex. 1. Pleura visceralis. 2. Pleura parietalis. 3. Extra-pleural layer of tissue.

Fig. 2 (Berg) Intrapleural and extrapleural pneumothorax. Apex part detached below the lower limit of adhesion. A horizontal part of the pleura parietalis distended

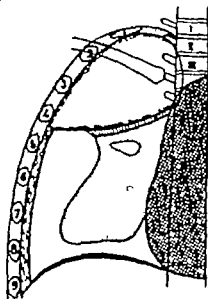


Fig. 2

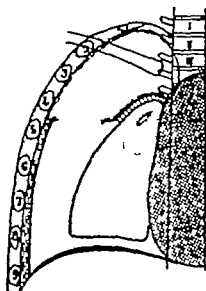


Fig. 3

between the upper part of the lung and chest wall.

Fig. 3 (Berg) Combined extrapleural and intrapleural pneumothorax, (Pneumothorax mixte). Pleura cut through right round. Combined pneumothorax cavity established. Pleura parietalis covers apex region.

cases in which it would otherwise not have been feasible. In a number of cases, however the desired effect of the collapse is not obtained because of the existence of adhesions which cannot be removed by means of intrathoracic cauterization. This is particularly the case in the presence of extensive adhesions in the apex region.

The author reports 5 cases in which following a rib resection, the adherent part of the lung was freed by separation of the tissue lateral to the parietal pleura and cutting of the detached parietal pleura which created a combined intrapleural and extrapleural pneumothorax, a pneumothorax mixte. The procedure is best explained by the accompanying schematic pictures

SAMUEL KAHN M.D.

Lata, G. A. Latent Bronchial Carcinoma with Initial Cerebellar Symptoms (Carcinoma bronchiale latente con sintomatologia iniziale cerebellare). *Pravda med. argent.* 1946 33 1232

Bronchial carcinoma may cause nervous symptoms either from pressure on various nerves or from metastases in the brain. Metastases of bronchial carcinomas are very frequent in the cerebrum. It is said that of every 9 tumors of the brain 1 is metastatic and that 38 per cent of these metastases are from bronchial carcinomas. This is true to such an extent that at the Mayo Clinic a roentgenogram of the cranium is made at once in every case of tumor of the brain.

Nevertheless metastases of bronchial carcinomas to the cerebellum are rare. It is still rarer for them to

occur without metastases elsewhere in the brain and for them to cause symptoms while the bronchial carcinomas are still latent symptomatically, although the latter finding is not extremely unusual in metastases in the cerebrum.

Such a case of cerebellar metastasis with cerebellar symptoms preceding pulmonary symptoms is described in a man of 49. Three months before admission to the hospital his gait became unstable and after about a month he presented dizziness, headache, nausea and vomiting. He was finally obliged to go to bed and on admission to the hospital he showed mental confusion in addition to the above symptoms. He had lost 8 kgm in weight. He showed a tendency to fall to the left. Romberg's sign was negative. There were no respiratory symptoms. Lumbar puncture could not be performed on account of calcification of the vertebral ligaments. Cisternal puncture showed increased pressure of the spinal fluid. The symptoms indicated tumor of the left cerebellum and a roentgenogram of the thorax showed great enlargement of the hilar shadow to the right.

Later roentgenograms very plainly showed a tumor of the posterior part of the right lower lobe. A diagnosis was made of metastatic cerebellar tumor associated with the bronchial tumor on the right side. A decompressive operation was performed with some relief of the brain symptoms but the patient died after a period of about 2 months of acute bronchopneumonia and cachexia.

AUDREY G. MORGAN M.D.



## HEART AND PERICARDIUM

Harken, D. E. and Williams, A. C.: Foreign Bodies In and in Relation to, the Thoracic Blood Vessels and the Heart Migratory Foreign Bodies within the Blood Vascular System. *Am. J. Surg.* 1946 72 80

Three cases of migratory foreign bodies successfully removed from intrathoracic blood vessels, and the salient aspects of the surgical technique employed are reported in this article. Each of the patients was wounded in battle the first in the intracavicular region by a 30 caliber machine gun bullet. On thoracotomy the bullet was palpated in the left pulmonary artery but it became dislodged accidentally. Subsequently it was found in the right pulmonary artery at a second operation. A schematic drawing illustrated the probable migration of the bullet.

The second patient received a shell fragment in the right upper mediastinum. At operation the fragment was discovered in the upper portion of the innominate artery. The artery was completely intact. As to the course taken by the missile, it was suggested that it entered the right side of the chest and the pulmonary vein, or the left side of the heart then carried into the aorta and thence to the innominate artery where it lodged.

The third patient was struck in the right axilla at the level of the fifth rib by a machine gun bullet. At operation the bullet was found to lie in an abscess cavity anterior to and including the anterior surface of the lower branch of the left pulmonary artery. On removal a full arterial stream issued from the defect. Débridement of the cavity and repair of the artery resulted in complete recovery. It was thought that the bullet must have entered the circulation through the liver then entered the inferior vena cava, the right auricle, right ventricle and left the heart by way of the pulmonary artery.

Four cardinal indications for removing intravascular foreign bodies are presented (1) to avoid the hazards of vascular occlusion (2) to diminish the dangers of sepsis (local and systemic) (3) to prevent erosion and hemorrhage and (4) to remove the possibility of embolism. Each of the 3 cases reported had one or the other of these indications for surgical intervention. STEPHEN A. ZIEGLER, M.D.

Groes, R. E.: Technical Considerations in Surgical Therapy for Coarctation of the Aorta. *Surgery* 1946, 20 1

Coarctation of the aorta is a congenital abnormality which can be corrected by direct surgical attack on the lesion. The narrowed or completely obstructed segment can be excised, and the remaining portions of the aorta can be brought together by an end-to-end anastomosis. Groes discusses the technical considerations in surgical correction for coarctation of the aorta in 3 patients so treated.

For anesthesia, the author prefers cyclopropane, administered through a tightly fitting face mask. A

vein cannula in an ankle vein is used to permit the administration of fluids and blood during and after the operative procedure.

The surgical approach is made through the posterior thoracic wall by means of a liberal incision. The aorta is exposed by a longitudinal incision of the overlying parietal pleura from the midthoracic area up over the aortic arch and over the left subclavian artery. This permits the narrowed portion of the artery to be readily seen and palpated. Severing of the vessels to free the aorta from the surrounding structures is done cautiously, and when the pericardium arteriosum is cut a high degree of mobility is gained for the aortic segment. Within the mediastinum the left vagus nerve and the recurrent laryngeal nerve are to be kept in mind and constantly avoided. A revamped Moynihan straight intestinal clamp without rubbers is employed for clamping the aorta. This instrument accommodates vessels of various sizes; it cannot slip sideways and permits considerable pressure with very little crushing effect. Silk constitutes the suture material and the aortic anastomosis is accomplished as far as possible by means of the usual type of Carrel stitch. It cannot, however be relied upon uniformly therefore a continuous mattress type of stitch including all layers, bringing intima to intima, and turning the vessel ends outward is employed.

The prevention of cardiac collapse is accomplished by (1) removing the remaining (upper) aortic clamp gradually over a period of 5 or 6 minutes so that the rush of blood into the lower aortic segment is somewhat retarded (2) tipping the patient into a mild Trendelenburg position to facilitate the return of blood to the heart and (3) quickly injecting from 150 to 250 c.c. of blood (under pressure) into the ankle vein cannula to augment the circulating fluid.

The chest is closed carefully care being taken to avoid bleeding into the pleural cavity. The wound usually heals per primam. By removing segments of the ribs so that the ends of the bone cannot touch, postoperative pain can be kept at a minimum and sedation markedly reduced. Postoperative accumulation of fluid in the pleural cavity is aspirated as required. STEPHEN A. ZIEGLER, M.D.

Fauteux, M., and Swenson O.: Pericoronary Neurectomy in Abolishing Anginal Pain in Coronary Disease: An Experimental Evaluation. *Arch. Surg.* 1946, 53 169.

It is generally believed that the nerve fibers carrying pain impulses from the heart and coronary vessels follow the course of the coronary vessels. They are concentrated for the most part around these vessels forming a loose spiral network, and converge around the origins of the coronary arteries before passing over to plexuses located between the pulmonary artery and aorta, and on the surface of the aorta.pressor and depressor fibers are present in the plexus between the pulmonary artery and aorta. It is important to interrupt the pain fibers as near the heart as possible, not only for the essential reason

of not missing any but also for the reason of avoiding severance of important nerve branches to the lungs which is not without serious risks

The objectives of surgery in the therapy of coronary disease are the improvement of coronary circulation, blockade of vasomotor reactions, and the eradication of anginal pain. The operations of cervical and dorsal sympathectomy interrupt some pain pathways but it has not been proved that all pathways have been cut nor that circulation improves. Clinical experience has borne out this belief.

Investigation has shown experimentally and clinically that venous ligation aids in opening and dilating the arterial anastomoses of the extremities. This view is tenable in the case of the coronary circulation also as evidenced by the studies following coronary venous ligation.

With these thoughts in mind the operation of pericoronary neurectomy was devised. If it would block reflexes then it should abolish anginal pain. Experimental work on the dog showed that in controls there was 20 per cent survival after ligation of the circumflex artery. In a group of dogs prepared by coronary venous ligation, there was 50 per cent survival after ligation of the artery. In a third group prepared by pericoronary neurectomy alone the survival rate was 60 per cent after arterial ligation. In a fourth group prepared by pericoronary neurectomy and coronary venous ligation, the survival rate was shown to be 86 per cent following ligation of the artery.

The conclusions drawn were that coronary venous ligation helps to open and dilate the coronary anastomoses and that pericoronary neurectomy blocks reflexes, thus aiding in the prevention of ventricular fibrillation and rapid death. The unsolved problem in these studies was the extent to which the operation could diminish pain in coronary disease.

The experimental method for the study of cardiac pain, which has become fairly well standardized, was devised by Sutton and Lueth. This method was applied to a control group of dogs which reacted as postulated. It was also applied to a group of 10 dogs prepared in advance by pericoronary neurectomy. Of this group 6 gave no response, 1 gave no response on five occlusions and a questionable response on another 2 were doubtful, and 1 had a positive reaction graded one plus. One dog in the series developed a ventricular tachycardia on the first occlusion with no evidence of pain. It is interesting to note that these attacks are often followed by ventricular fibrillation in the intact dog.

Two patients who have submitted to the operation of pericoronary neurectomy combined with ligation of the great cardiac vein, have been under observation for more than a year. Seven others who have been operated upon more recently are under observation. The clinical results are in accord with the experimental findings. As yet no final judgment can be reached regarding the procedure but there seems to be enough justification for further clinical trial.

EDWIN W. PASSARELLI, M.D.

# SURGERY OF THE ABDOMEN

## GASTROINTESTINAL TRACT

Kalljaer R.: Nutritional Abdominal Allergy from a Surgical Standpoint (Ueber eine nutritive abdominale allergie vom standpunkt des chirurgen) *Acta chir scandinav.* 1946, 94 Supp. 3

The first 118 pages of this work are concerned with a review and evaluation of the literature of the general subject of allergy in an attempt to establish some norms in the universal conflict of experiences and opinions.

Particular attention has been allotted to the consideration of the subject of allergy in the special surgical subjects of gastric and duodenal ulcer of diseases of the bile passages, of appendicitis and of a few other disease pictures of surgical interest in the realm of abdominal allergy. The remaining 206 pages are taken up with the author's clinical and histopathological studies of the role played by allergy in these same surgical conditions.

The various methods of study considered in the first part such as the Prausnitz-Kuestner test, the matter of food antipathies, the exposure of the patient to the suspected food entities or food categories and the withholding of these factors, and the leucopenic index, are given but brief attention, almost exclusive study being made of the skin tests. The histopathological part is concerned with the occurrence and significance of the local tissue eosinophilia in cases of ulcer, cholecystitis, and appendicitis.

The material consisted of 705 patients, of which 91 (68 males, 24 females) presented cases of gastric or duodenal ulcer, 86 (10 males, 76 females) disease of the bile passages, 159 (88 males, 71 females) appendicitis, and 310 (146 males, 164 females) various forms of abdominal distress of undetermined nature. The control material consisted of 83 patients (69 males, 14 females) who were not suffering from any of the cited surgical abdominal conditions and were not presumed to be affected by allergic disease. The cutaneous tests were made on the upper part of the back. They were chiefly intracutaneous and were at first conducted with the extracts of Parke, Davis and Co. and later with the extracts prepared by Frugoni after the method of K. Hansen of Luebeck.

From his studies the author considers that food allergy is not of material significance in the pathogenesis of gastric or duodenal ulcer, the tissue eosinophilia probably resulting from local changes in the ulcer. However, some cases of gastritis with local eosinophilia may be the result of food allergy. As regards the bile passages, food allergy may cause acute biliary colic or induce certain abdominal symptoms which remain after cholecystectomy, however, such conditions are not believed to play any great part in the causation of bile tract disease. Here again

the local eosinophilia of the gall bladder is assumed to be merely an aspect in the normal development of the cholecystitis, or it may be an expression of an allergy which in a few cases might cause a special, less acute type of cholecystic inflammatory reaction. In appendicitis the eosinophilia observed in the mucosa, or even that type of local infiltration permeating the entire wall of this organ, is interpreted to be of about the same significance as that observed in the case of gall bladder disease. Finally, in the group of less well characterized abdominal symptoms, allergy is obviously one of the various etiologic factors which may be at work, however, in a large series of cases it cannot be considered as of paramount importance.

Nevertheless, in the gastrointestinal inflammations the question of allergy is of great significance, because allergy frequently gives rise to the clinical features of an acute abdominal condition. The group the author divides into 6 subgroups.

The first of these subgroups consists of those cases presenting the symptoms of disease of the urinary tract, liver or bile passages, of tuberculous hypodermatitis or peritonitis or of intraperitoneal adhesions. Here in the author's material there was no instance of suspicion of a nutritional allergic etiology for the manifestations.

The second subgroup comprises apparently gastrointestinal affections, and the third comprises the cases of achylia gastrica, without any evidence of allergy.

The remaining 3 groups consist respectively of cases of gastritis, enteritis, and colitis in which the incidence of positive skin tests was somewhat greater than in the control group although not sufficient to constitute a statistically demonstrated difference. In none of these groups could allergy play a predominating role as an etiologic factor. In these patients there is usually a discrepancy between the subjective and objective manifestations. The patient complains of severe pains with little or no pain on pressure, and the defense musculature is slight or absent. The temperature is normal or but slightly elevated. It may however exceed 39 degrees. A moderate amount of leucocytosis may be present, but an eosinophilia will seldom accompany the acute attack.

Finally the author reports an apparent instance of pancreatic irritation which seemed to have been caused by nutritional allergy, however he does not consider it of sufficient import to have any bearing on the subject here treated. This case and a few other experiences are considered of value for further studies on the subject of nutritional allergy in surgical abdominal conditions, and the author recommends especially that attention be given to the selection and employment of more reliable allergens.

JOHN W. BRESNAHAN, M.D.

Bell, H. G.: The Treatment of Cardiospasm by Esophagogastrostomy. *Surgery* 1946 20 104.

The etiology of cardiospasm is still in dispute. Comparatively few cases are reported in which an operation was performed in an attempt to relieve the condition.

Dilatation is the simplest procedure and should always be given a trial. Of the operative procedures esophagogastrostomy seems the most logical. The author reports on 10 such procedures. The results were very satisfactory; there were no deaths and 8 of the 10 patients received complete relief. Two patients required subsequent operations.

In the last 2 cases the flaplike valve action of the redundant posterior wall of the anastomosis caused the persisting symptoms. A method of correcting this in which a stitch is used to anchor the posterior wall of the anastomosis to the posterior wall of the stomach is described. F J LESKMAN JR., M.D.

Grimson K. S., Reeves, R. J. Trent J. C., and Wilson, A. D.: The Treatment of Patients with Achalasia by Esophagogastrostomy. *Surgery* 1946, 20 94.

Progressive dysphagia and starvation occasionally necessitate surgical intervention in cases with derangement of function of the lower esophagus.

The authors report on a series of 9 cases in which an esophagogastrostomy was performed on patients with achalasia. A transabdominal approach was utilized, the esophagus was mobilized and care was taken to bring down the dilated segment of the esophagus. Incisions were made into the esophagus and fundus and an anastomosis was performed. There were no operative mortalities in the 9 cases. The cases exhibited marked improvement.

The theories of causation of the disorder are discussed. The authors believe that the esophageal

dilatation is secondary to the chronic obstruction and not idiopathic. Cases in which a sympathectomy was performed for hypertension revealed no disturbance of esophageal function. Similarly, cases in which a vagotomy for peptic ulcer was performed revealed no disturbed function. The authors believe that the myenteric plexus easily controls motility by itself and may be only partially regulated by sympathetic and parasympathetic impulses. The fundamental pathology may reside in lesions of the myenteric plexus. F J LESKMAN JR., M.D.

Walters, W.: Diverticula of the Stomach. *J Am Med Assn.* 1946 131 954.

Five cases of diverticula of the stomach were presented. All the patients concerned had symptoms of severe dyspepsia which had led them to seek medical and surgical treatment. Two of the patients had been managed on a medical regimen for peptic ulcer prescribed elsewhere. In the belief that a gastric ulcer was present in 1 case, and a duodenal ulcer in the other.

In each case roentgenological examination of the stomach at the Mayo Clinic revealed the presence of a diverticulum. Gastroscopic examination was performed in but 1 case. In another case it had been performed elsewhere before the patient came to the clinic. In 1 case the diverticulum was not found at the first operation but since the symptoms persisted a second operation was performed at which time the diverticulum was found and removed. Four patients were relieved of their symptoms of epigastric pain after removal of the diverticula. The diverticulum of a fifth patient was inverted and comparable relief was obtained thereby.

In all cases the diverticula extended from the posterior wall of the stomach, just off the lesser curvature. In 4 cases the surgical approach to the area

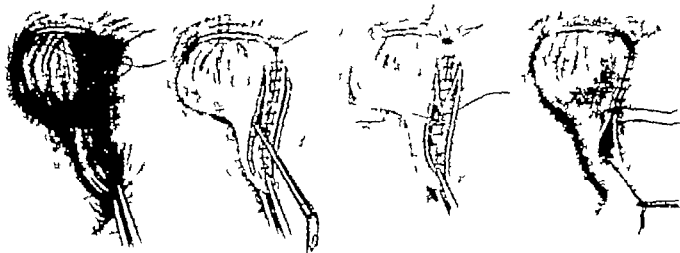


Fig. 1. (Grimson, K. S. et al.) The drawings illustrate the importance of extending the incision for esophagogastrostomy or cardioplasty through the stomach and small lower esophagus into the enlarged portion of the esophagus

to insure adequate drainage. Section, rather than the use of temporary clamps or ties about the esophagus, facilitates upward extension of the incision.

in question was made by dividing the gastrolleal ligament and the gastrocolic omentum which permitted exposure of the diverticulum by drawing the fundic end of the stomach downward and toward the midline. In 1 case the diverticulum was approached through the gastrotrophic omentum. In the fifth case, the presence of multiple blood vessels in the wall of the diverticulum, plus the inflammation present in the diverticulum as a result of the retention of food, undoubtedly accounted for the hemorrhagic episodes.

Retention of food in the diverticula undoubtedly produces gastrospasm this plus the diverticular gastritis, accounts for the pain.

Naturel G.: Fibromas of the Stomach (Un fibroma del estomago) *M. J. Med. T.* 1946, 31

The author describes a case in which a true fibroma of the stomach was accidentally found at autopsy. In reviewing the literature he describes tumors of the stomach which, by their location, symptomatology and complication suggest malignancy and for this reason are usually treated surgically and radically.

Benign tumors of the stomach in contrast to the malignant ones, are rare and were considered exceptional up to some time ago. In spite of the progress in diagnosis the pathologic-anatomical literature remains scarce. In the world's literature 6 fibromas were reported in 1929, 14 in 1932, 22 in 1937, 40 in 1932 and 63 in 1941 in contrast to the notable number of myomas (386) and papillomas (316). In order of frequency the true fibromas come after the myomas, papillomas, and adenomas.

Fibromas of the stomach are interesting because of their rarity and because of their clinical symptomatology which very often simulates that of a malignant tumor and misleads the clinician, radiologist and surgeon. Diagnosis of benign tumors of the stomach is rather difficult because the clinical, objective and objective symptoms are common to other stomach affections (gastritis, ulceration, carcinoma) and only by the histological examination can we arrive at a correct diagnosis.

The author describes a case of true fibroma of the stomach found accidentally at autopsy in a patient who died from pneumonia. He gives the pathologic (macroscopic) and histological (microscopic) description and states that the tumor originated from the submucous connective tissue solely. According to the literature the fibroma of the stomach is usually rounded or oval and of a firm elastic consistency it varies in size from that of a nut to that of an adult head, the average being that of a hen's egg, it is often pedunculated, its weight varies with its size reaching as much as 5500 gm. and its surface is smooth or slightly irregular and broken which gives it a tendency to ulcerate. On section the surface is a pallid gray, the tendonlike reflections revealing tortuous undulating bundles with connective tissue fibers. This tumor is generally found in men of middle age.

The lipoma may be differentiated by its softness and yellow color, the myxoma by its special consistency and gelatinous transparent aspect, the angiosarcoma by its richness of vessels and the sarcoma by its red berry color and scarcity of connective tissue fibers, which differentiates it from the fibromas or myomas. Hematomatous tumors cannot be differentiated easily at operation. The tuberculous and leucic granulomatous form cannot be differentiated at the light from true tumors and frequently only a histological examination will lead to their correct diagnosis.

G. ALVAREZ LITA, M.D.

Gasper J. B., and Vidal-Colomer E.: Thread Employed as Suture Material in the Stomach: Is the Possible Cause of Postoperative Complications (Los hilos de sutura gástrica como posible causa de complicación postoperatoria) *Rev. op. y ginec.* 1946, 5, 213

This article concerns 4 cases in which some form of surgical treatment for ulcers had been done and in which a recurrence of the subjective symptoms took place subsequently.

X-rays showed the presence of an ulcer and gastroscopic examination revealed the association of first operation.

The patients were operated upon by different surgeons and the technique employed was different in each case. The gastroscopic appearance of the lesion and the proximity of the thread demonstrated the causal relationship beyond doubt.

STEFAN A. ZIEGLER, M.D.

Blain A., III and Kennedy J. D.: The Effect of Penicillin in Experimental Intestinal Obstruction. *Bull. Johns H. Hosp.* 1946, 19, 1

In this experimental study on 30 dogs, a simple intestinal obstruction was produced by division of the ileum and closure of the ends. Strangulation of a portion of the proximal part of the ileum was produced by ligation of all the veins over a 60 cm. length of bowel and ligation of all vessels over a short segment of this portion.

All dogs received blood transfusions routinely following surgery and these were repeated as indicated by frequent hematocrit determinations. Saline solution was given in sufficient quantities to prevent hypochloremia. Gelatin solution was given if the hematocrit rose despite the administration of saline solution.

Ten of these dogs received no further treatment and survived from 16 to 35 hours. Pathologically the bowel was swollen and contained blood (unless perforation had occurred). The peritoneal cavity contained from 500 to 2,000 c.c. of a bloody transudate resembling blood serum with a hematocrit between 12 and 15. Ulceration and necrosis of the bowel wall were marked.

The other 10 dogs were treated with massive doses of penicillin in addition to the treatment outlined

above. One dog died in 26 hours while 9 were protected for 50 hours or more, and 8 for 72 hours or more. Two dogs were subjected to resection and side-to-side anastomosis after a period of 72 hours and were cured.

The bowel at autopsy in the penicillin treated group was generally thick and firm instead of friable as in the control group. Microscopically there was hemorrhage necrosis and ulceration. In some dogs some healing was seen less infection was present otherwise the findings were identical with the control group.

Careful and complete blood chemical studies were made and reported. Bacteriological studies showed that the same organisms were present as at the time of operation in both groups.

The authors conclude that penicillin in massive doses prolongs life in strangulated ileal obstructions for a limited period of time. A plea is made for antibacterial therapy in all cases of strangulated obstructions or cases in which strangulation cannot be ruled out preoperatively but as an adjunct to and not as a substitute for early and adequate surgical procedures.

THOMAS C. DOWGLASS, M D

Bohmansson G. The Problem of Surgical Arrest of Massive Hemorrhage in Peptic Ulcer. *Acta chir scand.*, 1946, 94 362

Widely divergent opinions are still held by the advocates of active surgical intervention on the one hand, and those who recommend expectant medical treatment on the other, in the treatment of acute hemorrhage due to peptic ulcer.

The author's observations are based on over 200 cases of hemorrhage due to ulcer which were submitted to operation during the acute stage of the hemorrhage. The author considers the factors which should be borne in mind in deciding for or against operation. After reviewing the work of Meulengracht, he believes that although the mortality was only 1 per cent, the primary material was not classified according to the severity of the hemorrhage and it is therefore not directly comparable with that in other statistical surveys.

Treatment with food, fluids and blood transfusions has considerably improved the prognosis in cases treated conservatively. A typical example is cited in the statistics from Orebro Sweden since 1939, when the benefits of this form of therapy were recognized. The percentage of cases of manifest hemorrhage treated operatively has dropped from 45 per cent to 7 per cent since that time. The choice of therapy whether operative or conservative was determined by the joint decision of both the internist and the surgeon. Although treatment by conservative methods is certainly of great value, there always remains a category of cases in which medical therapy is helpless but in which radical surgical intervention offers a chance of saving the patient's life and preventing another fatal hemorrhage. Even the devoted followers of the Meulengracht method recognize this fact.

It is generally agreed that operation should not be undertaken in cases of occult hemorrhage in cases in which manifest hemorrhage does not affect the general condition of the patient in the form of shock or severe anemia nor in those cases in which bleeding can be checked promptly by medical treatment. There are certain general or special contraindications to any form of surgery which should also be considered here. Surgery is contraindicated in conditions such as cerebral hemorrhage severe kidney disease, marked senility heart failure and so forth.

The author delineates two groups of cases in which he recommends that operation be considered in order to prevent further hemorrhage.

1 Cases in which the roentgenogram reveals a niche, in which there has been previous perforation or in which a definite diagnosis of callous ulcer has been made at an earlier date and which exhibit one of the two following characteristics (a) serious periodical hemorrhages in the course of treatment with diet, and (b) severe anemia with continuous hemorrhage and decreasing serum protein levels.

2 Cases in which hemorrhage brings the blood levels below the shock threshold and in which it is difficult to raise the blood pressure with transfusions.

Relief from shock is the first step. This is accomplished by means of large blood transfusions lowering the head of the bed and the administration of oxygen. Protein infusions may be used when hypoproteinemia is present.

The objective of the operation is exact hemostasis resection or excision, and the prevention of further hemorrhage. Palliative operations are of no value. Surgery should be undertaken as soon as possible after shock has been treated to avoid the danger of another hemorrhage. The author uses Bilroth's I or II procedure under spinal anesthesia. Repeated blood transfusions to combat the anemia are given postoperatively. The serum protein levels and carbon dioxide level are carefully checked and the parenteral supply of fluid is gauged according to the needs of the patient. Oral feedings are instituted as soon as possible by giving strained foods with a high vitamin and high protein composition including oral amino acid preparations. The toxic effect of residual blood in the alimentary tract is counteracted by avoiding hypoproteinemia and thereby restoring the intestinal function as quickly as possible. The danger of incomplete healing along the line of suture due to edema of the intestinal wall is obviated by keeping the serum protein level within normal limits at all times.

The following succinct sentences from Bohmanson's article are worthy of quotation as a rule the internist prefers to postpone operation as long as possible while the surgeon favors operating as soon as possible. Therefore in the interest of the patient the two each knowing his own and the other's possibilities as well as limitations, should co-operate and shoulder the responsibility jointly. It would seem that the internist's objective should be not to lose any cases postoperatively because operation is done

too late, while the surgeon's aim should be to operate only in cases where there are vital indications for operation and to be able to justify his decisions against operation by autopsy material from the medical service. These objectives are difficult to attain but are well worth the effort.

The results of this program are as follows:

The total mortality for manifest hemorrhage has decreased from 9.1 per cent in 1939 to 5.1 per cent. The number of cases operated upon has decreased from 45 per cent to 7 per cent of the total. The mortality for conservatively treated cases has decreased from 6 to 5 per cent while the postoperative mortality has dropped from 13 to 5 per cent.

HAROLD LAUFMAN, M.D.

Cummins, G. M., Jr., Grossman, M. L., and Ivy, A. C. A Study of the Time of Healing of Peptic Ulcer in a Series of 69 Cases of Duodenal and Gastric Craters. *Gastroenterology* 946, 7 20.

The determination of "healing time" of peptic ulcer is important, in a practical sense, for the evaluation of new methods of treatment and for judgment of the efficacy of treatment in an individual case, and it is important theoretically for a comparison of the healing power of peptic ulcers in man and in lower animals. A review of the literature reveals that accurate data on the rate of healing are not available. The healing time judged by the time of disappearance of the crater radiologically as was done in this series, has its limitations of interpretation. The data on the estimation of the healing time for a series of 63 duodenal and 6 gastric craters are presented. The average "healing time" for the former group was 37 days and for the latter 43 days, by x ray. The treatment time of x ray examinations and roentgen studies were standardized as much as possible. A comparison was made of the estimation of healing time by x ray and gastroscopy in gastric craters. No correlation was found between the healing time and the size of the crater, age of the patient, recurrence, or the duration of symptoms.

Chronic duodenal or gastric ulcers in man usually heal rapidly under conditions of strict medical management. This observation is of great significance in the light of experimental observations on animals, and its implications have hitherto been unrecognized. When the healing time of an experimental excision ulcer of the pyloric or duodenal mucosa of the dog is compared with the usual rate of filling of a crater of a duodenal or gastric ulcer in man under strict medical management, the difference is not striking. Similarly the healing time of an excision ulcer of the stomach of the rabbit on rough food is comparable to the filling time of the crater of a gastric ulcer in man. There are actually only two differences between the healing of an excision ulcer in the dog and the healing of a "chronic" peptic ulcer in man. One is that in most ulcer patients favorable conditions are required for prompt healing; the second is that in some ulcer patients the lesion heals very slowly and occasionally perforates or erodes a

blood vessel even under favorable conditions. These two factors are related to the striking tendency of peptic ulcer in man to recur after it has healed.

CHARLES BARD, M.D.

Shapiro, A. L. and Robillard G. L.: Morphology and Variations of the Duodenal Vasculature; Relationship to the Problems of Leakage from a Postgastrectomy Duodenal Stump, Bleeding Peptic Ulcer and Injury to the Common Duct. *Arch. Surg.* 946, 5 571.

After a rather complete review of the literature on methods of closure of the duodenal stump in gastrectomy or pylorotomy, the authors conclude that the most prevalent complication is leakage of the stump. This complication is believed to account for the largest part of the mortality ranging from 2 to 30 per cent, which is reported for this operation. It is noted that the recent literature on techniques of duodenal mobilization prior to closure stresses the necessity of adequate freeing of the duodenum from the pancreas. The authors found only two brief comments on the possibility that this procedure might devascularize the duodenal stump and thus defeat the purpose for which the technique was designed.

In addition to reviewing the descriptive literature on the anatomy of the duodenal vasculature, the authors dissected 62 bodies. The supraduodenal artery was present in 70 per cent of the specimens but was of small size. This vessel is practically always ligated in the course of gastrectomy. In 55 per cent of the cases the large anastomotic arcade between the superior and inferior pancreaticoduodenal vessels representing a connection of the celiac axis

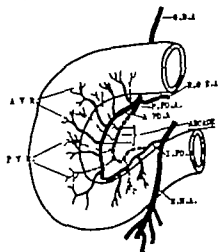


Fig. 1. The peripancreatic pancreaticoduodenal arterial arcade. This was present in about 75 per cent of the cases. G.D.A. indicates the gastroduodenal artery; R.G.E.A. the right gastroepiploic artery; P.P.D.A., the posterior pancreaticoduodenal artery; A.P.D.A., the anterior pancreaticoduodenal artery; I.P.D.A., the inferior pancreaticoduodenal artery; S.M.A., the superior mesenteric artery; A.V.R., the anterior vasa recta, and P.V.R., the posterior vasa recta.

Fig. 2. Common variants in pancreaticoduodenal arterial circulation. Left, Anterior arcade partly complete, with inferior pancreaticoduodenal and postero-pancreatic arteries branching (present in about 15 per cent of the cases). Right, Mesenteric arcade and branching pattern (present to some extent in 10 per cent of the cases). G.D.A. indicates the gastroduodenal artery; A.S.P.D.A., the anterior superior pancreaticoduodenal artery; P.S.P.D.A., the posterior superior pancreaticoduodenal artery; R.G.E.A., the right gastroepiploic artery; L.P.D.A.A., the inferior pancreaticoduodenal artery and S.M.A. the superior mesenteric artery.

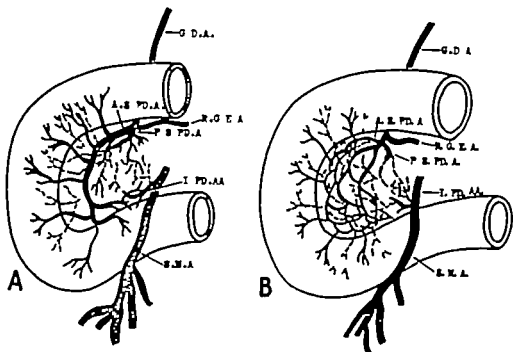
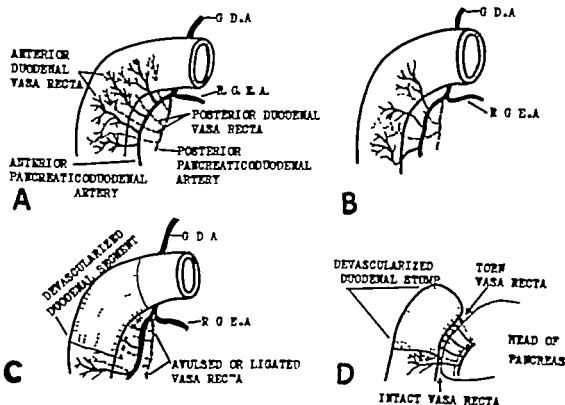


Fig. 3. Variations in configuration of the vasa recta at the region of the duodenal stump. A, Usual pattern. B, Widely spaced "blow-out" pattern. C, Devascularization of the duodenal segment by avulsion of the ramal duodenales in separation of the duodenum from the head of the pancreas. D, Extent of devascularized duodenal stump susceptible to ischemic necrosis resulting in many commonly adopted procedures for gastrectomy.



with the superior mesenteric artery was present (Fig. 1). In 35 per cent of the specimens a complete arcade was absent. In 15 per cent the superior pancreaticoduodenal vessels were well represented but large connections with the inferior pancreaticoduodenal vessels were lacking (Fig. 2 left). In 10 per cent neither the superior nor the inferior pancreaticoduodenal vessels were well developed and the anastomosis was even less prominent (Fig. 2 right). Anomalies were noted in the origin of the pancreaticoduodenal vessels and were carefully described

The configuration of the vasa recta of the region of the duodenal stump is described and well illustrated (Fig. 3) to show the effect of ligation of these end arteries during mobilization of the duodenal stump.

The arterial supply of the common bile duct was carefully worked out and illustrated. Injuries to these end vessels might well result in localized ischemic necrosis and later unexpected stricture or fistula.

The necessity for minimal surface exposure



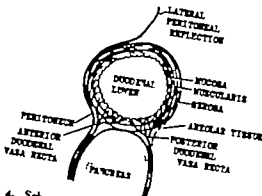


Fig. 4. Schematic cross section of the duodenum and vasa recta, demonstrating the end artery character of the vasa recta. This indicates the absence of major marginal or intramural anastomotic branches

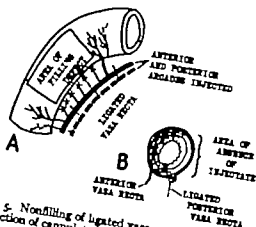


Fig. 5. Nonfilling of ligated vasa recta of the duodenum on injection of cannulated adjacent arcades and vasa recta. Experimental demonstration of the end artery character of the vasa recta. Left, Longitudinal segment. Right, Cross section.

In operations on this structure is stressed. The cur- culation of the pancreas is briefly reviewed.

The utility of ligation for the control of hemorrhage from a duodenal ulcer is demonstrated by an illustration which shows that such a procedure is tantamount to complete devascularization of the duodenum and head of the pancreas.

The vasa recta of the duodenum were injected with India ink to show their character as end arteries and the lack of intramural or marginal anastomoses (Figs. 4 and 5). This finding agrees with that of other workers on this subject.

The literature on the safety factor in mesenteric ligation is reviewed.

In conclusion the authors point out the similarity between the incidence of poor anastomosis of the duodenal vessels and that of duodenal leakage. In version of the freed duodenum to the point of pancreatic attachment so that intact rami duodenales may provide an intact intestinal circulation is suggested.

THOMAS C. DOUGLASS, M.D.

Cave, W. H.: Duodenal Injuries. *Am. J. Surg.* 1945, 73: 26.

The author reports 118 cases of duodenal injury with a mortality of 55.9 per cent in the first 10 days. The site of the wound of entry was fairly consistent, the missile entering the right side of the trunk, either front or back, in 85 per cent of the cases. The patients who died were in a more severe state of shock upon entry than those who recovered. In more than half of the deaths shock and hemorrhage were the recorded causes of death. Two fatalities resulted from peritonitis due to injuries overlooked at operation, one resulted from a laceration of the common duct and the other from a perforation of the third portion of the duodenum. An important finding was the factor of multiple complicating lesions, which usually the case in duodenal injuries. In only 3 cases did the damage involve the duodenum alone. It was shown that the mortality was doubled in the presence of 3 complicating injuries and tripled in the presence of 4. In 9 cases there was laceration of the vena cava with 8 deaths. There were 2 cases of portal vein laceration, 2 of laceration of the pancreaticoduodenal artery and 1 each of laceration of the hepatic and right spermatic artery. All of these cases terminated fatally.

There is a fairly constant wound pattern when the duodenum is injured. For example, if it is a wound of the right upper quadrant that has involved the right kidney, liver and right colon, injury to the duodenum is quite likely. Pancreatic injury occurred in 9 cases with 8 deaths. Fat necrosis was a marked feature in 1 case, both at operation and necropsy. The gall bladder was injured in 19 cases, and cholecystectomy was necessary in 8. Fifteen patients had associated chest injuries. Damage to the blood supply of the right side of the colon was not an infrequent finding in this series; right colectomy was required in 3 cases.

After repair of the laceration or transection of the duodenum, the site of repair was drained in most of the cases and the peritoneum was closed over the wound. Two duodenal fistulas developed, both occurred in cases of transection of the duodenum with end-to-end anastomosis.

It is obvious from this report that duodenal injuries carry a high mortality and too much stress cannot be placed upon the advisability of thorough exploration of the duodenum in cases in which there is any possibility that the missile has perforated the retroperitoneal space behind the right colon. At curate exploration can be done only by reflecting the right colon.

HAROLD LUTTMAN, M.D.

Fallis, L. S., and Warren, K. W.: The Surgical Treatment of Jejunal Ulcer. *Am. J. Surg.* 1944, 7: 4.

Some 15 per cent of the patients undergoing gastroenterostomy develop jejunal ulceration. All of the jejunal ulcers appear opposite the stomach or in the efferent loop. A patient who suffers a rupture of a postoperative jejunal ulcer will have had, in many

stances a former perforation of a gastroduodenal lesion. It would appear that some patients exhibit not only an ulcer forming diathesis but equally important a perforative tendency. The serious complications of jejunal ulcer are hemorrhage free perforation and gastrojejunal fistula.

Intensive medical therapy is tried in almost every instance of jejunal ulceration but the response is generally poor and most of the victims are subjected to surgery without undue delay. In addition to the usual preoperative preparation for gastric resection it is important to cleanse the colon thoroughly because the jejunal ulcer may be adherent to the colon and this organ may have to be opened in the course of the operation.

The authors technique consists in detaching the transverse mesocolon from the anastomotic area and then resecting the involved portion of jejunum containing both the anastomotic site and the ulcerated area with its adjacent mesentery. If the previous operation has been a gastroenterostomy subtotal gastric resection is then performed in the usual manner. Isoperistaltic retrocolic terminolateral gastrojejunostomy is then completed with the anastomosis lying distal to the restored jejunum. Peritoneal soiling is limited by using a closed technique.

HAROLD LUTWACK, M.D.

Bray, E.: Invaginations of the Haustra of the Cecum (Le invaginazioni delle haustra del cieco) *Minerva med. Tor.*, 1946 1 213

The author cites and describes 6 cases of invagination of the haustra of the cecum—the highest number of cases coming under the observation of one man—in the period from 1940 to 1945. Research into the records revealed only 40 cases published up to the present time. The author states that this morbid form apparently escapes the clinical diagnosis being frequently mistaken for acute appendicitis and that at operation the rarity of the affection is more apparent than real. He describes the clinical data that may suggest invagination of the haustra and advises that the examiner should keep the condition in mind to avoid its being unrecognized during surgical intervention.

The affection is relatively rare and must be recognized by the examiner. The author cites 6 cases under his observation admitted as acute appendicitis in which invagination of the cecal haustra was found at operation; the appendix was relatively normal or secondarily involved in edematous pathology.

Various predisposing causes for this condition were given: mobile cecum, ulcerations, foreign bodies, the presence of oxyuris, inflammations and circumscribed spasms, modifications of intestinal peristalsis caused by a parietal lesion or the beginning of more progressive invaginations.

The symptomatology has few characteristic elements and usually causes the cases to be referred to the surgeon as acute appendicitis. The onset is often sudden with cramplike pain at times becoming continuous and referred to the epigastric perium-

bilical zone or right lower quadrant. Vomiting is not constant. The temperature is normal or slightly elevated. The pulse is usually good. The abdomen is generally soft or one may find a certain resistance in the right lower quadrant. Presure elicits pain at McBurney's point or a bit higher and one may at times palpate a more or less defined and tender mass.

As a rule the surgeon does not make a preoperative diagnosis but he may suspect the condition clinically by the rapid appearance in the iliocecal region of a tumefaction of doughy consistency, which is painful and tender to pressure accompanied by cramplike pain but no fever.

At operation if the parietal peritoneum appears more edematous than red if a bloody serous discharge is encountered and if the cecal wall is edematous the surgeon is cautioned to expose the cecum and search for its invagination.

At times the roentgenological examination may be of value. The diagnosis is based on a defect in the filling of the cecal wall at the expense of one or more haustra usually on the external cecal border.

G. ALBIN LIVA, M.D.

Kay J. H. and Lockwood J. S.: Experimental Appendicular Peritonitis. The Prognostic Significance of Certain Hematological Factors, Especially the Prothrombin Time. *Surgery* 1945 50 36

Although there has been a definite reduction in the mortality from appendicular peritonitis since the introduction of new chemotherapeutic agents there has remained considerable uncertainty as to whether the apparent reduction is due to chemotherapy or to improvements in ancillary methods of treatment, such as maintenance of fluid, electrolyte and blood requirements and intestinal decompression. Because of the importance of peritonitis as a cause of death in penetrating wound of the abdomen the problem was of sufficient wartime importance to study the basis of chemotherapy in the light of the new advances in our understanding of the pathogenesis of morbid changes.

The authors produced necrosis of the appendix in dogs by ligation and studied the animals from the standpoint of various chemical and pathological tests. Peritonitis was produced in or control animals with a mortality of 41 percent. The majority of deaths occurred between 24 and 48 hours.

Nonprotein nitrogen level averaged 36 in the living group of animals and 46 in the dying group. Total protein concentrations showed a fall on the third postoperative day in the survivors, a fall coincident with hemorrhage. During the acute stage however there was no significant difference between these values in the surviving and dying animals. Chloride determinations were obtained on animals which received intravenous fluids as well as on those which took fluids orally. There was a real correlation between the chloride level and the outcome of the fatal cases. Serum chloride was low level also however in the survivors.

the two groups. Bacteriological examinations revealed that the pathogens occurred with almost equal frequency in the exudates of animals which survived and of those which succumbed. Further tests of the red blood count, white blood count, and hemoglobin showed no differences of significance in the dogs surviving and dying, although these values followed a typical course.

The only significant finding was the observation that blood taken during the crisis of peritonitis did not clot readily and when it did clot it was in the nature of a soft thrombus and clot retraction did not occur. Prothrombin time determinations were made at 24, 48, and 72 hour postoperative periods. It appeared that animals whose prothrombin times were consistently normal survived whereas animals whose prothrombin times were prolonged as much as 3 or 3 seconds at the 24 and 48 hour periods tended to die. An occasional animal in the latter category survived but remained in poor condition until the prothrombin time had returned to normal. Further more there appeared to be a relationship between prolongation of the prothrombin time and the severity of respiratory distress. As a result of this finding chest roentgenograms were taken at various periods. These indicated that there was a definite association between the onset of pulmonary disease and the development of prolongation in prothrombin time.

The prolongation in prothrombin time appears to be related to the failure of the clotting mechanism in the blood of animals dying of peritonitis and to the occurrence of hemorrhagic changes in the peritoneum, liver and lungs of many of these animals. Experiments with protamine indicate that it is unlikely that heparin is responsible for this finding. One obvious explanation is the development of severe injury to the liver parenchyma from anoxia or bacterial toxins. It is suggested that this mechanism may be a disturbance in the equilibrium between circulating proteolytic and antiproteolytic factors. The study of the physical properties of blood in peritonitis indicate that the disease may be separated roughly into 4 stages and that these properties change from one stage to another. It appears that changes in the prothrombin time not only reflect the various stages of the disease but also seem to be of prognostic value even before the onset of the disease.

HAROLD LAUTMAN, M.D.

Ricketts, W. E., and Palmer, W. L.: Complications of Chronic Nonspecific Ulcerative Colitis. *Gastroenterology* 1946, 7: 55.

In a series of 306 cases of chronic nonspecific ulcerative colitis, complications were present in 64 (21.06 per cent). The complications were classified into five groups: (1) those involving the colon itself; (2) those involving adjacent structures; (3) those distant from the colon; (4) complications resulting from deficient nutrition; and (5) a miscellaneous group. The complications in the first group may be listed as follows: polyps in 21 cases (10.0 per cent) stric-

ture in 8 (3.9 per cent) obstruction in 6 (2.9 per cent) and carcinoma in 3 (1.4 per cent). Hemorrhage occurred quite frequently but there was no fatality from this cause. Ulcerated hemorrhoids were noted in 13 cases (6.8 per cent).

In the second group internal or external fistulae were found in 9 cases (4.4 per cent). Perforation with peritonitis was observed in 7 (3.4 per cent).

Complications distant from the colon were as follows: lesion of skin and mucosal surface in 10 cases (10.64 per cent), arthritis in 12 (5.83 per cent), venous thrombosis in 4 (1.94 per cent), hepatitis in 1 case (0.48 per cent) and septic infection in 17 cases (13.10 per cent).

Listed among the complications derived from deficient nutrition were malnutrition and anorexia although the incidence and severity of the condition could not be determined. In a subgroup of 23 children there were 3 cases of infantilism, an incidence of 13.1 per cent. Peripheral neuritis, an incidence in 3 cases (1.45 per cent).

A miscellaneous group of complications included several conditions, viz. pleuritis in 2 cases (0.97 per cent) and endocarditis in 3 cases (0.94 per cent).

CHARLES BROWN, M.D.

Silani, C.: Suppurative Perisigmoiditis (Subperisigmoiditis suppurative). *Arch. Ital. Chir.* 1945, 67: 130.

Four cases of suppurative perisigmoiditis are reported by the author. 3 of the patients were males and 1 was a 9 year old girl. In 3 cases abscesses formed in the anteroinferior portion of the left iliac fossa and in 1 case the abscess was located in the retroiliac region. In 3 cases an incision and drainage of the abscess were done according to Roux's method while in the fourth case the pus drained spontaneously through the intestinal tract. All 4 patients recovered. The condition may be acute or chronic. The acute type may assume a plastic or suppurative form and the latter may or may not cause a perforation. Two types of chronic perisigmoiditis may be distinguished: stenosing, plastic, and pseudotumoral. The condition may follow a trauma or may be the sequel of diverticula.

Pain fever and symptoms of peritoneal irritation are usually present. Differential diagnosis must be made from suppuration originating in the female genital organs, tuberculous peritonitis, appendicitis, abscess.

Röntgenological examination is essential for the diagnosis. Perisigmoiditis creates an image of intestinal stenosis with a smooth outline generally seen. The prognosis is usually favorable. External or internal fistulas frequently form and establish communication with the intestines, urinary bladder or vagina.

The treatment is surgical. A simple incision and drainage is sufficient unless perforation of a diverticulum is present when resection of a portion of the sigmoid may be required. JOSEPH E. NUGENT, M.D.

Torr, J., and Campos, E.: Surgical Treatment of Cancer of the Rectum and Sigmoid (Tratamiento quirúrgico del cáncer del recto y sigmoides) *Arch. cubanas cancerol.* 1946 5 34

The authors advocate a 1 stage abdominoperineal operation for cancer of the rectosigmoid region. They prefer an artificial anus in the iliac region to perineal colostomy. Urographic studies should be made in every case before the operation is performed because they may reveal a double ureter or another anomaly of the urinary tract.

In obstructive cases Devine colostomy is recommended.

The authors stress the importance of proper pre-operative treatment.

One operative team is sufficient. The perineal resection requires little time if the abdominal dissection has been done in the proper manner.

The operation is usually performed by the authors under spinal pantocain anesthesia and a blood transfusion is given during the procedure.

The resection should include the sigmoid rectum anus with its sphincter levator ani ischioanal fat mesosigmoid and pelvic peritoneum. The preoperative introduction of ureteral catheters is highly recommended because it contributes to the avoidance of lesions of the ureters.

It is important to suture the free border of the mesosigmoid to the abdominal wall to avoid the possibility of a hernia in the region of the colostomy.

Sim's position is recommended by the authors for the perineal resection. JOSEPH K. NARAT, M.D.

Yódice, A. R.: Surgical Treatment of Cancer of the Rectum (Tratamiento quirúrgico de cáncer del recto) *Arch. Soc. cir. hosp., Santiago* 1946 16 123

This article is an excellent résumé of the surgical management of rectal cancer. It presents the history of the operative treatment and the various techniques involved and relates the historical development of the three approaches—the perineal, abdominoperineal, and abdominal—employed in surgery for carcinoma of the lower bowel. Palliative treatment is reviewed under the title of colostomy which appears to have been used exclusively in the beginning and is retained to the present day as a preparatory step to any definitive surgery for bowel cancer.

The historical summary may be appreciated from the following outline:

1. Palliative treatment—colostomy cecostomy, Pilleore 1776 lumbar colostomy Amussat 1839 and abdominal colostomy Allingham 1875

2. Curative treatment—resection via perineum, Koenig 1882 with previous abdominal colostomy. Resection amputation of rectum and adjacent tissue Lisfranc, 1826 sacral resection opening through peritoneum and sacral anus Bard enbeur 1880, and Kraske, 1885 perineal resection removing stump of sigmoid after abdominal colostomy Lockhart Mummery 1908 Resection and anastomosis end to-end anastomosis Kocher 1875

via vagina Desquins 1890, and Murphy Tuttle 1900 via anterior perineal route Cuneo, 1908 and by means of a glass tube, Lockhart Mummery 1908. Also anastomosis at different times Mikulicz Kattner 1910 Resection from below through the anus preserving the sphincter Dieffenbach 1845 and via the terminal rectum pull-through or invagination Hochenegg 1888.

Curative treatment—resection exclusively through abdomen. Resection and anastomosis in different stages exteriorization and double-barreled colostomy Block, 1892 and Mikulicz, 1902 previous rectal mobilization Schoeffler 1903 and single-stage resection with double barreled colostomy Paul 1895 Resection and anastomosis per primam open method Reybard, 1833 and Dixon with colostomy preceding closed, or aseptic method Soulingoux 1896 and Wangenstein without previous colostomy. Resection and definitive abdominal colostomy closure of distal stump Hartmann 1923.

Curative treatment—resection via abdominoperineal route. With definitive abdominal colostomy Single stage—Miles 1908—extensive amputation of the rectum and mesosigmoid and Gay Turner 1934—preceded by perineal resection. Two-stage—Cooley 1915—(1) definitive abdominal colostomy and invagination of inferior barrel for rectal traction and (2) perineal resection D Jones 1915—(1) mobilization of sigmoid and pelvic peritonealization with abdominal sigmoidostomy superficial and (2) perineal amputation Turner and Rankin 1931—(1) definitive abdominal colostomy with closure of distal barrel and (2) perineoabdominal extirpation Lahey, 1930—(1) definitive abdominal colostomy with division and separation of the barrels and (2) extirpation, abdominoperineal.

Also resection and low end-canal—Maunsell 1892—mobilization abdominal after Dieffenbach, and low perineal, after Hochenegg and resection and end to-end anastomosis—Volkman and Kocher—abdominal mobilization and perineal anastomosis.

Significant factors which must be considered in any surgery for carcinoma of the large bowel are the patient's age, length of illness psychological background, probable surgical reaction, location of the tumor and social standing of the patient.

The author recapitulates the general knowledge regarding the surgical anatomy associated with cancer of the lower bowel presenting numerous drawings. He believes that the importance of the critical point of Sudeck is exaggerated. He thinks that the danger point is farther to the left and designates it as the dangerous sigmoidal point.

Operability depends upon the age of the lesion and the general condition of the patient at the time of first consultation and according to the author's experience as many as 85 per cent of the patients are operable.

The mortality depends upon the technique employed. In abdominoperineal resection it is between 10 and 12 per cent but since the introduction of chemotherapy this figure has been reduced to 7 per

## INTERNATIONAL ABSTRACTS OF SURGERY

cent inasmuch as peritonitis is the principal cause of death.

Operation for cancer of the lower bowel requires upon the fundamentals of surgery during the operation and intelligent postoperative therapy.

Reoperative car must include the correction of constipation and infection of the rectum and sigmoid as far as possible. The patient should be put in a position of blood transfusion and a selected dietary regimen. Twenty-four hours preceding surgery a continuous spinal anesthesia should be inserted. Steps in the judicious use of the various operative methods employed in cancer of the lower

D'Ericks, C.: *Cavernoma of the Liver*. 2 Cases Treated by Hepatic Resection (I. censored). *Arch. med.* 1946 60 168.

Two cases of cavernoma of the liver are reported both occurred in women. In the first case there was occasional attacks suggesting an acute abdomen condition a subicteric color of the skin, bile in the urine high blood urea (185 85 mm. Hg.) and an indistinct yellow color of the heart both over the apex and over the base of the thorax.

Laparotomy disclosed in addition to a somewhat enlarged gall bladder an orange sized, sessile, rather sharply delimited tumor which was nodular and of a somewhat darker color than the liver tissue itself. It was situated on the under surface of the right hepatic lobe. Sutures of heavy catgut were placed around the mass and it was excised, the resultant mass of gall bladder being covered by an epiploic flap and by the caecum.

The patient died of acute cardiac insufficiency in the fourth postoperative day and autopsy disclosed in addition to the usual findings in heart failure a postoperative paralytic ileus the enlargement of the gall bladder already noted and also a moderate double stasis.

The second patient was apparently in robust health. Her only trouble was a tumor mass in the abdomen which grew in a few months from the size of an orange to that of an adult head. Physical and laboratory methods of examination showed the tumor to have a downward curvature of the stomach to the left and downward, and the spleen upward, to the front of the colon. The mass was freely movable with respiration and of a rather firm consistency with an irregular surface.

At laparotomy the dark red neoplasm was found to be attached to the under surface of the left lobe of the liver. Interlocking sutures were used to justify the area of the tumor attachment and histological examination of the extirpated mass disclosed an angioma cavernosum. In removing this tumor a slight injury to its surface was incurred which resulted in bleeding that could be controlled only by extirpation of the neoplasm itself.

The author wishes to emphasize that this accident shows the danger to the patient of even insignificant abdominal trauma and the importance of early surgical treatment of the condition.

JOHN W. BERRY, M.D.  
D'Ericks, G.: *Hepatic Cavernoma from the Single Standpoint. Critical Review of the Literature*. 71 Operated Cases (I. censored). *Arch. med.* 1946 60 168.

None of the statistical compilations from the medical literature of hepatic cavernoma seem to have been complete. A careful study of the literature up to the end of 1930 has disclosed 69 cases of hepatic

## LIVER, GALL BLADDER, PANCREAS AND SPLEEN

Villages, J., Falcet A. and Duarte M.: *Nonparasitic Cysts of the Liver*. (I. censored). *Arch. med.* 1946 60 168.

Nonparasitic cyst of the liver is a very rare type may be unilocular or multilocular solitary or multiple and are often accompanied by liver failure. They vary in size from that of a pinhead to that of an adult head. In most cases they cause few symptoms unless they become large enough to cause pressure on the neighboring organ. If they are in the pedicle of the liver they may exert pressure on it and cause ascites or cirrhosis. The cyst content may be a yellow green red, or opaque. The fact that these cysts frequently occur in association with cysts of the spleen or pancreas or that they sometimes exist with meningococci or polydactylism suggest a congenital origin. Familial occurrence is rare but Bunting has reported a case in 3 brothers associated with polycystic kidneys. The patients are generally in good general health as the tumors are benign but late in the disease there is a depression of the general health with emaciation profound malnutrition and anemia.

The authors describe 5 cases of their own 2 in males and 3 in females. The diagnosis of these cysts is generally made only at operation, as it was in the authors' cases. In the first case the preoperative diagnosis was stenosis of the pylorus in the second, hydatid cyst of the liver in the third, the beginning of the menopause possibly associated with appendicitis or prolapsed kidney in the fourth tumor of the floating kidney cholecystitis or stones in the fifth. Excision of the cyst in 1 case. Recovery was uneventful in all of the cases.

AUGUST G. MORGAN, M.D.

cavernoma which have undergone operation. To this number the author adds the 2 cases of his own which were reported in *Riforma Medica* (1946 60 168).

On examining the entire material of 71 cases it is seen that in 81 per cent a tumefaction could be palpated in the abdomen and in a few instances a connection with the liver was indicated but in the majority no connection seemed possible. Localization showed a preference for the left lobe while in most other conditions the right lobe is involved. X-ray examination—which was done in only 6 of these patients—has proved of no value in locating the disease. A "murmur" over the tumor and changes in size have been given as the basis for diagnosis in only 2 cases; however one author noted only the absence of these characteristics of cavernoma. The symptoms of abdominal pains and digestive disturbances and even the rupture of the cavernoma have never led to the correct diagnosis; the usual condition suspected is an acute abdominal condition with subsequent operative or autopsy clarification of the condition. Although the female sex predominates (89.2 per cent) among the 56 patients of whom the sex was given and although these tumors have come to operation predominantly in the years of sexual activity pregnancy has not proved to be a clear cut factor in their etiology or development.

The prognosis is less favorable than for cases of benign tumors in general because of the complications of which the gravest is rupture of the tumor itself—spontaneously in 7 cases and during operation in 6; and because the location of the tumor renders excision difficult or impossible. In 1 case (Pozzi) rupture occurred following operation which made a total of 13 cases of rupture among which only 3 patients were saved. In 1 of the author's patients the tumor was injured at operation and the resulting hemorrhage could be controlled only by excision of the mass. Even this discussion of the prognosis does not give a true picture of the gravity of the condition since only the cases of patients operated upon are here recorded.

In 1 of the 7 cases of spontaneous rupture excision was done and in 6 direct hemostasis was attempted; there was only 1 recovery. In 5 of the 6 cases in which rupture occurred during the operation direct hemostasis was attempted with death of the patient in every instance and in the remaining case (the author's second) the patient was saved by hepatic resection.

Other methods of treatment than those cited have been roentgen therapy which resulted in a marked diminution of the tumor mass in 3 instances; injection of a sclerosing liquid (varicoelidin) in 1 case; and tamponade of the nonexcisable tumor with gauze impregnated with vivocoll (coagulating animal plasma). These offer encouraging prospects for the future but the author is of the opinion that for the present hepatic resection remains the treatment of choice in the majority of cases of hepatic carcinoma.

JOHN W. BRYAN, M.D.

Mirizzi P. L., Suárez C. V., Saravia E. C., San Martín A. F. and Others: Accidental Section of the Hepatic Ducts; Ligation of the Right Duct and Anastomosis of the Left to the Common Duct over a Vitallium Tube (Sección accidental de las ramas del hepático. Ligadura de la derecha y anastomosis de la izquierda al hepático común sobre tubos de vitallium). *Rev. Med. Argent.* 31: 1946 30 11 204.

A 31 year old woman had been suffering for 4 months from typical attack of gall stone colic. The gall bladder could not be visualized roentgenologically. At operation a Mayo incision was made under spinal anesthesia with percaine (7½ mgm.) and an enormously thickened adherent gall bladder containing numerous stones—one of which was wedged into the bladder neck—was removed in the retrograde direction. What appeared to be a shortened cystic duct was doubly ligated and sectioned. It was then noted that the hepatic duct had been ligated and sectioned at the level of the confluence of the two main and Basterreica and Medrano were called in on the case to reconstruct the bile passages. An attempt was made with a Vitallium tube of vitallium; however an assistant accidentally tore the right hepatic duct across which rendered its repair impossible. The torn duct was therefore ligated and the left hepatic duct was anastomosed to the common duct by a single vitallium tube bent at an angle of 175 degrees.

In the postoperative course there was an immediate elevation of the level of bilirubin which reached a height of 25 mgm. per 1000 c.c. of blood on the second day and then dropped to 16 mgm. from on the seventh to the twenty first day to 12 mgm. on the thirty seventh day and finally to 0 on the fifty eighth day. Except for this sign of biliary obstruction the postoperative course of the patient was perfectly normal. Considerable bilirrhagia was noted but the authors believe that this leakage came from the anastomosis rather than from the ligated duct.

The authors conclude that the case confirms the experimental hypothesis of the innocuity of ligation of one of the hepatic ducts. However they do not think that the results obtained justify the deliberate and intentional interruption of any part of the bile passages.

In the discussion SAN MARTÍN refuses to admit that the normal right hepatic duct was ligated and prefers to believe that the vessel ligated was a branch of a double duct or actually an accessory right hepatic bile duct which he admits has been reported by Descomps in 10 per cent of his cases.

However SUÁREZ believes that although the roentgenogram does appear to show that the vitallium tube might be projecting into a right hepatic duct in stead of a left one, although the cholangiographic examination with air contrast cannot be repeated because of the fact that the biliary system has been completely closed, a careful study of the details of the intervention makes it possible to admit that the theory of Basterreica is correct. This is of great

upon the fact that this surgeon is a master of his craft and has worked for 18 years with another great master, Bengolea. He believes that his affirmation can be accepted that he actually had under his hands the hepatic hilus which was totally separated from the common duct, that the possibility of suppressing a great part of the biliary secretion by ligating one or more of the hepatic ducts has been abundantly demonstrated experimentally that the compensatory hypertrophy of the remaining hepatic tissue is known to be extraordinary and that the patient's ability to live comfortably with total suppression of the external secretion of the pancreas should suggest the same possibility with reference to the hepatic gland. This discussion cites 20 instances of hepatic ducts occurred. He cites an injury to the main bile duct of the right lobe of the liver which has been suppressed as demonstrated by cholangiography and finally he demonstrates roentgenograms showing such anomalies of the biliary tract in which extirpation of the gall bladder could have resulted in other than injury to the right or possibly both hepatic ducts.

FRANKS and SEVEN declares that the cholecystectomy from the fundus to the neck of the gall bladder is less liable to such accidents as are here discussed than in doubtful cases a portion of the bladder should be left intact rather than risk such an event and that a cholecystectomy should be instituted as soon as the diagnosis of gallstones is made.

CASANO and PASMAN believe that neither type of extirpation of the gall bladder from the fundus to the neck or the retrograde type can be shown to be superior to the other and that the best method will be determined by the local conditions found at operation. Injury to the bile passages will occur with either method. Pasman points out that the neck to fundus type is relatively bloodless because of initial ligation of the cystic arteries because fundus to neck type is bloody. However he has obtained good results from the injection of adrenalin into the dissection. This method he ascribes to a suggestion made to him by Villegas.

JOHN W. BRANNAN, M.D.

Royer, M. Solari, A. V., and García, M. L.: Non surgical Cholangiography in Vesicular Lithiasis (La colangiografía no quirúrgica en litiasis vesicular). *Arch. Argent. Ciruj.* 1946, 1046.

Royer, M. Solari, and García performed non surgical cholangiography for the exploration of the intra hepatic and extrahepatic biliary passages in 1940 and presented their article in November 1941. In August 1941 Lee of Philadelphia presented a procedure which he uses to visualize the biliary tracts by injecting a radio-opaque substance into the gall bladder during peritoneoscopy but there are no published results up to the present. Royer has confirmed that the work was done simultaneously and independently

in Philadelphia and Buenos Aires. After studying the paper of Lee, Royer found that the idea was the same, however the authors are more advanced as Lee visualizes only the gall bladder and, at times, the cystic duct rather poorly. Lee agreed verily to use their technique. Royer et al. are the only ones who have used and published the method showing an integral vision of the whole biliary tree, the anatomy of the biliary ducts and roentgenograms of cholangitis. Mirizzi and Urrutia have compared surgical and non surgical cholangiography rather inadequately.

For the following reason, the authors' method is more efficient than other methods of operative or postoperative cholangiography: previous laparotomy is unnecessary and peritoneoscopy is actually less compared to surgery. A study of the biliary passages, approximating normal, may be made, no morphine or general anesthesia being necessary; there is no shock due to peritoneal trauma and therefore the normal physiology of the biliary tract can be observed; this method allows visualization of the gall bladder which is not possible with other methods of cholangiography and, last, a study of the cystic hepatic and common bile ducts may be made in the same manner as in other cholangiographies.

The method cannot be used in all cases and presents the following difficulties. If a very high or very low point is necessary for injection of the gall bladder, the immediate selection of another site is impossible or the injection must be postponed for another sitting. Injection into a much diseased and damaged gall bladder is contraindicated because of the danger of subsequent bile peritonitis and if the gall bladder is sclerotic in general, it cannot be observed or if it can be examined, injection is impossible because of nonexistent vesicular light reflex. However, these conditions are of little importance as both are indications for operation. Adhesions around the gall bladder as in the omentum or colon, prevent visualization and injection. In 23 cases the authors failed to inject the gall bladder.

Twenty seven cases were diagnosed by this method and the condition diagnosed was confirmed by operation. The method is useful in cases of obstructed gall bladder that is, when cholecystography is negative and there is no bile on duodenal sounding. Cholecystolithiasis is most probably the cause of the obstruction if in spite of the negative findings there are subjective symptoms of hepatic colic. These symptoms may be simulated by other processes, such as acute and chronic cholecystitis, external compression of the cystic duct and dyskinesia of the biliary passages.

Non surgical cholangiography makes an accurate diagnosis of these conditions, establishing the prognosis and indicating the method of treatment, whether medical or surgical. In all cases in which cholecystography and duodenal sounding do not clear the diagnosis, the author's method will enable

one to diagnose the obstructed gall bladder easily. Also, the presence or absence of stones can be determined on visualization of the biliary tract. When the cystic duct is free, it is important to investigate the organic function of the gall bladder. A peritoneoscopy presupposes the examination of the gall bladder walls (fundus) and the form of this organ before an attempt is made to determine the normal or abnormal anatomic condition and complement this examination by provoking the evacuation of the gall bladder to see its functional state. Before in cases of nonobstructed gall bladder with negative cholecystography and good vesicular evacuation after duodenal sounding, the diagnosis of cholelithiasis offered difficulties but it is precisely in these cases that the authors' method confirms and assures decisive results. The value of the method diminishes relatively in positive cholecystographies although a sure diagnosis of cholecystolithiasis can be established and better visualization of the biliary passages can be obtained, especially with regard to existing calculi in the biliary duct. It is important to utilize the various positions in the roentgen examinations in a doubtful diagnosis of cholecystolithiasis in the ventral view a dorsal view should be taken, or vice versa. Also the motility of the stones may be observed in the different positions. The standing position suggested by Åkerlund may be applied to cases in which the visualization of stones in the gall bladder is difficult in the supine or dorsal position.

Among the advantages of the authors' method is the easy and effective diagnosis of cholecystolithiasis as the stone shadows appear distinct and intense

The length and integrity of the cystic duct may be observed which fact is much appreciated by the surgeon as it indicates the technical difficulties he will encounter but which cannot be deduced from the roentgen pictures. If the common bile duct is visualized up to the sphincter of Oddi exploration of these ducts during operation will be unnecessary.

There are some dangers that should be emphasized. To date 88 cholangiographies have been registered with no mortality nor infection except in 3 patients who had been operated upon from 8 to 10 days after cholangiography. Omental adhesions were seen at the point of vesicular puncture but in the other patients the point could not be ascertained. Only in 1 case with bile leakage in which complications were feared the patient had intense pain in the evening and on examination the next morning the bile leakage from the incision made for peritoneoscopy was revealed. With a larger cannula peritoneal examination showed no irritation. During the operation peritonitis without bile was found the liver and gall bladder were normal and the point of puncture was hard to find. After cholecystostomy the patient recovered uneventfully.

Two cases of erroneous interpretation were registered in the 144th observation a diagnosis of stone was made but the patient was operated upon 9 days after cholangiography and no stone nor point of puncture was found in the gall bladder and in the 169th observation the roentgen picture seemed to show 3 stones at the neck of the bladder but nothing was encountered at the operation.

A. B. VICENCIO M.D.



# GYNECOLOGY

## UTERUS

Pavoni, A.: The Innervation of the Uterus (L'innervazione dell'utero) *Riv Ital G* 1944 37 5

The author gives a detailed review of the clinical and experimental work that has been done on the innervation of the uterus. Some authors have shown in animal experiments that the pregnant uterus contracts more or less regularly even when it has been completely isolated from the central nervous system by section of the spinal cord. Clinically spinal anesthesia isolates the uterus from the central nervous system and leaves it to be regulated by the autonomous ganglionic system of the organ itself. Under these circumstances the body of the uterus shows an increase of tonus and decrease of contractions. While this shows that the spine has an inhibiting or regulatory action on tonus and a stimulating action on contractions, it does not show whether the regulatory fibers run in the sympathetic or parasympathetic system. Moreover the cervix, unlike the body of the uterus, does not show increased tonus when cut off from its spinal connections but can be dilated easily. Thus, however, does not prove that there is a sympathetic control for one of these parts of the organ and a parasympathetic control for the other. The most that can be said is that the autonomous ganglionic regulatory system of the uterus controls the tonus of the body while that of the cervix is regulated by stimuli from the uterus itself although it is impossible to say whether the motor and sensory impulses run through sympathetic or parasympathetic fibers.

The sympathetic fibers to the uterus come from the lumbar and sacral tracts. It is possible, however, that some of the branches of the thoracoabdominal sympathetic may reach the adnexa through the utero-ovarian plexus. The parasympathetic fibers run for the most part in the pelvic nerve while the vagus plays little part in the innervation of the uterus. It is probable that as for other abdominal organs, parasympathetic fibers of spinal origin reach the uterus through the posterior roots, and that their spinal center is in the intermediate zone of the posterior horn.

The adnexa apparently receive fibers from the phrenic nerve also. There are more or less free anastomoses between the fibers of the hypogastric plexus and those of the internal spermatic plexus. The many sympathetic and parasympathetic fibers in the uterine musculature divide into delicate fibrils and run in all directions being distributed to all parts of the organ. It is not certain whether as in other hollow organs, there are intramural nerve cells or ganglia which constitute a true autonomous nervous system, but it is probable that the fundamental plexus of Boeck and the terminal reticulum of Stoeck act as an autonomic system. In any case the many ganglia

scattered along the extrauterine course of the sympathetic fibers are of great value in this respect.

The greater part of the efferent sensory fibers follow the sympathetic, of which the spinal centers are in the first and second lumbar and second and fourth sacral segments. Visceral pain is transmitted through these. The afferent branches for the uterus have motor inhibitory and trophic fibers, but it has been impossible either from clinical or clinicophysiological data to determine whether they are localized in the sympathetic or parasympathetic nerves.

While the pregnant uterus when separated from its connection with the central nervous system is capable of expelling its contents the extrinsic innervation certainly has a function of co-ordination and regulation.

Many important problems in regard to the innervation of the uterus still remain to be settled and until they are settled it will be impossible to establish definitely the mechanism of the various functions of the uterus during and in the absence of pregnancy.

ARMANDO G. MORICCA, M.D.

Gianaroli, L.: Necrosis of Fibromas and Polyps of the Uterus (La necrosi dei fibromi e polipi uterini) *Riv Ital G*, 1944, 37: 377

Fibromas and polyps of the uterus frequently undergo necrosis because of pressure of the fibrous tissue on the muscle fibers and blood vessels, followed frequently by secondary infection. Necrosis occurs particularly frequently in solitary nodules of medium size. There are various types of necrosis, the aseptic and soft types being most frequent, followed in frequency by the red, calcareous, and cystic necroses. The septic, myxomatous, and hyaline forms are rarer. Red necrosis is characterized by hemoglobin imbibition caused by extravasations of blood and is followed by necrobiotic degeneration.

The author presents statistics from other authorities and discusses 111 cases of his own which were seen in 10 years at the Obstetrical and Gynecological Clinic of Bologna. Among a total of 6,577 gynecological examinations there were 803 cases of fibromas or polyps in a good state of preservation and 111 which had undergone necrosis. The average age of the patients in his group was 43 years. The most frequent symptom for which the patients came to the clinic was abnormal hemorrhage. The patients also presented pain, rise of temperature, a feeling of rapid increase in the size of the tumor and amenorrhea.

This complication of fibroma is most frequent during pregnancy and as the patient approaches the menopause. In about half of the cases the heart is more or less seriously affected but the blood pressure remains normal. Anemia shows somewhat higher values than normal. Serious kidney lesions are rare but slight bladder disturbances are not in-

frequent. The symptoms insofar as they differ from those of ordinary fibromas or polyps are doubtless caused by the absorption of toxic substances from the tumor.

Treatment consists of removal of the uterus. It is a mistake to rely on conservative measures in the hope of overcoming the symptoms. Among the author's cases there were 6 deaths a percentage of 5.4 as compared with 1:1 among cases of tumors which have not undergone necrosis.

Four of the deaths were due to circulatory collapse 1 was due to bronchopneumonia, and 1 to acute purulent peritonitis. In 60 cases the post-operative course was absolutely normal while in the others it was complicated by fever for varying periods of time or by circulatory collapse.

AUDREY G. MORAN, M.D.

Marshall, W. Holloway A. L., Irby L. E. and Peacock, C.: *Inspissated Blood and the Growth of Fibromatous Uterine Tumors. Preliminary Report. Am J Surg.*, 1946 72 57

The author after discussing some of the hypotheses concerning the cause of uterine fibroids proposes a theory of positive chemotropism to account for their origin. He had noted after repeated intra-dermal injections of blood serum into his thigh that a large fibromatous area developed. He suggests that in the presence of chronic uterine infection blood is forced into the uterine stroma by the contractions of the uterus during menstruation. The blood becomes inspissated and attracts fibroblasts to the traumatized areas when the fibroblasts begin to grow the foundation of a tumor is laid.

Concerning the experimental production of fibrous tumors in animals by estrogenic stimulation he suggests that the increased blood supply may produce minute hemorrhages which are followed by fibroplasia. The injection of blood serum into one uterine horn and saline solution into the other in a young dog failed to produce tumor formation.

J. ROBERT WILLSON, M.D.

## ADNEXAL AND PERIUTERINE CONDITIONS

Zuckermann C.: *Torsion of the Fallopian Tube (Volvulus salpingeae). Rev Mex cir* 1946 14 35

The author presents a case of torsion of the fallopian tube, the third one he has seen in 20 years. This condition is rare because of the fact that the mesentery of the tubes is broad and short. So far there are only about 300 cases of this condition on record. The patient was a 23 year old nullipara who came with the complaints of severe lower abdominal pain and frequent vomiting of 24 hours duration. The menstrual history was irregular with the last menses occurring 10 days before the onset of the present illness. She also complained of a white vaginal discharge. The pulse temperature, and blood pressure were all normal. All laboratory examinations revealed normal values. The pertinent findings were as follows: marked lower abdominal pain, ten-

derness over the suprapubic and both iliac regions, slight enlargement of the uterus and both tubes and marked tenderness of the right adnexa. Because of the severe pain an exploratory laparotomy was done. The following operative findings were noted: hematosalpinx of the right tube with torsion of its mesentery imminent perforation of the wall of the tube ovarian cysts about the size of an orange on the right side hydrosalpinx of the left tube, and chronic appendicitis with numerous adhesions.

The right tube and ovary, and the left tube and the appendix were removed. The abdomen was closed without a drain. The patient made an uneventful recovery. Macroscopic findings showed that the left tube was filled with serofibrinous exudate the mass being located at the distal two-thirds of the tube. It had the appearance of a neoplasm. The right tube was markedly engorged with blood. The cyst contained sebaceous fluid and some hair.

The pathological diagnosis was dermoid cyst of the right ovary and hematosalpinx with torsion on the right side.

The mechanism underlying the pathology was believed to be a hydrosalpinx which later developed into a hematosalpinx because of torsion of the mesentery. Practically all the cases of torsion of the tube recorded revealed an abnormally long tube and as a consequence, a long mesosalpinx. There was in almost all of the cases an accompanying ovarian cyst.

The author also reports a case of torsion of a normal tube. This occurred in a woman who was hysterectomized several years previously. He then cites the literature concerning torsion of the fallopian tube. In conclusion he suggests that this condition be considered in cases of acute abdominal conditions, especially when all other conditions have been ruled out.

SALVADOR S. TRINIDAD, M.D.

Rojas D. A.: *Ovarian Dysgerminoma (Disgerminoma del ovario). Bol Soc obst gín B Aires* 1946 25 33

Rojas reports 4 cases of ovarian dysgerminoma, 3 observed in women less than 30 years of age and 1 case in a woman 26 years old. The menstruation was normal in all except 1 who started menstruating at the age of 9. In the last patient there were 2 pregnancies the first ended at 7 months with the birth of a child who died 19 days later. The second pregnancy ended in a dystocic delivery at the end of 9 months. The other 3 patients were virgins. The size of the tumor was that of the head of a fetus or of an adult in 3 cases and in the fourth case it was so large that it filled practically all of the pelvis and abdomen. In 2 cases the tumor was rotated and pathological evidence of defective irrigation could be found.

All of these cases have had a very favorable benign course and 2 have been followed up for nearly 5 years. In 3 cases a subtotal hysterectomy with extirpation of the adnexa was done and in 1 case only extirpation of the diseased ovary was done.

WILLIAM E. RICKETTS, M.D.

# OBSTETRICS

## PREGNANCY AND ITS COMPLICATIONS

Parviainen, A.: On the Possibility of Nephelometric Examination of Proteinuria in the Prophylaxis of Nephrogestosis (Sur la possibilité de l'examen néphélométrique de protéinurie dans la prophylaxie d la néphrogestose) *Acta obst. gyn. scand.* 1946, 6 161

The appearance of nephrogestosis is the most disturbing complication of pregnancy and delivery.

The subjective symptoms of this condition are often mild and do not disturb the patient. During the usual prenatal examination the ordinary signs of nephrogestosis—swelling, elevated blood pressure, and impaired urinary function—are found late. Albuminuria occurs before these signs. The author considers all cases of albuminuria during pregnancy as pathological and has employed the so-called nephelometric test as the most delicate test to prove the presence of this condition.

The purpose of his work, the author states, is first of all to ascertain, with the aid of the nephelometric test, whether a determination of a minute amount of albumin in the urine made once in the course of pregnancy has any significance in nephrogestosis as to the prognosis during delivery and then to determine in the same individual the variations in the amount of albumin in the urine during pregnancy and labor and try if possible, by these tests to determine the influence of excitement and eventual fatigue on the amount of albumin and the prognosis.

The nephelometric method which the author has employed is one modified and tried by Brummer. It is to be published at a later date. It has, among other things, proved that small amounts of protein, up to 1 mgm. per cent. can be derived from many substances, but those larger than 1 mgm. per cent. come manifestly from albumin. The method is very simple.

A total of 310 specimens of sterile urine were examined by the author. All the specimens were taken from women from 3 to 10 months pregnant, the majority of the specimens being taken during the last part of pregnancy.

All the women tested had frequented the prenatal clinic from March to May 1945. Simultaneously with the nephelometric tests of the urine specimen the sulfasalicylic acid test and the test of Heller were done. The sulfasalicylic acid test was positive in only 5 cases (1.6%) and opalescent in only 3 of the cases. Heller's test was positive in only 2 cases (0.6%).

Following the nephelometric method, the presence of albumin ( $\leq 1$  mgm.%) was proved in 103 (33.2%) of the total of 310 cases. The amounts of albumin were for the most part relatively small (from 1.0 to 2.0 mgm.%) By this method smaller quantities of albumin in the urine can be detected than by either

the sulfasalicylic acid test (in which opalescence begins only at 22.7 mgm.%) or Heller's test.

In 230 of the 310 cases examined, the results were checked at the time of delivery.

In only 2.0 per cent of the cases which showed less than 2.0 mgm. per cent of albumin by the nephelometric test the patients showed signs of nephrogestosis and these revealed a mild form of this condition.

Of the patients who showed more than 2.0 mgm. per cent of albumin by the nephelometric test, 23 per cent developed a severer grade of nephrogestosis.

Thus, with a single nephelometric albumin determination made relatively early in pregnancy the danger of impending nephrogestosis can be ascertained with great exactitude. By observing these cases more closely prophylactic measures can be employed to prevent the development of severe nephrogestosis. BLACKWELL MARKHAM, M.D.

Härjola, O.: Studies on the Peripheral Blood Picture during Pregnancy and the So-Called Anemias of Pregnancy (Beitrag zur Kenntnis des peripheren Blutbildes während der Schwangerschaft und der sogenannten Gravitäts-Anemien) *Acta obst. gyn. scand.* 1946, 26 7

The object of this study has been to clarify the nature of the blood picture in pregnancy and in anemia of pregnancy. An attempt was made to determine whether or not the anemia of pregnancy is associated with certain changes in the blood picture and whether the anemia of pregnancy is a true anemia or a manifestation of a hydremic state. Investigations were made with respect to the following factors:

1. Hemoglobin content of the blood,
2. Erythrocyte count,
3. Color index,
4. Reticulocyte count
5. Leucocyte and differential count,
6. Erythrocyte diameter and its range
7. Total and average volume of erythrocyte per cubic millimeter,
8. Volume index and saturation index of erythrocytes
9. Serum iron
10. Examinations of the urine for albumin and sugar,
11. Stool examinations for parasites,
12. Test meals for free and total hydrochloric acid.

As a control group 16 healthy nonpregnant women were chosen for study. A second group consisted of 84 healthy pregnant women. The patients exhibiting anemia during pregnancy were divided into two groups: (1) those with mild anemia (hemoglobin from 60 to 69 per cent, Sahli) 71 patients and (2) those with severe anemia (hemoglobin less than

60 per cent, Sahli), 51 patients. Some of these patients were studied during several months of their pregnancies.

A review of the literature on hemoglobin values and erythrocyte counts during pregnancy reveals marked differences of opinion among various authors, most of whom conclude that these values are lowered. Some maintain that they are increased while others report that they are unchanged or variable. Studies on 82 healthy pregnant women indicate that hemoglobin levels and erythrocyte values are approximately the same for all months of pregnancy and correspond with the values found in the normal control group. In normal gravidas compared with nonpregnant women, the color index shows a slight rise, especially in the later months of pregnancy. The number of cases is too small and the range too great however to draw any definite conclusions from the increase of the average color index value. Reticulocyte values are fairly constant and show an increase from the fourth month on up to 35 per cent. It can be concluded that pregnancy gives rise to a brisk regeneration of red cells.

These studies show that there is a leucocytosis from the beginning of pregnancy the increase being more marked toward term but remaining within physiological limits. From the second month on, and becoming pronounced at the fourth month there is a shift to the left of the neutrophilic leucocytes. No consistent decrease of eosinophils was observed, although in a few cases they disappeared and in others they decreased. The basophilic leucocyte, lymphocyte and monocyte counts correspond to normal values. The mean diameter of the erythrocytes and the range of variation in individual cases showed no alteration when compared to the values obtained in healthy nonpregnant women. Pregnancy did not cause anisocytosis nor did it influence significantly the cell volume or saturation index. The values of serum iron appear to be increased during the entire period of pregnancy and especially toward term.

It was found almost without exception that in the group of pregnant women with mild anemia, having hemoglobin values between 60 and 69 per cent, the erythrocytes had decreased in proportion to the hemoglobin while the color index maintained a ratio comparable to that found in healthy gravidas. The average value for reticulocytes in all cases was increased about 13 per cent compared to values for healthy gravidas which indicated more active erythropoiesis. As in the group of healthy gravidas there was a leucocytosis, more marked in the last months of pregnancy. The neutrophilic leucocytes were increased from one month of pregnancy to the next, and the same shift to the left was observed as that in healthy gravidas. The range of the erythrocyte diameter was greater than in normal pregnancy and anisocytosis though slight was observed but the reduction in the amount of hemoglobin did not influence the mean value of the diameter of the red blood cells. The reduction in hemoglobin in this

group did not affect the cell volume nor saturation of the erythrocytes. From the sixth month on the serum iron showed a distinct decrease averaging 36 per cent compared with that of healthy gravidas who showed an increase in serum iron. This fall was not in direct proportion to the reduction in erythrocytes. A hyposideremia was noted as a result of the decreased hemoglobin. The secretion of gastric hydrochloric acid did not appear to be related to the serum iron level. It is concluded that the blood changes noted in the group of mild anemias of pregnancy represent a true anemic state which cannot be explained simply on a basis of hydremia or thinning of the blood.

In the group of severe anemias with hemoglobin values below 60 per cent (Sahli) it was found that the fall in hemoglobin was greater than that of the erythrocytes when comparison of mean values was made with respect to the healthy group of gravidas. The color index was decreased 20.8 per cent. A 50 per cent increase in reticulocytes on comparison with the nonpregnant group and an 11 per cent increase on comparison with the group having mild anemia was noted. The average values for leucocytes were increased over those obtained in healthy gravidas and were found to increase from month to month. There was no correlation between the decrease of hemoglobin and the increase in leucocytes. A shift to the left and an increase in neutrophilic leucocytes from month to month was found. The remaining white blood picture showed no departure from normal. The mean diameter of the erythrocytes was not affected by the diminished hemoglobin but anisocytosis was increased 18 per cent over that observed in healthy gravidas. Studies on the erythrocyte volume revealed cases in which the volume was normal and others in which it was decreased. Thus both normocytic and microcytic types of anemia were encountered. The diminished hemoglobin was associated with no significant change in saturation. The mean serum iron value was found to be decreased 61 per cent compared with the same value for healthy gravidas. The secretion of gastric hydrochloric acid did not appear to be a causative factor even in the most severe cases of anemia of pregnancy.

The author did not encounter malignant anemias of the pernicious or aplastic type in this series of cases.

JOHN L. LINDQUIST, M.D.

#### LABOR AND ITS COMPLICATIONS

Johnson, H. W. The Clinical Diagnosis of Varying Degrees of Uterine Contraction Rings. *Am J Obst.*, 1946 52 74

It is assumed that the contraction rings generally reported are of the severe variety and occur with obstructed labors. Reasons are given for the firm conviction that a milder variety or subclinical and larger group occurs with otherwise unobstructed labors.

The maternal mortality operative incidence and fetal mortality as reported in a collective review of

the literature, are compared with similar figures obtained from treatment of a large series of subclinical or early contraction rings. The incidences of contraction rings in several institutions in Houston, Texas, are given to show the variance due to this complication of labor.

Early rupture of the membranes is believed to be a predisposing factor in the development of uterine rings. Temporary or functional rings are recognized. Cardinal signs and symptoms of ring dystocia are given and the development and diagnosis of these rings are depicted in diagrams. The usual methods of delivery in association with ring dystocia are described.

EDWARD L. CORNELL, M.D.

Moracci, E.: Study of the Mechanism of Delivery in Brow Presentation. (Contributo allo studio del meccanismo del parto per la fronte) *Arch. ostet. g.* 1946, 51, 17.

The material for this study comprises 14 cases of frontal or brow presentation which were observed in the period between November 1, 1936 and October 31, 1943. Five of these terminated spontaneously and the author observed these personally. Five of the 14 patients were primiparas. The position of the fetal head during engagement in 5 instances was occiput left anterior and in 5 it was occiput right posterior, in 3 it was occiput right anterior and in the remaining case it was occiput left posterior. All deliveries except 1 were at term. The fetal weights exclusive of the premature infant were less than 3,000 gm. in 4 instances, between 3,000 and 3,500 gm. in 6 and between 3,500 and 3,750 gm. in 3. Thus, in 9 cases the weight was above 3,000 gm. which refutes the claims of some writers that the fetus in brow presentation is always premature.

In the 5 cases of spontaneous birth there were 3 fetal deaths. In the 9 of artificial delivery there were 6. The methods used consisted of a Thurn maneuver, a vertex presentation being substituted for the brow presentation; this resulted in a normal delivery with a live child. Version resulted in a dead fetus. Forceps delivery in 3 cases resulted in a dead fetus in each case. The 2 cesarean sections resulted in the delivery of 2 living children and, finally, 3 craniotomies were done on fetuses which were already dead. The author thinks that these results should cause the profession to think seriously of extending the indications for cesarean operation.

In all 5 of the spontaneous deliveries the pelvis of the mother was normal and in all 5 the presentation never changed—the frontal bosses retained their relationship to the pelvic axis throughout the entire period of labor. In 2 cases the position was occiput left anterior in the others it was occiput right posterior. In the latter 3 fetuses and in the 1 immature infant the face rotated anteriorly with the root of the nose under the pubic arch.

In the 3 normally developed infants the mouth could be felt to be widely opened during this process becoming fixed under the pubic arch. In the other rotation was not complete, the nose and superior

maxilla coming to rest under the ischiopubic rami in the vicinity of the subpubic angle, and the engagement was effectuated in a diameter intermediate between the right oblique and the anteroposterior (the parabellique diameter of Matal). Even in this case the wide opening of the fetal mouth with the stemming of the border of the superior maxilla (hypomochlion of rotation) against the right ischiopubic ramus could be demonstrated.

The author admits that delivery may occur in brow presentations by other mechanisms and from other positions for instance when the head penetrates in a transverse position or the face turns backward into the hollow of the sacrum and persists in this position; however he thinks that such mechanisms are the exception and not characteristic of the typical brow presentation. Madame La Chapelle thought that the greatest diameter of the fetal head (13.5 cm.) in the typical brow presentation passed down on an even keel, parallel to the plane of the superior strait (of which the greatest diameter is 13 cm.) by a marked process of molding of the head. Mangiagalli thought that this diameter passed through the smaller diameter of the strait on a slant with the chin end lower than the back of the head. Polisson thought exactly the opposite, viz., that the occiput passed through the superior strait in a lower position than the chin. However, Alfieri concluded, on the basis of experiments in which he pushed the head of fetuses mounted on a universal joint at the end of a wooden stake down through the skeleton of pelvis, that in the typical brow presentation the fetal chin stems against the superior ramus of the os pubis and gives back as the mouth of the fetus opens widely. Thus the maxillovertical diameter is substituted for the greatest, or mentosincipital, diameter and it is around this diameter (which is about 5 mm. shorter than the greatest diameter) that the fetal head rotates as a bascule to keep the frontal bosses always in the center of the pelvic axis.

It is this explanation of Alfieri that the author accepts, and in testing its validity he came upon his clinical findings of the open mouth of the fetus and conducted his cephalometric studies. In these studies the heads of 10 fetuses which had been born dead in the clinic were subjected to cephalometric measurements in a species of Broca cephalometer. The head was suspended in a position characteristic of the brow presentation, with the frontal bosses just touching the bottom of the box (which he designates as the plane of the frontal bosses). The other diameters were measured by means of movable points attached to the side pieces which were graduated in millimeters. By this means it was found that with the mouth closed the average length of the mentosincipital, or greatest cephalic, diameter was 137.6 mm. and with the mouth opened it was 159.6 mm.

Also it was found that the new direction of the mentosincipital plane had changed from one practically parallel with that of the superior plane of the pelvis (plane of the frontal bosses) to one at an angle

of 10 degrees with the sincipital end entering the superior strait and passing down to leave the inferior strait before the chin entered the cavity of the small pelvis. Thus no flexion of the head (bascula motion) appeared to be necessary until the sincipital end of the mentosincipital diameter had passed through the inferior strait and was resting on the perineum.

The author thinks that in this manner he has demonstrated the possibility of explaining the movement of the fetal head in brow presentation without the difficulties which have previously been considered insurmountable.

JOHN W. BRENNAN M.D.

### MISCELLANEOUS

Laffont, A., and Curtillet A: Anatomoclinical Study of the Osteomalacic Pelvis (*Étude anatomo-clinique du bassin ostéomalacique*) *Gyn. Méd.,* Par., 1946, 45: 28

This report has been prepared by Laffont and refers to material accumulated during the period while he was working in collaboration with Curtillet in Algiers. The observations were conducted on the material in the museum of the University of Algiers and include clinical and roentgenological studies of several of the authors' own patients.

The stress of muscular pull is accorded only secondary importance in the development of the deformities characteristic of osteomalacic pelvis and the muscular factor is given but scant attention. The authors believe that the entire pathological picture can be explained on the basis of the interplay of forces when the weight of the upper part of the body passes downward through the spinal column to the sacrum and the "ground thrust" upward passes through the femur and hip joint. However, these forces produce different effects consonant with the different body postures, that is, on standing, sitting or lying, and this leads naturally to a 3 way division of the theme. However it is not to be understood that osteomalacic deformity seen in practice is a pure deformity that is that it is always the result of the forces in action only in the standing, sitting or lying postures. In the fully developed deformity an attentive study will enable the observer to distinguish the factors in the final result which originated while the patient was still able to walk about, from those which developed when the sufferer was compelled to abandon walking and sit or lie on his back or side.

While the patient is still ambulant the deformities which develop involve the superior and inferior rami of the pubis, the region of election of pelvic fractures and the sacrum, lumbar vertebrae, sacroiliac joint and posterior region of the iliac ala. The heavy, bony mass of the ilium lying back of and upward from, the glenoid cavity (the so-called sciatic spur of Latarjet and Gallios) encompasses the region of the *incrusa ischiadica major* and resists deformity.

Anteriorly the pubic rami are crumpled inward and take with them the glenoid structures so that the socket of the hip joint comes to face anteriorly



Fig. 1 (Laffont and Curtillet) Deformity of the left side on lateral decubitus.

which diminishes the amount of abduction and external rotation of the femur. Of course in the last stages of the condition there are changes in the hip joint itself such as calcification of the labrum glenoidale and shrinking of the ligaments about the capsule which not only intensify the limitations of motion described but finally eventuate in inability to extend the hip joint itself. Posteriorly an exaggerated lordosis develops the sacrum is pushed downward tipped anteriorly and bent into a sharp hooklike deformity by the pull on its lower end by the powerful sacrotuberous ligament.

In the sitting posture the forces acting about the sacrum and adjoining structures continue, and in extreme cases even succeed in opening further the angle or dome formed by the massive resistant bony framework about the greater sciatic notch (spur of Latarjet and Gallios).

In the dorsal decubitus there are no important changes however if the patient lies upon her side the pressure of the body acts on the greater trochanter and region of the anterior superior spine of the ilium, exaggerating further the curve of the iliac crest and the inward deformity of the pubic rami on that side so that the end result will be that depicted in Figure 1. Such extreme deformities are probably more common in Algerian women because of their oriental habit of sitting cross-legged on the floor.

Medical treatment, such as endocrine therapy is not considered, the discussion being confined to the prevention or amelioration of the deformities consequent to osteomalacia of the pelvis in the female. Since the sacrum tends to lose its structural peculiarity of wedgelike or keystone-like integration into the sacroiliac joint and to hang loosely by the sacroiliac ligaments the author suggests doing an early sacroiliac arthrodesis by osseous implantation into the space between the angle formed by the posterior end of the iliac ala and the posterior aspect of the sacrum. This will perhaps prevent the development or accentuation of the downward and forward sinking of the sacral mass and the effect of the added calcium in the implant on the general calcium metabolism can be observed. The retraction at the hip joint might be relieved by sectioning of the ligament of Bertin. The author on 2 occasions has sectioned the pubic rami, once from above downward in one

patient and from behind forward in the other in order to increase the space between the pubic bones and to make the vagina more permeable in this way an appreciable correction of from 15 to 30 mm. was obtained.

JOHN W. BRENNAN M.D.

Vara, P.: Studies on Elderly Primiparas (Studien ueber alte Erstgebarende) *Acta obst. gyn. scand.* 1946, 26 S pp. 2.

Of 19,216 primiparas delivered at the Women's Clinic of the Helsinki University from 1937 to 1941 3,557 were 30 years of age or more. Of the latter 2,592 were from 30 to 34 years of age, 778 from 35 to 39 years, and 197 were 40 years or more. A comparison was made between full term deliveries in these patients and those in young primiparas under 30 years. A considerable increase in the number of older primiparas began in 1935 and has persisted. Breech position occurred in 3.38 per cent of the older primiparas, a slightly higher incidence than that observed in the younger group. Contracted pelvis and deflexion conditions showed no increase. Premature rupture was much more frequent in the older group, occurring in 28.16 per cent as compared with 0.86 per cent in the younger women. Early and late ruptures were less frequent in the older primiparas. The incidence of premature rupture was the same in cases with contracted and with normal pelvis, which indicated that contracted pelvis plays no part in the etiology of premature rupture. Of the various stages of labor the third was that showing the greatest difference in the older primiparas from that in young primiparas, although this too was only apparent. Previous abortion definitely shortened the course of labor. The duration of labor in premature rupture was 6 hours less than in early rupture and 3 hours less than in late ruptures. Surgical delivery in full term pregnancies with normal pelvis was required in 22.43 per cent and was distributed as follows: forceps, 12.51 per cent, cesarean section 4.26 per cent, dilatation or uterine forceps 2.39 per cent, amniotic placental manualis 0.95 per cent, craniotomy 0.56 per cent, internal version plus extraction 0.10 per cent. The incidence of surgical delivery increased with age being 18.67 per cent in the age group from 30 to 34 years, 26.1 per cent in that from 35 to 39 years and 43.6 per cent in that from 40 years and up. The incidence of surgical intervention for contracted pelvis was 43.9 per cent. The total incidence of surgical intervention in full term deliveries in elderly primiparas was 23.94 per cent almost 50 per cent higher than that in young primiparas. Previous abortion seems to diminish the need for surgical intervention.

The incidence of nephrogestosis was no higher in the elderly than in the young primiparas, but cases of severe nephrogestosis, eclampsia, and eclampsia were more frequent in the older group. The total incidence of infection showed no increase in the older as compared to the younger patients.

As age advances the incidence of uterine myoma and extragenital disease is higher including organic

cardiac disease. Primary weakness of labor pains was noted in 6.8 per cent of the elderly primiparas and secondary weakness in 18.21 per cent—over 50 per cent more than in young primiparas. Rupture of the soft parts occurred more frequently in the older group but only ruptures of the first degree.

The bleeding tendency in the third stage of labor does not seem greater in elderly than in young primiparas but atonic hemorrhages of less than 500 gm. occurred much more frequently in the older group particularly in patients of 40 years or more. The incidence of placenta previa (0.25 per cent) was somewhat higher than in younger patients (0.09 per cent), but ablatio placentae ante tempus showed no significant increase as compared with that in the younger group.

Weak labor pains occurred considerably more frequently in the older patients. From the indications for forceps delivery it was evident that inertia, exhaustion, or both constituted about 40 per cent of the indications. Inertia and exhaustion constituted indications for cesarean section in 29.9 per cent, and in completed deliveries inertia occurred in 6.86 per cent and exhaustion in 18.21 per cent of cases, thus in twice as many of the older patients as in the younger group.

The maternal mortality in full term deliveries was 0.55 per cent (in spontaneous deliveries 0.12, and in surgical deliveries 4.1 per cent). In cesarean sections the maternal mortality was 4.9 per cent and in forceps deliveries 0.7 per cent. This mortality rate was considered as being "probably greater than in younger primiparas. The average weight of the infant, 3,535 gm. was definitely greater than that in the younger group. The general ratio of male to female infants in the entire material was 107.05 to 100.0, but in patients of 40 years or more the ratio was 136.6 to 100.

Asphyxia occurred in 7.36 per cent of the infants, being an indication for forceps delivery in 17.9 per cent and for cesarean section in 14.2 per cent of the cases. The infant mortality rate for full term deliveries was 3.07 per cent (corrected figures 2.70 per cent), and was definitely greater than that in young primiparas. In spontaneous deliveries the infant mortality rate was 2.23 per cent and in surgical deliveries, 5.6 per cent. In breech deliveries it was 8.1 per cent. In extraction cases, the infant mortality rate was 33.3 per cent in dilatation or uterine forceps cases, 18.5 per cent in forceps deliveries 3.1 per cent and in cesarean sections, 2.2 per cent. Premature rupture did not influence the infant mortality.

Premature deliveries occurred in 8.51 per cent of the older women, thus statistically they were only probably higher than in young primiparas. In premature rupture nephrogestosis occurred in 36.0 per cent (with eclampsia in 13.9 per cent, and eclampsia in 5.9 per cent). Ablatio placentae ante tempus occurred in 5.3 per cent of the premature deliveries. The incidence of surgical intervention was the same as in full term deliveries (23.1 per cent).

and the incidence of cesarean section was 6.9 per cent. The maternal mortality in premature deliveries was 2.3 per cent, and the infant mortality in the different weight groups was as follows: for infants weighing from 600 to 995 gm. 100 per cent; for those weighing from 1,000 to 1,495 gm. 67 per cent; for those weighing from 1,500 to 1,995 gm. 37 per cent; and for those weighing from 2,000 to 2,495 gm., 16 per cent.

Elderly primiparas may be classified into two groups, one group of constitutionally completely normal subjects and the other of infantile-hypoplastic and presenile parturients. The latter suffer more complications in delivery than the former. In infantile-hypoplastic women conception is retarded. If conception was retarded more than 2 years the incidence of surgical intervention was higher (28.2 per cent) and the duration of labor longer (27 hrs. 55 min.) than in subjects in which conception took place before the 2 year period (24 per cent and 25 hrs. 54 min. respectively).

The women requiring surgical intervention were shorter and stouter than those in whom spontaneous delivery was possible. The age of onset of the menses which was definitely retarded as compared with the younger group had no effect on the frequency of surgical intervention.

Since 1935 puncture of the membranes has been employed routinely to hasten delivery when the os uteri has opened to 4 cm. and the conditions are otherwise normal. Also cesarean section has been done promptly rather than expose the infant to the difficult forceps delivery. In the period from 1935 to 1941 rupture of the membranes was instituted twice as often as in the period from 1927 to 1934. The use of forceps delivery diminished from 19.16 per cent to 9.02 per cent, while cesarean section on the other hand increased from 2.19 per cent to 3.56 per cent. The maternal mortality rate fell from 0.88 per cent to 0.28 per cent and the infant mortality rate increased from 1.72 per cent to 3.39 per cent. However this last increase was noted only in spontaneous and breech deliveries and was attributable to employment of the majority of the regular nursing staff in Army work during the years from 1939 to 1941, which left the problem of deliveries in the hands of temporary workers.

Since the prognosis of both mother and child is less favorable in elderly primiparas these patients should receive most careful attention. A careful anamnesis and physical examination will reveal changes due to age as well as delayed conception. Elderly primiparas should always be hospitalized for delivery.

EDITH SCHANCK MOORE



# GENITOURINARY SURGERY

## ADRENAL, KIDNEY AND URETER

Fornl, P: Paroxysmal Hypertension Caused by Tumor of the Suprarenal Medulla (L'ipertensione parossistica da tumore medullo-surrenalico. *Arch. Ital. chir.* 1945 67 223.

The symptomatology of a suprarenal medullary tumor in a 32 year old man was complicated by tuberculosis of the kidney.

The author points out that a tumor with functioning chromaffine cells in the medullary zone of the suprarenal glands may be responsible for hyperadrenalinemia, which in turn may cause paroxysmal attacks of hypertension.

Removal of the tumor resulted in a complete cure.

JOSEPH K. NARAT, M.D.

San Martino, N: Statistical Report on 73 Patients with Unilateral Renal Tuberculosis Treated by Nephrectomy (Relazione clinico-statistica su 73 pazienti affetti da tubercolosi renale unilaterale nefrectomizzati) *Arch. Ital. urol.* 9 3, 80 809.

From a discussion of an extensive material the author hopes to be able to clarify the various guises under which unilateral renal tuberculosis may be found, and thus lead to a better understanding of the early diagnosis of this condition in order that surgical treatment may be given promptly.

Men were affected with kidney tuberculosis some what more frequently than women, perhaps because of their more frequent exposure to physical exhaustion and trauma. Those most frequently affected were in the fourth and fifth decades of life. There was a personal history of complicating tuberculous involvement of other organs in 44.1 per cent of the cases. These were subdivided as follows: tuberculosis of the lungs, 2.06 per cent, of the bones, 5.4 per cent, of the genitalia, 9.5 per cent, and of the pleura, 23.2 per cent. (Among his own cases the author found concomitant tuberculous involvement of the lungs in 1.03 per cent of the osseous system in 2.06 per cent, and of the genitalia in 12.3 per cent.) The symptomatology was predominately renal in only 13.6 per cent of the cases and predominately cystic in 67.1 per cent.

The author anticipates the most troublesome delays in diagnosis in the patients with symptoms of urinary colic suggesting calculus and those with hematuria suggesting tumor. The urine was clear and free of pathological elements in only 1.03 per cent of these patients. The tubercle bacillus was demonstrated in the urine in 53.4 per cent of the cases.

The author believes the most satisfactory method of demonstrating the bacillus of Koch to be centrifugalization of a large amount of urine (1 liter) in the apparatus of Forsell and seeding of the sediment on Petraguan's medium with asparagus. The sur-

face of the plate is scraped after 7 or 8 days with a platinum loop and the material thus procured is transferred to a microscopic slide and stained by the method of Ziehl.

The affected kidney was removed under spinal anesthesia (2.5 c.c. of procaine hydrochloric acid in 4 per cent solution). The total mortality was 61 per cent: 3 patients (4.1 per cent) died on the day of operation, and 2 died some months afterward. All the others were cured of their symptoms; however, in 2 the symptoms reappeared some years later and tubercular involvement of the remaining kidney was found.

One instance of horseshoe kidney was encountered and in this the kidney was divided at the isthmus and the affected part was successfully removed.

JOSEPH W. BICKMAN, M.D.

Bouchard, R.: The Effect of Renoureteral Lithiasis on the Upper Urinary Tract (Le retentissement de la lithiase reoureterale sur les voies urinaires supérieures) *J. urol. med., Par.*, 1944-45, 51 151.

The routine use of urography in the study of the morphological changes produced by calculi has yielded interesting results. Pyelography reveals only the excretory passages, such as the ureter, renal pelvis and calices, but urography reveals more. In some urograms an opacity of the entire parenchyma may be demonstrated, showing the effect of the calculus on the intraparenchymatous excretory passage and on the uriniferous tubule itself. In a urographic study of 38 cases of lithiasis, including 22 cases of calculi in the renal pelvis, 5 in the calices and 11 in the ureter the author observed an image which he believes to be of diagnostic significance. He feels, therefore, that urography should be the method of choice, especially since the dangers of introducing a probe into the ureter in cases of aseptic lithiasis may thus be avoided. This danger of infection has led to a more routine use of urography. With the aid of intravenous urography it is possible in a case of renal colic to demonstrate the cause as a calculus from the presence of dilated calices, even if the calculus has been expelled or is invisible in the roentgenogram. By this means a more favorable prognosis can be established in cases showing a marked dilatation above the calculus, a finding hitherto only too frequently taken as an indication for nephrectomy.

The significance of retrograde dilatation is wholly different from that of dilatation due to inhibition of the innervation. The former is a result of increased urinary pressure with resulting strain and eventual exhaustion of the muscle fibers. In the presence of irreversible lesions of this type, nephrectomy would be imperative. On the other hand, when it can be demonstrated that the dilatation is due merely to a hypotonia of the muscle fibers, the power of con-

traction may still be retained. Such a process permits of greater optimism. In spite of the recommendations for conservative treatment in urinary lithiasis nephrectomies are still done for dilatations considered irreversible according to classic interpretations.

The author believes that the theory of pathogenesis presented will permit extension of the indications for conservative operations. He emphasizes the utility of laying down any rigid rules in the presence of a physiology as complex as that of the urinary apparatus but hopes that his theory will help to limit the indications for nephrectomy in lithiasis.

The renal pelves do not show any changes roentgenographically in the presence of a calculus except for the distention due to the stone itself. In the calices, however, the calculus will produce either a multiplication or dilatation of the calices. In the latter instance, the calyx appears as a tube the papillary end of which terminates in an irregular or convex surface instead of in the ordinary cupule, and there is a rounded dilatation at the origin of the calyx resembling a grape seed. In cases of calculus in the ureter the urogram shows marked, regular sphenical dilatations at the level of the origin of the calices, but the pelvis and ureter appear normal. This is not in harmony with the classical theory of a retrograde dilatation. It seems more likely that a reflex hypotonicity is released by the ureteral segment traumatized by the presence of the calculus.

EDITH SCHANCHER MOORE

Garrey F. K., and Gomberg, D.: Vaginal Ureterolithotomy. *J. Urol.*, Balt. 1946 56 49.

The authors present 13 instances of vaginal ureterolithotomy of which only 1 was unsuccessful. This swells the total of such cases recorded in the literature to 127. The single failure reported occurred when the stone slipped to a proximal position and the abdominal approach was necessary to recover the calculus.

To obviate this complication in the future the authors suggest fixing the stone in the ureteral position by wedging it with a ureteral catheter passed alongside of it.

The advantages and disadvantages of the procedure are tabulated. The salient advantages of the vaginal approach are less shock, rapid convalescence, and ease of operation, while the abdominal approach carries with it definite shock, difficulty of lower ureteral isolation, and postoperative hernia, along with a much more prolonged postoperative course associated with drainage. The abdominal approach, however, permits the exposure of a greater length of the ureter and thus a greater range of calculus excision and the advantage of increasing the incision for greater ureteral visualization. It is to be noted that these 3 advantages of the abdominal route constitute the only 3 disadvantages of the vaginal approach to a ureteral calculus in the terminal portion of the ureter.

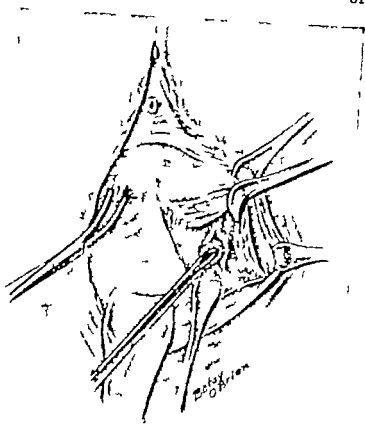


Fig. 1 (Garvey and Gomberg) showing corvix retracted incision through vaginal wall, exposure of ureter which has been incised, and calculus removed.

The authors report some slight but distinctly advantageous changes in the operative procedure of vaginal ureterolithotomy. A blunt curved hemostat is used to separate the underlying tissue after the lateral wall of the vagina is incised rather than finger tip dissection.

When the ureter is visualized following blunt instrument dissection an Allis is placed around the ureter above the stone, the ureter forceps is incised longitudinally over the stone and the latter is removed. The distal and proximal portions of the ureter are then dilated to prevent postoperative ureteral edema with obstruction. The ureter is closed with sutures in the adventitia. A small soft rubber drain is left in the wound but not against the ureter and the vaginal wound is closed. The drain is removed in 24 hours and the patient is permitted to be ambulant at this time.

The authors method affords direct visualization of the ureter and thus the previous complications of uterine artery trauma with hemorrhage and vesical and peritoneal drainage should be avoided.

ROBERT LICH, JR., M.D.

Hill R. M.: Embryoma of the Kidney in the Adult. *Brit. J. Urol.* 1946 18 53

The author reports the thirty-sixth case of a Wilms tumor in the adult. Of the 36 patients, only 4 have survived for an appreciable length of time. The patient whose case is now presented has sur-

vived 5 years. The course of the disease with a pathological description of the various reported cases, is given. It is noted that seemingly a Wilms' tumor is less malignant in adults than in children.

The treatment of nephrectomy plus irradiation is considered most satisfactory since the survival rate in this group was about twice that of cases in which surgery or irradiation was used independently. There are at least two instances of Wilms' tumor in the adult in which the patients have survived 4 and 10 years.

The case reported is that of a 35 year-old mother who experienced sudden abdominal pain associated with faintness. The patient complained also of some pain in her right side following exertion, and a year previously had had some irritative vesical symptoms for a few days. Examination revealed a large mass in the right renal area which moved with respirations. At operation using a transperitoneal approach the right kidney was found to be the site of the tumor and a smooth globular organ with dilated veins over the surface was demonstrated. Following nephrectomy the patient was given 3 500 roentgen units of deep x rays and during the past 5 years there has been no evidence of recurrence.

The renal tumor was ovoid in contour and measured 13 by 9 cm. with a lower pole replaced by an encapsulated blood cyst with yellowish bosses. Histologically the tumor revealed three principal cell types: (1) smooth muscles some of which were well differentiated and others of sarcomatous type, (2) lipomatous tissue well differentiated but some of which was primitive in type and (3) primitive blood sinuses.

The article is well illustrated and contains a full bibliography. ROBERT LUCI, JR., M.D.

Kable, P. J., and Schenken, J. R.: Aneurysm of the Renal Artery following Partial Nephrectomy. *J. Urol.*, Balt. 1946 56: 1.

Kable and Schenken report the seventy ninth case of aneurysm of the renal artery following partial nephrectomy. The patient was a 33 year old white male who entered the hospital because of pain on the left side associated with hematuria. A renal calculus had been removed from the right side 4 months previously. The patient has a mild secondary anemia, a normal phenolsulfonphthalein reaction on each side, and a closely approximated circular shadows of calcareous density overlying the inferior pole of the left kidney and identified by pyelography as located within a dilated lower calyx. Partial left nephrectomy of the inferior pole was performed.

Because of distention 6 days after operation, an enema was ordered after which the patient complained of intense pain in the left lower quadrant and passed 600 c.c. of fresh blood and numerous clots. Intravenous infusions were administered, and 48 hours later a second hemorrhage occurred. The pelvis of the left kidney was irrigated with water and adrenalin solution. During the entire postoperative course the urinary output was consistently good.

The patient went to his home by ambulance, 10 miles away but again began to bleed and was returned to the hospital. In preparation for a left nephrectomy spinal analgesia was given, but the sharp drop in blood pressure contravened the operation. He was transfused several times and later discharged.

Fifty two days after operation the patient again began to bleed profusely. He was brought back to the hospital by ambulance and died a few minutes after admission to the hospital. At autopsy a mass, obviously an aneurysm, was found at the lower pole of the left kidney. The clot was composed of the usual laminations of fibrin, islands of agglutinated platelets, and masses of red blood cells and polymorphonuclear leucocytes. A small number of fibroblasts had invaded the clot in some areas. The wall of the aneurysm showed remnants of muscle fibers but for the most part was composed of chronically inflamed connective tissue or granulation tissue. A large number of macrophages filled with hemosiderin pigment were present in some areas around the wall. Immediately adjacent to the wall the renal tissue showed moderate interstitial fibrosis, a heavy infiltration with chronic inflammatory cells, and, in one area, a large mass of chronically inflamed granulation tissue which was continuous with the granulation tissue wall of the sinus tract. A section taken from the rounded protruding areas of cortex showed a diffuse infiltration of polymorphonuclear leucocytes in the interstitial tissues and in the tubules. Stains for elastic tissue showed fragments of elastic fibers in the wall of the aneurysm. Bacterial stains revealed cocci and bacilli within the wall of the aneurysm and in the blood clot. Smears of the exudate in the sinus tract at the lower pole of the kidney showed gram positive cocci and gram negative bacilli. The mucosa of the bladder was intact in the sections examined, but an area just deep to the mucosa showed an infiltration of round cells. The histological diagnosis was mycotic intrarenal aneurysm with rupture into the renal pelvis, and chronic and acute pyelonephritis.

The authors comment that the sex distribution is slightly in favor of males. All the factors operative in aneurysm in other sites seem to be operative in this case, including trauma, infection, syphilis, congenital defects of the arterial wall, and periarthritis nodosa. The presence of a mass is an infrequent sign.

The diagnosis has been made on the basis of a ringlike shadow observed in x rays of the kidney, ureters and bladder the ring representing calcified deposits in the wall of the sac. Aortic arteriography has been employed for diagnosis. Treatment is prompt surgery, preferably nephrectomy. The surgeon must exercise extreme caution, and the possibility of aneurysm must be suspected in any case in which palpation of the renal fascia reveals pulsation and a bruit. A bluish discoloration of the flank indicates perirenal hemorrhage.

DAVID ROSENBLUM, M.D.

Pfeiffer G. E., and Gandin, M. M.: Massive Perirenal Lipoma with Report of a Case *J. Urol.*, Balt., 1946 56 12

Pfeiffer and Gandin report a case of massive perirenal lipoma. This condition must be considered in the diagnosis of immense abdominal tumors. It is most commonly seen in females equally often on either side, and usually in patients between 40 and 60 years of age. About 35 per cent of retroperitoneal lipomas are of perirenal origin. There is no definite dividing line between simple hypertrophy of the fatty capsule of the kidney and perirenal lipoma. The tumor may arise from the renal capsule or perirenal tissue, it is retroperitoneal, of considerable volume may be flabby and pseudofluctuant, hard and fibrous, or of any consistency between these two extremes, multilobular reddish or yellowish gray slightly vascular and surrounded by a capsule which permits easy enucleation. It may contain sarcomatous areas but unless malignant the growth is usually slow. It may displace the kidney or envelop it. Associated renal calculi may be present. Symptoms are due to compression and enlargement, such as vague gastrointestinal disturbances, mild backache, or increase in size of the abdomen. The tumor may reach enormous size. There may be weakness, fatigue, nervousness, genital and lower extremity edema, dyspnea, bloating, constipation, vomiting, diarrhea, melena, and eventually cachexia and death. Urinary symptoms are usually absent. Pressure may produce hydronephrosis, pyelitis and oliguria, ascites and dilatation of the superficial abdominal veins and varicocoele. Because of their size these tumors are frequently confused with large ovarian tumors, inoperable abdominal malignancy, ascites, pancreatic cyst, cirrhosis, and pregnancy.

The diagnosis should be considered in a large abdominal tumor in an adult from 40 to 60 years of age with mild gastrointestinal symptoms and backache with a history of slow growth, the tumor being relatively smooth, rounded, lobular, and soft. An x-ray film of the chest will show elevation of the diaphragm on the involved or both sides, and there may be upward dislocation of the heart. The gastrointestinal series will reveal dislocation of the intestinal tract. The urine is usually negative but pyelographic studies will demonstrate a distorted ureter and dislocation of the kidney. Transperitoneal nephrectomy is usually indicated. The prognosis is grave and recurrences are frequent.

The authors report the case of a 49 year old white male who was admitted for treatment of an abdominal tumor. He was emaciated above the abdomen and had massive edema of the lower torso and lower extremities, and his abdomen protruded tremendously. The mass filled the entire right flank from the iliac crest to the left costal margin at the anterior axillary line. Retrograde pyelography showed the right renal pelvis to be displaced far into the left upper quadrant of the abdomen so that it lay farther to the left than the left renal pelvis. Upon opening the abdomen, the presence of an enormous lobular fatty

mass filling the abdomen was confirmed. It weighed 26½ pounds. The left kidney was in normal position. The primary incision was begun at the left of the ensiform, made diagonally downward to the right, and terminated at the right flank. An additional left transverse incision was made. The renal pedicle was first clamped and tied, and the tumor was delivered. Five yards of 3 inch gauze strip was used to fill the enormous dead space. The incision was closed with through and through interrupted alloy wire sutures and interrupted fine stainless steel for the fasciae. The pathological report stated that the gross specimen consists of tumor and kidney. The tumor is encapsulated and coarsely lobulated, approximately spherical in shape and 37.0 cm in diameter. Its weight is 26½ pounds. On cut surface it consists largely of fat and fibrous connective tissue in varying proportions. In some parts the fat predominates and in others the fibrous connective tissue predominates. The kidney is compressed and distorted. It is also atrophic. Its weight is 90 gm. The cortex is thin and averages 0.5 cm in thickness. The medullary substance is approximately 0.5 cm in thickness. The pelvis is compressed, and the kidney is probably nonfunctioning due to pressure. Study of several sections taken from different places in the tumor shows the tissue to consist of fat cells and fibrous tissue with the latter type predominating. There is no evidence of malignant change. Further search will be made by studying additional sections from other areas and if diagnosis is changed supplemental report will be made. Diagnosis: fibrolipoma, abdominal benign.

The patient was discharged on the seventy-second day after a stormy convalescence complicated by low serum protein for which human serum and amino acids were administered. Certain physiological alterations merit comment such as the edema, which was due to (1) pressure of the tumor upon the vena cava resulting in venous stasis distal to the point of compression and also (2) nutritional depletion caused by growth of the fibrolipoma at the expense of the remainder of the body and so contributing to the reduction of the total serum protein.

DAVID ROSENBLUM, M.D.

Moore T.: The Retrograde Movement of Ureteral Calculi *Brit J. Urol.*, 1946 18 60.

The author briefly refers to the literature and describes in detail Legeus's case in which the calculi were so extremely mobile that he placed the patient in the Trendelenburg position, shook him, clamped the upper ureter to prevent the stones from falling back into the ureter, and then extracted the calculi from a renal calyx.

The case reported is that of a 22 year-old male with two stones which moved from the ureter to a renal calyx during the preliminary radiographic examinations. At operation the lower ureteral stone was extracted through a paramedian abdominal incision with the thought that the other stone could be milked down the hydroureter and removed through

the same ureteral incision. After the first stone had been removed the second was found not to be palpable. The ureter was then plugged and with a renal incision the renal stone was removed from a renal calyx. The sizes of these stones were  $\frac{3}{4}$  inch and  $\frac{1}{4}$  inch.

The need of x ray localization of ureteral calculi immediately before surgery is emphasized. Retrograde passage of ureteral calculi is dependent upon antiperistalsis or gravity. ROBERT LICH, JR., M.D.

Orofino, A.: The Histopathological and Pathogenic Study of Chronic Pericystitis, with Special regard to the Lesions of the Terminal End of the Ureter. (Contributo allo studio istopatologico e patogenetico delle pericistiti croniche con speciale riguardo alle lesioni del tratto terminale dell'uretere) *Arch. Ital. urol.*, 1945, 31: 139.

Anatomically, the urinary bladder is found to be surrounded by fibrous connective tissue which in part is covered with pelvic peritoneum. Smooth muscle is found at the terminal end of the ureter which aids the opening and closing of the mouth of this organ.

Chronic pericystitis may be subdivided into two types: (1) pericystitis of bladder origin and (2) that of extrabladder origin. In the latter type, inflammation of the adjacent organs or in some cases remote infection are the principal causes. This may spread either by direct extension or through the lymphatics. Pericystitis may be caused by attacks of appendicitis, typhilitis, sigmoiditis, proctitis, epididymitis, prostatitis, and colitis.

Pathologically two forms of pericystitis are present, the edematous and the sclerolipomatous. The edematous form is similar to pelvic cellulitis; it involves the terminal end of the ureter and results in obstruction. The sclerolipomatous form is characterized by fibrotic tissue interwoven with adipose lobules, and a hypergenesis of collagenous fibers with a decrease of cellular elements. This fibrotic process also involves the terminal end of the ureter and produces obstruction. The nerve supply to the bladder may also be affected by the edema or the fibrolipoma; this change may give rise to disturbances of bladder contraction and the painful crises that accompany it. Unless the anatomy and pathology of pericystitis is understood great diagnostic difficulties in establishing the true nature and site of the lesion are encountered. ARTHUR F. CROLLA, M.D.

#### BLADDER, URETHRA, AND PENIS

Niceley, E. P.: Gunshot Wounds of the Urinary Bladder in Wartime. *J. Urol.*, 1946, 56: 50.

Eleven cases of vesical injury are discussed: 1 of an extraperitoneal wound, 4 of intraperitoneal wounds and an associated injury of the abdominal viscera and, in addition, 4 of wounds of the bladder and rectum and 2 of vesical damage alone.

These cases present symptoms which vary with the size of the vesical opening, associated injury and

the length of time before the diagnosis is made. Intraperitoneal lesions present signs of shock in addition to urinary symptoms of vesical retention, pain over the bladder region, urinary retention, and hematuria.

The diagnosis can be made readily when there is a large opening in the bladder by using the method of introducing fluid and noting the amount reabsorbed. In smaller lesions cystography is often the most useful method, either with air or a halogen contrast media. Very small lesions can be most readily diagnosed by cystoscopy, but when an exploratory laparotomy is done cystoscopy may not be necessary.

An exploratory operation should be executed immediately after the diagnosis is made and the peritoneum is controlled. The bladder should be opened, the openings repaired, and a cystostomy tube of large caliber left in place. The urethral catheters are removed. Urethral catheters may be introduced into the renal pelvis to keep the operative site free of urine. When intraperitoneal damage is associated with the peritoneal cavity is opened, the necessary repairs are executed, and the urine is removed. Drainage is made without drainage. In combined vesical and rectal perforation both a cystostomy and a colostomy are to be done to divert both the urine and feces from the repaired area. The important factor in treatment is that the cystostomy tube be kept open and free of clots so that intravesical pressure cannot be exerted at any time.

The prognosis in these patients is considered good provided that the diagnosis is made soon after injury and proper treatment is executed. In the opinion of the author complete recovery in a simple gunshot wound of the bladder may be anticipated in from 4 to 6 weeks after the time of injury. ROBERT LICH, JR., M.D.

Cortese, G.: Value of Urethrography in Male Genital Tuberculosis. (Valore dell'uretrografia nella tubercolosi genitale maschile) *Arch. Ital. urol.* 1945 67: 884.

Urethrographic studies in 17 cases of external genital tuberculosis in man enabled the author to establish the presence of involvement of the bladder or of the prostatic gland, while the clinical examination alone failed to reveal such involvement. In several instances the rectal examination disclosed prostatic and vesicular lesions while the roentgenograms furnished negative results. Conversely in other cases the rectal exploration failed to show any pathology while the urethrograms demonstrated complete destruction of the prostatic gland.

Urethrographic studies should be supplemented by laboratory tests such as cultures of the prostatic secretion, biologic tests, and search for tubercle bacilli in stained specimens.

Urethrographic studies are of great value in following the evolution of the deeply located genital tuberculosis and for the evaluation of its treatment. JOSEPH K. NARAY, M.D.

## GENITAL ORGANS

Higbee, D. R.: Benign Prostatic Obstruction. *J. Urol., Balt.* 1946 56 83

The author compares the 3 types of prostatectomy in a series of consecutive cases done under spinal anesthesia.

In the group of 100 suprapubic prostatectomies 79 were two stage operations and 21 single stage procedures. The mortality in this group was 5 per cent and was limited to the two stage group. Of the 5 patients who died in this group 2 did not survive cystotomy, 2 deaths were due to a postprostatectomy septicemia and 1 death followed a large pulmonary embolus.

In the group of transurethral resections the mortality was 4 per cent. Three deaths in this group were due to heart failure and 1 was due to a septicemia following the removal of vesical calculi and prostatic resection.

The perineal group consisted of 100 patients with a mortality rate of 3 per cent. There were 3 deaths in this series: 1 due to heart failure, 1 to pulmonary emboli, and the last to carcinoma of the cecum.

The morbidity rate due to complications in the suprapubic group was 28 per cent as compared to 8 per cent in the transurethral group and 12 per cent in the perineal group. The average length of hospital stay was greatest in the suprapubic group and shortest in the transurethral group. However in the patients suffering complications the hospital stay was 45 days for the suprapubic group, 33 in the transurethral group and 28 days in the perineal group.

In reviewing the end results obtained after the 3 methods of prostatectomy there seems to be little difference. In short, then, the 3 methods may well be expected to give low morbidity and mortality rates and fulfill the purpose of surgery namely permanent symptomatic relief.

ROBERT LICH, JR. M.D.

D. Agata, A.: Biologic Reaction in 2 Cases of Tumor of the Testicle—Friedmann's Reaction (Reazione biologica su due casi di tumore del testicolo—Reazione di Friedmann). *Sperimentale* 1946 98 72

Two tumors of the left testicle are reported: one in a 31 year old laborer and the other in a 32 year old laborer. In both, the neoplasm appeared without history of trauma, and grew rather rapidly. There was no evidence in either patient of hereditary taint or of other disease, except that there was a positive Wassermann reaction in 1. In both patients the Friedmann reaction was positive before the testicle was removed. In one the reaction became negative a few days following the operation, but a month later it had again become positive coincident with the development of pain in the lumbar region and the appearance of what seemed to be metastasis in a lymph gland of the lumbo-aortic region. This suggests a prognostic value for the Friedmann reaction in this condition. In the other patient the reaction remained positive throughout.

The biologic reaction was also noted immediately upon removal of the tumor and the subcutaneous implantation of small pieces and upon the intraperitoneal injection of triturated suspensions of the tumor. In the first patient cited, the reaction proved negative for the implantation but positive for the intraperitoneal injection. In the second case the reaction was positive in both instances.

Both tumors were diagnosed histologically as seminomas. However the positive Friedmann reaction showed that there may also have been present some elements of a teratoma with the inclusion of chorioepitheliomatous cells and in the second case cited the microscopic picture of some fields exhibited structures strongly suggestive of Langhans cells. The author therefore, leans toward the view that these tumors are unilateral developing teratomas of the testicle.

JOHN W. BRENNAN, M.D.

# SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

## CONDITIONS OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Wertheimer, L. G.: Limitation of Movement of the Scapulohumeral Joint by a Muscle Anomaly (Limitação dos movimentos da articulação escapulo-humeral por anomalia muscular) *Rev Hosp Clin.* 1946, 1: 191

It is very rare for the movement of the shoulder joint to be limited by the presence of an anomalous muscle. The author describes such a case in a young man of 20 years. The right anterior axillary fold was very abnormally developed, extending to the middle of the arm when the arm was abducted. In addition to this deformity the patient presented dorsal scoliosis and absence of the palate. His mind was normal. Examination of the right side showed a chondroepitrochlear muscle, apparently with two muscle bundles uniting in a tendon which passed to the epitrochlea. On the left side there was a similar but much smaller muscle. The chondroepitrochlear muscle on the right side was found to react to electrical stimulation of the brachial plexus. There were no qualitative or quantitative abnormalities in the reaction. The pectoralis major muscle was much smaller than normal. It also reacted to electrical stimulation but the contractions were rather weak.

Operation was performed on the right side for the purpose of freeing the movements of the shoulder

On sectioning the two muscle bundles felt on palpation a third bundle was found beneath them. The two superficial bundles were sutured to the lower surface of the tendon of the pectoralis major and the third shorter one was fixed to the middle of the other two. Immediately after the operation the arm could be lifted to maximum ante flexion. A thoracoplasty cast was applied in a position of hypercorrection. This operation not only restored normal movement of the arm but the action of the pectoralis major was strengthened by the attachment of the muscle bundles to it.

AUDREY G. MORROW, M.D.

Billing, L., and Ringertz, N.: Fibro-Osteoma, a Pathohistocytological and Roentgenological Study *Acta radiol.*, Stockh., 1946-47: 179

This study undertakes to clear up some questions on the pathology of fibro-osteoma, and stresses the possibilities for roentgenological diagnosis. A survey of the literature is made, although the great variation in nomenclature makes evaluation of the ones difficult.

Most of the benign tumorlike new formations of bone in the skull may be grouped as a pathological entity but the great variation in tissue makeup makes them differ widely in pathological appearance. The term fibro-osteoma is used to define lesions having a distinct anatomical connection with the skeleton and in which there is a ground substance of connective tissue containing clumps and spicules of bone tissue. The relative cellularity, vascularity and maturity of the involved tissues vary so that the tumors range from the soft, predominantly fibrous, to the calcified osteomas. No cartilage is found in these tumors, which fact distinguishes them from osteochondrogenous exostoses.

A series of 25 cases is presented in a tabular survey and the discussion stems from the findings in these. Photomicrographs illustrate the stages of maturity of tissue described in various individual lesions or even combined in the same tumor. Regressive changes often occur in the more mature type of tumors with osteoclasts in part or all of the lesion. When the bone-dissolving process is terminated the giant cells disappear and only a fibrous mass remains.

The anatomy is best demonstrated by roentgenograms of thin slices of tumor because photomicrographs are marred when other parts lie over the tumor. The lesions may be localized, solitary or multiple causing swelling of a part of a cranial bone or of the entire bone, and when several bones are involved the suture lines are obliterated. In some projections it is possible to show the thin cortical delimiting the mass.

The jaws are sites of predilection the frontal sinus and ethmoidal area also being common locations. In diffuse involvement the condition may be unilateral or include the entire face and anterior skull.

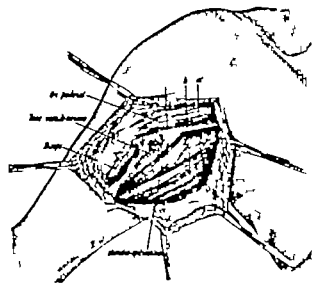


Fig. 3. (Wertheimer.) Turning back the skin flap and sectioning the aponeurosis, it is found that the chondroepitrochlear muscle presents a lateral bundle which at the upper end is divided into two bundles, a and a' and a median bundle b which is directed toward the thorax. The vasculonervous bundle of the arm is seen between the biceps and the chondroepitrochlear muscles. The pectoralis major muscle is seen to be very small.

The most common types of importance for clinical and roentgenological diagnosis are divided into 4 classes and described in detail. All occur chiefly in youth with active growth about puberty and produce symptoms of a mechanical nature due to deformity of the bone. Retardation of growth is often spontaneous, and when tumor tissue is of a mature type there is rarely recurrence after simple removal. Malignant degeneration is not unusual but the tissue may be mistaken for osteogenic sarcoma and intensive irradiation may result in sarcomatous degeneration.

As to the pathogenesis fibro-osteoma is probably not a true neoplasm but a growing malformation similar to the embryonal development of membrane bone. One case in a rib is noted with roentgen and pathological findings identical with the cranial type of fibro-osteoma. The osteoid osteoma of Jaffe is recognized as being pathogenetically dissimilar.

FRANCES E. BRENNER, M.D.

Rosh R., and Raider L.: Primary Malignant Bone Tumors. *Am. J. Roentg.* 1946 56 75

Of the 235 cases of primary malignant bone tumor seen in the Radiation Therapy Department at Bellevue Hospital in the past 20 years 114 were too advanced for any treatment. The 121 treated cases fell into the following groups (Classification of Registry of Bone Sarcomas American College of Surgery) (1) osteogenic sarcoma, 45 cases (2) chondrosarcoma, 8 cases (3) endothelioma, 32 cases, (4) multiple myeloma, 18 cases and (5) giant cell sarcoma, 18 cases.

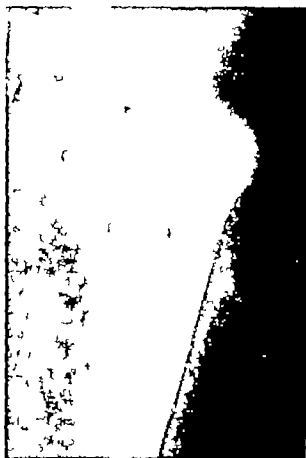


Fig. 2. (Rosh and Raider) Original roentgenogram showing osteocartilaginous tumor the margins of which are still intact.



Fig. 1 (Rosh and Raider) Osteogenic sarcoma. Left, Appearance at time of admission, showing destructive lesion of the upper third of left femur. Right, Following radiation therapy showing regeneration of bone.





Fig. 3. (Rosh and Raider) Chondrosarcoma, appearance at last admission

In spite of controversy on the value of irradiation therapy, the impression remains that the best hope of cure lies in the combination of intensive irradiation and surgery. The tumors are radiosensitive in the following order: endothelioma, multiple myeloma, giant cell sarcoma, osteogenic sarcoma, and chondrosarcoma. The procedure of working up each case is outlined together with the technique of irradiation.

Twenty two of the 45 cases of osteogenic sarcoma occurred in patients under the age of 20 years. In the following two decades there were 5 and 3 cases, respectively; there were 18 cases, more of the osteolytic type, among the patients more than 40 years of age. Most of the cases (31) had metastases, and were therefore treated by irradiation only. In 14 cases excision also was done, with 6 survivors for 1 year and 4 for 5 years. Of the 5 patients who underwent amputation after irradiation 2 survived 3 years, and 1 5 years. Coley's serum appeared to make no appreciable difference in the results.

Chondrosarcoma, which may arise primarily or in a pre-existing chondroma or osteochondroma, was found in 8 patients. Three of these survived more than 5 years, and all of them died of pulmonary metastases. Again, intensive irradiation followed by excision or amputation when feasible, was the method of treatment.

Endothelial tumors known as Ewing's tumors metastasize early and rapidly to the lungs, lymph nodes, and the skeletal system. Of the 32 patients with this condition 20 were under 20 years of age, and only 1 was known to be a survivor after 5 years. Although the irradiation may be used diagnostically the prog-

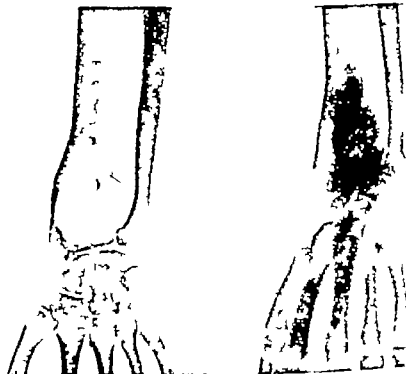


Fig. 4. (Rosh and Raider) Giant cell sarcoma. Left, Shows destructive lesion expanding the bone with dissolution of the cortex medially. Right, Same case, 6 months later following irradiation therapy shows regeneration of bone.

nosis is poor since not over 10 per cent of the patients are permanently cured by the best of treatment.

Multiple myeloma is invariably fatal and the 'punched out' areas of osteoporosis are often the site of pathological fractures. Irradiation is palliative, often permitting fractures to heal and yielding symptomatic relief. Of the 18 patients with this condition only 7 survived 3 years.

Giant cell sarcoma is not particularly radiosensitive, but it yields the greatest percentage of cures to radiation therapy. Excision and radiation are the authors' preferred treatment, and there may be complete regeneration of the bone following such therapy. Of 18 patients 6 underwent excision and irradiation treatment and of these, 4 were alive and well 3 years later. Four patients received irradiation treatment only and of these, 3 were well after 3 years.

Early recognition of malignant bone tumors followed rapidly by intensive treatment offers a good chance of permanent cure. The radiation therapist is of increasing importance in making the diagnosis and then prescribing and giving the irradiation therapy.

FRANCIS E. BREDENECHE, M.D.

#### SURGERY OF THE BONES, JOINTS MUSCLES, TENDONS, ETC.

Latex, R., and Frantz, V. K.: Absorbable Gauze in Bone Surgery. *Am Surg.*, 1946, 124-28.

This is a report of a series of experiments in which oxidized cellulose (absorbable gauze) fibrin foam and absorbable gelatin sponges were placed in cortical cavities or between the fragments of fractured bones of dogs.

By using the three substances in adjacent ribs of the same animal individual variations in tissue reactions were eliminated as a source of error.

Osteogenesis was markedly retarded by the presence of absorbable gauze, but fibrin foam or absorbable gelatin permitted healing almost as rapidly as that seen in control defects.

This interference with bone healing by absorbable gauze whether it was placed in cortical defects, fracture lines, or in a bone from which a segment had been removed suggested to the authors that it may be a valuable material for use in arthroplasties. Preliminary trials in this work have been encouraging.

NEWTON C. MEAD, M.D.

Snedecor S. T.: Bone Surgery of the Hand. *Am. J. Surg.*, 1946, 72-363.

A series of 10 cases in which various types of bone surgery accomplished an improvement of function in severely deranged hands are presented with excellent illustrations. Bone surgery was not undertaken unless it would assuredly restore added usefulness to the hand, and was always considered in relation to the condition as a whole. Surgery of the bones cannot be performed on the hand through scar tissue. Good skin with subcutaneous tissue was a prerequisite for this work. Occasionally nerve grafting or



Fig. 1. (Snedecor) Left, Useless remnant of index finger with loss of head of second metacarpal apparent non-union of the metacarpal but at operation it was found to be firmly united; right, removal of second metacarpal and transplant of distal half of fifth metatarsal onto shaft of third metacarpal after restoration of joint space. (Courtesy of American Journal of Surgery.)

neurolysis was performed earlier or at the time that the bone work was done.

A few cases with loss of thumb function were treated successfully. In 1 case in which the first metacarpal was gone, surgery consisted in the transfer of a useless metacarpal (the phalanges had previously been amputated) over to the thenar side and into the greater multangular. In instances in which this metacarpal was not available a tibial graft was occasionally used. There were instances in which the opposing action of the thumb was lost. In 1 case there was destruction of the thenar muscle with dense scar contracture. This problem was solved by freeing the scar and bringing the thumb around in an opposition position. A small bone block was taken from the tibia to hold it. This was wedged down between the first and second metacarpals and held in place by a Kirschner wire. In another case in which opposition of the thumb was lost because of scar tissue contracture, the thumb and remaining fingers possessed fair flexion and extension power and after the scar was freed an osteotomy was performed at the base of the first metacarpal and the shaft was rotated. This permitted it to move into a position of opposition to the index finger when a subsequent tendon transplant was made to motivate it. In cases in which the first metacarpal base was dislocated up into the wrist reduction was difficult but the condition was corrected by fixation with Kirschner wires which were removed within 5 or 6 weeks.

In malunion of the metacarpal fractures particularly in the cases in which the metacarpal heads had dropped forward the whole intrinsic muscle mechanism of the fingers was thrown out of gear. Severe extension contractures of the

metacarpophalangeal joints developed and at operation it was often necessary to do a capsulectomy on the collateral ligaments of these joints in order to obtain 90 degrees of flexion. Fixation was accomplished by running Kirschner wires through the heads of several metacarpals to hold them up in place until healing occurred. Postoperatively the metacarpophalangeal joints were maintained in a position of 90 degrees flexion for 2 or 3 weeks in order to prevent the recurrence of these extension contractures. At the same time active use of the phalangeal joints was encouraged to prevent stiffness of the fingers.

The closer to the normal length the metacarpals could be restored, the better was the ultimate function of the hand. Preliminary skeletal traction was found useful in accomplishing this. A bone graft was inserted subsequently. The problem of solving the loss of a metacarpophalangeal joint of an important finger was accomplished in the case of a blind officer whose finger function was truly important. The index finger was already missing so that its metacarpal stump had to be removed to eliminate scar tissue and make a smooth cleft between the thumb and middle finger. The space formerly occupied by the head of the third metacarpal was filled with dense scar tissue which had to be meticulously dissected out. A soft tissue covering was then prepared. The distal half of this third metacarpal was then borrowed for the graft and was notched into the proximal end of the metacarpal and fixed with a Kirschner wire. This single contact graft grew perfectly and the joint moved well. The flexor tendon had remained intact. Later, after union of the graft and motion in the joint had been well established, an extensor tendon graft was added and the finger functioned very well.

Cases were described in which the metacarpals were shifted to replace the loss of more important bones. In 1 case the distal end of the fourth metacarpal was missing and the finger was without nerve and tendon supply. This finger was sacrificed, and the fifth finger was moved over to take its place by the shifting of its metacarpal over to the base of the fourth.

Numerous arthroplasties of the metacarpophalangeal joints were successful. The base of the first phalanx in 1 case was trimmed up neatly and the sleeve mechanism around it was adjusted. In other cases the deformed heads of the metacarpals were replaced.

C. FRED GORDONSON, M.D.

Möllerud A.: A Case of Bilateral Habitual Luxation in the Posterior Part of the Shoulder Joint. *Acta chir scand* 1946, 94 181

The author describes a case of bilateral habitual luxation of the posterior part of the shoulder joint. A comparison is made with 8 other cases of posterior luxation of the shoulder reported respectively by Asplund and Sjövall.

The case was that of a domestic servant aged 18 who complained that she felt her shoulder slip as if the arm had gone out of joint when she performed

certain movements. There was no pain but she noted that the arm got tired, particularly during heavy work which involved constant luxation and reposition. She had noticed this for several years in the left shoulder and approximately 2 years in the right.

In the case described by Sjövall the patient was a powerfully built man aged 22 who by stretching the arm forward and upward during inward rotation could constantly produce backward luxation of the limb. Asplund's patient was a young man aged 18 in whom backward luxation of the shoulder joint could be produced by abducting the right arm to about 90 degrees, then stretching it forward during simultaneous inward rotation. This was true of both shoulders. In the former's case roentgenograms were negative, but in the latter's, they revealed flattening of the posterior part of the glenoid cavity while arthrography indicated an insufficiency of the capsular apparatus and an abnormally large posterior recess. These findings were verified at operation.

In Möllerud's case the mechanism of the subluxation was thought to be as follows: the more the arm approached the described position of upward and forward extension with simultaneous inward rotation the more favorable were the conditions for posterior luxation. The outward rotators which brace and support the capsule posteriorly would be lax since the antagonists were in action and the tendon to the caput longum of the biceps, which acts as an intra articular supporting ligament, would make the least resistance to a backward movement of the caput humeri. On the other hand outward rotation would hinder luxation. The outward rotators would then presumably be somewhat supported and with them the posterior part of the capsule even if it were abnormally slack.

Concerning the etiology it was believed that the condition was one of capsular insufficiency of congenital origin with abnormal laxity of the shoulder joint capsules, which allowed the subluxation to occur without trauma or defect in the capsule. This viewpoint was supported by the fact that the occurrence was bilateral. In Möllerud's case the luxation could be brought about without inward rotation, in contrast to the cases described by Sjövall and Asplund. In their cases the inward rotation was required in order to produce luxation. Accordingly Sjövall concluded on the basis of x-ray examination and postmortem experimental findings that the mechanism of luxation was as follows: on elevation and inward rotation of the arm the tuberculum minus thrusts against the glenoid cavity so that the caput humeri is pushed out of the socket and at the same time glides backward. In order that this may occur the capsule of the joint must be abnormally lax, especially in the posterior part. Thus, in post mortem experiments it was necessary to cut entirely through the capsule before luxation could be produced. In Möllerud's case the condition caused only slight inconvenience and operative treatment was not carried out.

C. FRED GORDONSON, M.D.

Freiberg, J. A.: Experiences with the Brittain Ischiofemoral Arthrodesis. *J Bone Surg* 1946 28 501

The rather high incidence of failure of osseous fusion following the use of standard iliofemoral operations, especially in the tuberculous hip, has been due to the distraction effect of the adductor muscles on the superiorly and laterally placed graft and in some cases to the presence of diseased bone in the superior portion of the acetabulum.

Brittain has pointed out that the mechanical strength of the ischiofemoral strut graft placed inferior to the hip joint, is superior to that of the lying buttress graft of the iliofemoral type. The former graft heals under compression force, while the latter must heal under tension—the force in both instances is supplied by the adductor muscles of the hip and thigh.

The basic principles of the Brittain ischiofemoral operation are simple. An adequate, rigid tibial graft must be firmly implanted in healthy pelvic bone. The proximal end of the distal femoral segment must be displaced medially to the ischium so that new bone need not develop across the dead space bridged only by the graft. Uniform contact between the cut surfaces of the femur and the graft ensures moderate immediate fixation, early healing and maintenance of the original operative position. In patients with tuberculous lesions the osteotomy should be done at a level and at an angle which will allow the graft to be embedded in bone not involved in the infectious process. The angle of osteotomy should vary according to the specific relations of the damaged hip joint, from the transverse plane to an angle of 45 degrees.

The indications for the Brittain ischiofemoral arthrodesis are multiple. The contraindications occur in those instances in which the diseased bone cannot be short-circuited by means of the osteotomy and graft.

The author performed 7 Brittain ischiofemoral arthrodeses in a period of 7 months and waited 6 months to determine the results in these cases prior to continuing this procedure. End result studies are reported only for these 7 patients operated upon from 13 to 30 months previously.

Among 6 patients with tuberculous hip joints upon whom the Brittain ischiofemoral arthrodesis was performed, osseous fusion developed in 4 within from 7 to 9 months. In 1 case, with postoperative extraneous complications, fusion is apparently taking place after 1 year. In 1 adult a painful, disabling traumatic arthritis of the hip was healed by osseous fusion in 4 months. Additional patients upon whom this operation has been performed are showing every evidence of a similar high percentage of osseous fusion.

The Brittain ischiofemoral arthrodesis ideally combines an intertrochanteric osteotomy which allows temporary joint rest and an inferiorly placed strut graft healing occurs under compression stresses rather than tension stresses as in the iliofemoral operations.

RUDOLPH S. REICHER, M.D.

Blair, H. C., and Morris, H. D.: Conservation of Short Amputation Stumps by Tendon Section. *J Bone Surg*, 1946 28 427

The stump length of the forearm is measured from the insertion of the biceps tendon to the bone ends of the stump. The minimum stump length allowing the fitting of a forearm prosthesis and furnishing enough leverage to activate it is  $1\frac{1}{4}$  inches.

When the elbow is flexed against resistance, the biceps stand out and similarly when the knee is flexed, the hamstrings become prominent. The effect is to crowd the prosthesis off the short stump; this inhibits the use of the prosthesis in flexion especially in the upper extremity. The authors have found that by excising 1 inch of the biceps tendon at or near its insertion, approximately 2 inches in length of useful stump are gained. In short, below the knee stumps, excision of the fibula and section of the medial and lateral hamstrings allow a gain of approximately 2 inches of useful stump length. A functional stump length of  $1\frac{1}{4}$  inches below the knee joint is usually considered the shortest which will allow the proper fitting of an artificial limb.

The authors have carried out the procedures described on 10 short forearm stumps and on 22 short below the knee stumps. Only 1 patient required reamputation at a higher level because of a severe flexion contracture of a below the knee stump. All other patients were fitted satisfactorily with prostheses.

VERNON C. TURNER, M.D.

## FRACTURES AND DISLOCATIONS

Maronneau, P. L.: Fractures of the Inferior Maxilla and Indications for a New Surgical Method of Treating Fractures: Osteosyntheses with Kirschner Wire (Considérations sur les fractures du maxillaire inférieur et les indications d'un nouveau moyen chirurgical de contention: le brochage). *J med Bordeaux* 1946 123 201

Holding of the bony fragments in fractures of the symphyseal region of the lower jaw bone by transversely placed and crossed Kirschner wires has already been described by others; however the author places the wires longitudinally along the ramus of the jaw and also uses the method for fractures of the angle and ascending ramus of the mandible.

The technique consists simply of placing a wheel of local anesthetic at the mandibular symphysis, denuding the bone for a distance of 1 cm., and passing the Kirschner wire backward within the substance of the horizontal ramus between the dental canal above and the lower edge of the jaw bone below. Upon reaching the fracture line the wire passes on into the posterior fragment which is maintained in place by an assistant. If, however, assurance of the correct alignment of the fragments is desired a preliminary wiring of the fragment, or fragments to the superior maxilla (homomaxillary splinting) is done and this is removed after the Kirschner wire has been placed. The jaw is then simply bandaged or a plas-

ter splint is applied externally to immobilize the mandible. The method assures perfect reduction gets rid of the unpleasantness of the continuous mandibulomaxillary occlusion, permits a moderate amount of precocious mobilization (so favorable to callus formation) shortens the period of healing and does not require a secondary surgical intervention for removal of the apparatus of osteosynthesis.

The author does not wish to identify his method with the popular method of intramedullary pinning which is not applicable to fractures of the mandible because of anatomical considerations.

JOHN W. BRENNAN, M.D.

Compere, E. L. and Schnurte, W. J.: Treatment of Congenital Dislocation of the Hip. *J Bone Surg* 1946, 28 555.

The most common cause of poor results in the treatment of congenital dislocation of the hip in children under 4 years of age is discontinuance of immobilization before an adequate hip joint is clinically and roentgenographically demonstrable. To be acceptable, the depth and slope of the superior acetabulum must be relatively normal, and the femoral head and acetabulum must fit accurately and articulate smoothly.

To avoid long periods of plaster immobilization, most surgeons have discontinued splinting when the hip joint seems stable. The hip joint may not redislocate but marked inadequacy of the acetabulum results in disability and possible redislocation later in life.

As the orthodontists reshape bones of the jaw by gentle pressure over long periods of time, so the ace-

tabulum and femoral head may be reshaped by months or years of corrective pressure. Fat and fibrous tissue obscuring the acetabulum will absorb if pressure is maintained long enough. To this end the authors use a modified Denis Browne splint with a long bar between the footplates to maintain abduction. This secures the constant pressure of the femoral head in the acetabulum without rigid immobilization. The patient is able to sit up, and may be taken out of the splint for bathing and graduated periods of freedom.

The routine of treatment as used for the past 3 years on 16 patients under 4 years of age, is outlined.

Position 1: Frog leg cast in 90 degrees of abduction for 3 months.

Position 2: Abduction spica cast for 3 months.

Position 3: Bilateral long leg plaster casts held widely apart and in slight internal rotation by a plaster strut, for 3 months.

Position 3b: Denis Browne splint with long spreader bar for 3 months which is removed daily for the bath.

Position 3c: Same as 3b but the splint is left off 1 hour each morning and afternoon with an additional hour of freedom per day added each week. The splint is kept on at night until the hip presents normal contours roentgenographically.

The case studies are illustrated by photographs of the positions and by roentgenograms, but it is too early for an end result study. However the authors believe that most congenital dislocations of the hip can be reduced, the reduction maintained, and a relatively normal joint developed by means of prolonged functional splinting.

FRANCIS E. BRIDGEMAN, M.D.

# SURGERY OF THE BLOOD AND LYMPH SYSTEMS

## BLOOD VESSELS

Barone A. M.: Multiple Perthes Test for Segmental Occlusion of the Deep Veins. *J. Am. M. Ass.* 1946, 131: 1406

The author emphasizes the importance of determining the patency of the deep venous system before injection or ligation treatment of superficial varicose veins. Perthes test for occlusion of the deep veins bases its conclusions on the physiologic actions of the skeletal muscles of the leg during walking. Perthes test consists of placing a tourniquet about the thigh just above the knee, sufficiently tight to compress the long superficial saphenous vein and prevent the reflux of blood into the distal saphenous system; the patient then walks vigorously or flexes and extends the knee repeatedly. The interpretation of the test is as follows: (1) if the varicosities collapse during the muscular activity the deep veins are patent, and the test is reported as negative; (2) if the varicosities do not collapse but become more distended and the patient notices pain or cramps in the leg with activity, obstruction of the deep circulation is present, and the test is reported as positive.

A positive Perthes test is sufficient proof of occlusion of the deep veins, but the author points out that a negative test may not always mean a complete deep circulation; such an instance may prevail in a segmental thrombosis. If an obstructing thrombus is present in a segment of a deep vein in the thigh, it is possible for the blood to make a detour around the thrombus by passing through a deep communicating vein below it into a superficial vein and then back into the deep vein through a communicating channel proximal to the thrombus. Therefore, an obstructing occlusion may be present in the deep vein and yet the varicose superficial veins will collapse on walking with a tourniquet above the knee (see diagram). In order to obviate such erroneous conclusions the author recommends the application of the tourniquet at 5 inch intervals from the knee to the groin as in this manner the level of the detour can be determined. Thus if the varicosities below the tourniquet collapse every time the patient walks with the tourniquet at different levels, there is no segmental thrombosis; but if a level is reached at which the distal veins remain distended and become more distended the tourniquet is constricting the detour level and preventing the flow of blood through the communicating vein into the superficial veins.

Cases which are suggestive of deep vein occlusion and therefore require the multiple Perthes test are (1) those with a history of thrombophlebitis or phlebotrombosis (2) those with a history of trauma especially fracture (3) those with a suspicion of deep vein occlusion as evidenced by pain

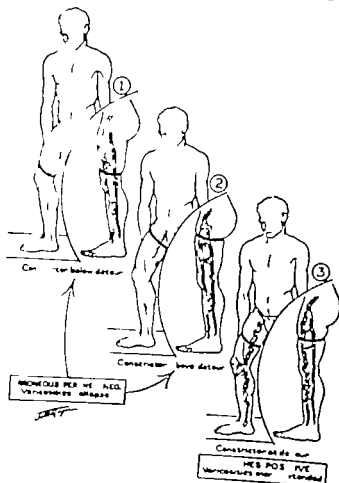


Fig. 1 (Barone.) Multiple Perthes test for segmental occlusion of deep veins.

and swelling (4) those with phlebographic evidence of obstruction and (5) those with an equivocally negative Perthes test.

The author emphasizes the necessity for ascertaining that the superficial venous dilatations are not compensatory to deep venous obstruction as failure to observe this phenomenon before instituting surgical treatment will result in undesirable and critical complications. EDWARD H. CAMP, M.D.

McGowan J. M.: Cervical Rib; The Role of the Clavicle in Occlusion of the Subclavian Artery. *Ann. Surg.* 1946, 124: 71

The author attempts to throw more light upon the syndrome of the cervical rib and scalenus anticus muscle. This study is derived from 9 cases of cervical rib, 3 of which required surgical treatment.

A review of the various theories presented in the past includes the theory of sympathetic hyperactivity from irritation of the sympathetic nerves, results in vasospasm. Jones Todd Telford and Blair incriminated the cervical rib alone as the predisposing factor of position of the thoracic girdle was recognized.

The importance of the scalenus anticus muscle was brought forth by Adson and Coffey and later the scalenus anticus syndrome as an entity per se was emphasized by Ochsner Gage and DeBakey. Judovich has implicated a narrowing of the costoclavicular space, whereas Wright believed that the nerves and blood vessels were pinched between the first rib and the clavicle. Ayresworth included the cervical rib as well as the first rib and also mentioned the possibility of trauma to the subclavian artery from excessive movement of the shoulder.

The symptoms produced may be either vascular or neurological, or both. The former are blanching, numbness, tingling, cyanosis, and coldness whereas the latter include radiating pain down the arm and occasionally into the neck and scapula, anesthesia, paresthesia and numbness, atrophy of the muscles supplied by the ulnar nerve, and finally trophic disturbances.

The irritative and destructive signs are the result of pressure, stretching, or friction of the brachial plexus and blood vessels between a cervical rib, fibrous band, or the scalenus medius and pectoricus muscles posteriorly and the scalenus muscle or clavicle anteriorly. The position of the ribs—either the cervical or the first thoracic—in relation to the shoulder girdle and the origin of the brachial plexus determine whether the structures will be put under tension, stretched, or pinched. If the rib is lateral the structure will be pinched between the rib and the clavicle, particularly when the shoulders are thrown back. A medially placed rib will press against the scalenus anticus muscle. In this group of cases any maneuver placing the scalenus anticus muscle under tension will produce or aggravate the symptoms, especially obliteration or diminishing of the pulse.

In only 1 case with a medially placed cervical rib was the Adson maneuver positive. The remaining cases revealed an obliteration of the pulse in the arm but not in the third portion of the subclavian artery which lies distal to the scalenus muscle. Thus the obliteration must have taken place where the artery passed between the cervical rib and the clavicle.

Mild cases may be alleviated by exercise tending to elevate the shoulder by strengthening the trapezius and levator scapulae muscles and instructions should be given to the patient not to throw back the shoulders. If surgery is indicated the scalenus anticus muscle is severed and a portion of the cervical rib is removed. The author believes that anterior scalenotomy alone would not be sufficient; however this procedure alone was not performed.

JACK L. WOODS, M.D.

Shumacker, H. B., Jr. and Carter, K. L. Arteriovenous Fistula and Arterial Aneurysms in Military Personnel. *Surgery* 94: 20-9.

The study comprises 245 arteriovenous fistulas and 119 aneurysms observed at the Mayo General Hospital, Galesburg, Illinois. The signs and symptoms were those usually described in these conditions except for the absence of evidence of myocar-

dial insufficiency in all but 2 patients. Generally the frontal cardiac area was demonstrably increased in roentgenographic examination in instances in which there was a large fistula, with the exception of lesions of the carotid vessels in which cardiac enlargement was usually absent. The correct localization of the aneurysm or fistula was generally easy and in only a few cases was an error in localization made. The most common difficulty arose in cases with lesions of the profunda femoral vessels in which the position, bruit and thrill could be eliminated only by compression of the overlying femoral as well as the involved profunda vessels. In other cases lesions of a branch close to the main artery were incorrectly localized to a larger vessel.

Arteriograms were useful in cases of intracranial aneurysm without bruit or thrill, in cases in which there was uncertainty regarding the exact localization of the lesion, particularly when tests showed the collateral circulation to be poor and in cases in which it appeared that the aneurysm was being "cured" by thrombosis. In the great majority of cases it was found that arteriograms were unnecessary.

The distribution of the lesions involved all the major arteries of the body except the abdominal aorta and the common iliac arteries. Nine patients had multiple aneurysms and fistulas. The problem of treatment was often complicated by the presence of associated injuries such as fractures and damage to the peripheral nerves. Thirty-three and eight-tenths per cent of the arteriovenous fistulas were complicated by nerve injury. In about half of these operative treatment was required, such as neurolysis or neurothraphy. Sixty-one and three-tenths per cent of the arterial aneurysms were associated with nerve palsies of which two-thirds required operation. Most of the serious nerve injuries were associated with lesions of the great vessels of the upper extremity.

Of the various tests used for determining the adequacy of the collateral circulation in the limbs, the Matis reactive hyperemia test was found most reliable and practical. The absence of pulses distal to an aneurysm or fistula in a limb which had maintained good circulation also proved an indication of adequate collateral circulation. The most useful sign which could be elicited at the time of operation was the maintenance of good color and warmth of the hand or foot during a prolonged period of accurate occlusion of the involved segment of the artery with a rubber shod clamp.

Since one of the most important factors in the development of adequate collateral circulation is arteriovenous fistula is the duration of the lesion, operation was usually not performed until the lesion was of 4 months duration or longer. The indications for early intervention were rupture (either external or subcutaneous) infection, severe myocardial insufficiency and associated severe nerve paralysis. The authors believe that repeated occlusion of the involved artery hastened the development of adequate

collateral circulation. Sympathectomy was utilized extensively to increase the collateral flow especially for axillary, femoral, and popliteal lesions. The results were generally good. However the only limb in which gangrene developed immediately after excision of a fistula had been sympathectomized. Similarly the only instance in which the ischemic paralysis followed operative cure of an aneurysm was one in which sympathectomy was performed at the conclusion of the operation.

The operative approaches were chosen to provide good exposure, but no incisions were used which followed the course of the vessels longitudinally across the axilla, the antecubital space, and the popliteal fossa, or which crossed normal skin creases of the neck and the groin.

Four operative methods were used for arterial aneurysms. When the sac was small and the neighboring nerves and vessels could readily be dissected free the entire aneurysm was excised. Intrascapular ligation of the artery without excision of the sac was employed primarily for large aneurysms not associated with peripheral nerve lesions. When the aneurysm was closely adherent to nerves which could not readily be freed from it beforehand intrascapular ligation of the vessels was followed by complete or subtotal excision of the sac. Proximal ligation of the affected artery was the method reserved for intracranial carotid aneurysms.

The operative technique usually used in the cure of arteriovenous fistulas was excision with quadruple ligation of the affected artery and vein together with ligation of branches which communicated with the fistula. In 33 instances the affected artery was preserved intact. Restoration of the artery was not feasible more often because the damage to the artery was often extensive, requiring excision of a portion which eliminated the possible use of such simple types of repair as ligation of the fistula or lateral suture. On the other hand, end to end suture or vein graft would have required the sacrifice of some important collateral branch which the authors considered unwise.

Cure of the aneurysm or fistula was achieved in all but 1 case, a large saccular arteriovenous aneurysm involving the right innominate and left subclavian vessels along with the arch of the aorta and superior vena cava. The majority of the patients showed no evidence of circulatory insufficiency after operation while at rest or with moderate exercise about the wards. Nevertheless, weakness and fatigability were frequently demonstrable after operative ligation of a main artery to the upper extremity, and intermittent claudication was common after interruption of a major artery to the lower extremity. Sympathectomy was performed in 34 cases of this type with only partial alleviation of the symptoms.

In the 33 cases of repair of arteries there were 6 failures. The other 27 cases showed no signs of arterial insufficiency after operation.

Among the 283 patients operated upon by the authors there were 6 major complications: 2 fatal

ities: 2 cases of gangrene, 1 temporary hemiplegia, and 1 ischemic nerve paralysis.

THEODORE B. MASSALL, M.D.

Elkin D. C. Cirsoid Aneurysm of the Scalp. *Ann Surg.* 1946 123: 591.

The author describes 4 cases of cirsoid aneurysm of the scalp encountered in the course of operations upon approximately 470 aneurysms and arteriovenous fistulas incident to wounds of warfare. When contributing arteries and outgoing veins form multiple anastomoses and become in reality a diffuse arteriovenous fistula the term "cirsoid" is generally applied. In one of these reported cases, the condition arose in the site of a pre-existing telangiectasia involving the scalp and ear and had as the more immediate etiological agent a long-continued irritation from wearing a helmet; the other 3 cases followed trauma to the scalp without any pre-existing vascular lesion.

Although methods of treatment are multiple, e.g., carotid ligation, multiple ligation of the lesion itself, obliteration with the galvanocautery, injection of sclerosing agents and surgical excision, the last method was considered more certain of cure and was the method of choice.

All of the patients were treated similarly: the principal artery or arteries leading to the lesion were independently ligated as a preliminary step. A scalp flap, horseshoe in shape and including galea, was then reflected to expose the lesion from the under side. Hemostasis was secured by finger pressure and by independently ligating and dividing each vessel as it was encountered in the incision. The main vessels including the central portion of the lesion were completely excised from the under side of the flap which was then replaced with interrupted silk stitches in galea and skin. EDWARD H. CAMP, M.D.

Moses, W. R. Ligation of the Inferior Vena Cava or Iliac Veins. *N. England J. M.* 1946 235: 1.

The author reviews the history of operative interruption of the inferior vena cava. In summarizing the literature on the subject in 1937 Krotoski collected 48 cases of ligation of the vena cava, performed by 27 operators. In 1944 Homans reported 14 cases of surgical interruption of the iliac vein for venous occlusive disease of the lower extremities.

Whether medical or surgical therapy will prove to be the more satisfactory solution for the problem of treatment of pulmonary embolism depends on the information to be gleaned from several more years of experience. The evaluation of any therapeutic approach to the problem of phlebotrombosis must of necessity await the clarification of the diagnosis of its presence. Phlebotrombosis resembles no other disease so closely as it does cancer in that the most significant phase of the disease occurs during the period when the diagnosis is the most obscure.

The following indications on which the decision for ligation of the vena cava may be based have been tentatively accepted by the author: thrombophle-



itis of the pelvic veins with pulmonary emboli pulmonary embolism associated with prostatic tenderness of recent or presumably recent origin especially with demonstration of deep tenderness along the anterolateral region of the rectum reasonably conclusive evidence of pulmonary infarcts the source of which remains obscure despite diligent search and venous occlusion of the lower extremities that would otherwise be treated by interruption of the femoral vein alone. The conditions governing the last are as follows: cellulitis or lymphangitis of the upper thigh, infections of the groin or the finding of enlarged and tender inguinal or femoral triangle lymph nodes recurrent emboli following bilateral ligation of the femoral veins femoral phlebothrombosis with tense edema extending above the knee the operative finding of adherent clot on exposure of the femoral vein and acute thrombophlebitis extending into the upper thigh clinically with the presence of pulmonary embolism.

In the prevention and therapy of pulmonary embolism ligation of the inferior vena cava is related to interruption of the femoral vein not as a substitute but rather as a complement. The medical literature is replete with sizable case series proving that femoral ligations are safe, simple and responsible for a significant decline in the mortality from pulmonary embolism. There remain, however certain conditions under which low ligations do not suffice and higher ligations than those of the femoral veins seem the procedures of choice. Thrombophlebitis of the pelvic veins with pulmonary emboli cannot be prop-

erly handled with any surgical intervention less radical than ligation of the vena cava.

Ligation of the vena cava is comparable to ligation of either iliac vein, requiring no more anesthesia, exposure, technical skill, or time. For these reasons, the iliac approach has been entirely abandoned by the author.

The operative technique of ligation of the vena cava is described, and the incidence and etiology of postoperative edema of the extremities are discussed.

Abstracts of the case histories of the 13 patients who died and the essential data on the 22 who survived are presented. HENRIET F. THURSTON, M.D.

### BLOOD; TRANSFUSION

Puyó Villafañe, E.: Intracardiac Transfusion (Sero transfusión Intracardíaca). *Sem. Méd., B. A.* 1946, 33 874.

The author reports 2 cases of shock in which the patient received an intracardiac transfusion with a successful result.

The first case was that of a 34 year old soldier who had an operation on his knee and collapsed 5 hours later. Adrenalin and citrated blood were injected intracardially. The patient survived only for a few hours. The second case was that of a patient with a wound in his neck and an aneurysm of the subclavian artery who had collapsed. He was given 500 c.c. of physiological solution intracardially and 300 c.c. of blood with very good results. The patient survived the operation. WILLIAM E. RICKETS, M.D.

# SURGICAL TECHNIQUE

## OPERATIVE SURGERY AND TECHNIQUE POSTOPERATIVE TREATMENT

Bohmanson G., Rosenkvist H., Thorsén, G. and  
Wilander O.: Clinical Experiences with Dex-  
tran as a Plasma Substitute. *Acta chir scand*  
1945, 94: 149.

Dextran is a polysaccharide of glucose molecules obtained as a special product in the manufacture of beet sugar. For intravenous use it is purified and its molecular weight is hydrolyzed down to about 100,000. It is used in a 6 per cent solution with a viscosity of 4.5 to 5.2. This solution when given to human beings, has a tendency to increase the sedimentation rate. No impairment of renal function was demonstrable on the basis of a careful check of the urinary output, specific gravity, excretion of sodium chloride, and urea clearance. Hippuric acid phosphatase, bilirubin and urobilinogen revealed no impairment of liver function. Erythrocyte leucocyte and thrombocyte levels were not affected. There was no sensitization due to repeated infusions. Transfusions, intravenous and intrasternal caused no local phlebitis, and paravenous leakage gave no severe pain. The increase in blood pressure following dextran was due to the increase in circulating volume. In every case of shock treated with dextran the rise in blood pressure was maintained for a satisfactory period of time. Oscillometric readings showed that dextran increased the strength of pulsation and also served to decrease the level of hemoglobin concentration in shock. About one-eighth of the infused dextran reaches the urine in 4 hours and the remainder is usually excreted in about 24 hours.

The reactions following the injection of dextran were mild—urticaria, chill, a rise in temperature, muscular pains, headache, and lumbar pain occurring occasionally.

BENJAMIN G. P. SHATKOFF, M.D.

Evans, J. A. and Bolter, R. J.: Subcutaneous Heparin in Anticoagulation Therapy. *J Am Med Ass* 1946 131: 879.

The authors report the recent experiences at the Lahey Clinic, Boston, Massachusetts, with the subcutaneous administration of heparin in anticoagulation therapy for cases of postoperative venous thrombosis. In the last 3 years and 10 months only 133 such cases developed in approximately 20,000 major surgical procedures. In 8 of these femoral ligation was performed, without further venous sequelae. This operation was reserved for cases of ambulatory recurrent calf phlebotrombosis with one or more benign pulmonary emboli or postoperative cases in which a second operation had to be performed. In the other 125 cases treated with anticoagulation therapy there was only 1 death. During the same period, approximately 40 patients died of sudden pulmonary embolism without warning.

The characteristic effect of dicumarol on clotting—a drop in the prothrombin percentage—is achieved in from 2 to 5 days. During the period of lag heparin has been given to prolong the coagulation time. Within the last 9 months the intravenous drip method of administering heparin has been discontinued and replaced by the more desirable method of subcutaneous injection. In this procedure Pitkin's menstruum (18% gelatin, 8% dextrose, and from 1 to 1 1/4% acetic acid in distilled water) which releases water soluble drugs slowly is utilized as a vehicle for the heparin.

The Pitkin's menstruum is supplied in 1 c.c. ampules containing 100 mgm. of heparin and 2 c.c. ampules containing 200 mgm. of heparin. Either ampule may be had with vasoconstrictors added—10 mgm. of epinephrine and 1 mgm. of epinephrine. The authors regard the following as the most effective dosages for patients under 150 pounds: 1 c.c. without vasoconstrictors and 1 c.c. with vasoconstrictors given simultaneously with the first dose of dicumarol and for patients over 150 pounds: 1 c.c. without vasoconstrictors and 2 c.c. containing vasoconstrictors. Daily prothrombin percentage determinations guide the dicumarol therapy and daily coagulation times, the heparin/Pitkin therapy. The dose is repeated if the coagulation time returns to normal before the dicumarol has lowered the prothrombin time to at least 69 per cent. An initial dose of 200 mgm. of dicumarol is given to patients under 150 pounds and of 300 mgm. to those over 150 pounds. A daily maintenance dose of 100 mgm. is given whenever the prothrombin is over 65 per cent.

Of the 18 patients in the author's series receiving heparin/Pitkin therapy, 9 were given no vasoconstrictor whereas the other 9 received it. The first group with no vasoconstrictors, showed an increase in coagulation time within 2 hours. Three patients responded in the first hour. The maximal effect took place between 12 and 24 hours later and the average duration of the effect was 41 hours. The second group showed approximately the same time of onset of effect and time of maximal effect. However there was a greater duration of the effect in these cases the average being 61 hours. When the heparin/Pitkin therapy was given in a ratio of 200 mgm. with vasoconstrictor to 100 mgm. without, a marked prolongation of effect was attained up to 108 hours in 1 instance. This result is more to be desired in cases in which heparin is being given alone than in those in which it is merely given during the latent period in dicumarol therapy.

Occasional side effects of heparin/Pitkin administration are mild and usually require no treatment. They consist of local pain, swelling, and tenderness. Symptoms of palpitation and mild vertigo caused by the vasoconstrictors subside within an hour without treatment.

The authors conclude that heparin administered subcutaneously in Pitkin's menstruum, with or without vasoconstrictors, is an effective agent in anti-coagulation therapy. B F LOOMSBURY M.D.

Bauer G : Heparin in Venous Thrombosis. *J Am. Med. Ass.* 1946, 131: 196

In the summer of 1940, a new method for the treatment of thrombosis of the deep vein of the leg was introduced at the Mariestad Hospital in Sweden. In preliminary investigations, phlebograms were performed on nearly 600 patients. In 246 of these patients studies were made of acute deep thrombosis. In another equally large group the chronic stage of the disease was studied. About 130 phlebograms and dissections were made to ascertain the normal anatomy of the veins of the leg.

It is now almost generally agreed that thrombophlebitis is a primary disease of the wall of mainly the subcutaneous veins, secondarily followed by thrombotic obliteration. On the other hand in the deep veins of the leg the clotting of the blood is the primary factor and only secondarily the wall of the vein becomes involved. Acute thrombosis of the deep veins, or phlebothrombosis are the terms for this process. About 250 phlebographic studies have shown that the process begins with a thrombus arising in a muscle vein and projecting into one of the larger veins where it becomes the starting point of a deposition thrombus the latter continues growing upward in the direction of the blood stream for 40 to 50 mm. gradually occluding the entire lumen.

The thrombus is anchored only at its lowermost end far down in the lower part of the leg. Within 24 to 48 hours the thrombus either gives rise to an embolus or more often, it fills completely the femoral vein and becomes attached to it giving rise to phlegmasia alba dolens. This course was proved by phlebography which also revealed an occurrence of thrombosis in the other leg in at least 30 per cent of all untreated patients. Recanalization of the thrombosed veins seldom occurs.

For the rest of the patient's life the drainage of the venous blood from the lower part of the leg is taken care of by the saphenous and an accessory system of subcutaneous veins. A mild state of venous stasis occurs and due to overloading the superficial veins undergo degeneration and distention and their valves become defective. This in turn increases the stasis in the lower part of the leg and leads to induration and ulceration of the skin. Leg ulcers, thought to be due to varices, were found in 80 to 90 per cent of cases, to be due to deep thrombosis, and therefore the term post thrombotic ulcer is proper. Deep thrombosis has ultimately led to permanent swelling of the leg in more than 90 per cent of patients to indurative lesions, and in about 80 per cent to leg ulcers. Early diagnosis is highly desirable in order to prevent fatal pulmonary embolism by vein ligation or anticoagulant therapy. The latter if used early, stops the thrombotic process in the lower leg thereby preventing late thrombotic sequelae.

None of the early clinical signs, such as rise of pulse, of temperature or swelling or tenderness over the calf are absolutely indicative of thrombosis unless confirmation is had by phlebography. No patient was treated by the author without x-ray confirmation of the diagnosis. The interpretation of x-ray pictures does not give rise to difficulties, provided careful technique is observed, and some experience is at hand.

In an initial group of 29 cases in which phlebography disclosed incipient thrombotization of the lower part of the leg, no heparin therapy had been used as yet. In 24 of these cases, spread to the femoral vein and the development of phlegmasia alba dolens were shown. Pulmonary embolism occurred in 11 cases, and proved fatal in 3. In 10 cases the thrombosis was bilateral. High femoral vein ligation was performed in 2 cases with pulmonary infarct.

The knowledge of the late results of thrombosis, when the popliteal and femoral veins were involved and put out of function was a warning against the continued use of femoral vein ligation and it was therefore decided to try heparin.

The prophylactic use of heparin was ruled out, and its use in fully developed thrombosis did not appear promising. Results with heparin in early thrombosis were favorable and the entire course of the disease was changed: there was no spread of thrombosis, fever, pain and swelling subsided in a short time and the patients left their beds in less than a week. The treatment consisted of (1) early diagnosis (2) immediate intensive heparinization (3) movement of the leg from the beginning (4) getting patient out of bed as soon as acute symptoms disappear and before the termination of heparin injections.

Heparin was administered by intermittent intravenous injections. 150 mgm. of heparin was given as the initial dose followed by 1 or 2 equal injections every 4 hours the last dose given late at night. On the following day, 3 or 4 injections were given with early morning and night doses of 150 mgm. and 1 or 2 mid-day doses of 100 mgm. After a few days the temperature returned to normal and swelling and palpation tenderness disappeared. The patient was then allowed out of bed and the heparin dose was reduced to 100 mgm. twice daily and was discontinued after 1 or 2 days. When leaving bed, the patient was provided with an elastic bandage or a Unna's paste stocking covering the foot and lower part of the leg for a period of 2 to 3 weeks.

It was found to be of utmost importance that the patient get out of bed before heparinization was terminated. In one case, for instance, disregard of this rule apparently resulted in death. It should be stressed that when heparin is no longer being administered the patient is on the following day totally unprotected against fresh thrombosis. The average stay in bed was 4.7 days after starting heparin therapy as compared with 40 days in the control group.

Getting out of bed may not be feasible in some cases, as in fractures of the lower extremities. Pro-

tracted heparin treatment was then used and tension and relaxation exercises were performed in bed even under a cast. In the protracted heparin treatment, heparin was given every other evening during the second week and every third evening for another week, and then discontinued. It was assumed that the body had by then adapted itself to the new condition. In none of the 32 patients thus treated was any recurrence observed.

In cases with massive pulmonary embolism larger doses were used i.e. 150 mgm. every 4 hours. An antispasmodic was also given.

If a phlegmasia alba dolens was already manifest as in patients previously treated by practitioners treatment was materially the same. In some cases response was fast in others somewhat larger doses and more prolonged treatment was necessary.

During a period of 5 years from 1940 to 1945 209 cases of acute thrombosis of the deep veins of the leg were treated. In almost all cases the diagnosis was verified by phlebography. In a comparative series of 264 cases of thrombosis observed during a period of 10 years there were 47 deaths. On the other hand of the treated patients, only 3 out of 209 died thus the mortality after heparin treatment dropped from 18 per cent to 1.4 per cent. Likewise, the mortality from pulmonary embolism dropped from 0.2 to 0.018 per cent. The following comparison is made of the thrombosis material at Mariestad Hospital Sweden, during a 10 year period when an old fashioned treatment was used and a 5 year period when heparin treatment was used.

	1940-1945 Conservative heparin treatment	1940-1945 heparin treatment
Number of patients admitted	25,628	16,495
Number of thrombosis cases	264	209
Fatal embolism	47	3
Mortality among thrombosis cases	18%	1.4%
Total mortality from thromboembolism	0.2%	0.018%

\*Of these, 79 patients (two fifths) were admitted because of thrombosis which had been contracted in their homes or at other hospitals, but had not received any treatment.

Contrary to general belief no intra abdominal subcutaneous, or other serious bleedings were encountered with heparin except for hematoma which was seen in 3 cases lasting only 2 days and was not followed by any renal irritation. It passed off without necessitating discontinuation of the heparin

regime or even reduction of the dose. In a case a mild bleeding into the knee joint occurred after operation for a lacerated meniscus. Thus there appears to be no contraindications to the use of heparin, and diseases of liver kidney or other parenchymal organs are not badly influenced. Puerperal bleeding was not affected and existing traumatic hematomas were not enlarged.

It is highly probable that a large majority of heparin treated patients will escape troublesome after effects which have been regularly observed in conservatively treated thrombosis patients who develop permanent leg swelling and later brown induration and ulcers.

ARTHUR J. LERBER, M.D.

#### ANTISEPTIC SURGERY TREATMENT OF WOUNDS AND INFECTIONS

Perez, M. Experimental Study of the Pathogenesis of the General Syndrome of Burns (Ricerche sperimentali sulla patogenesi dello sindrome generale da scottatura). *Arch. ital. chir.* 1945 67 343

The pathogenesis of the general syndrome of burns was studied in dogs. Under ether anesthesia the sciatic obturator and femoral nerves were resected. In order to avoid traumatic shock, novocain was injected into the nerve trunks before they were severed. A segment of each nerve, 2 cm. long was resected and in addition a periarterial sympathectomy of the femoral artery was performed. In one series of experiments the procedure was supplemented by a bilateral lumbar sympathectomy done via the transperitoneal route. Ten days later a burn was produced by immersing one of the lower extremities in hot water.

The general condition of the pulse, blood pressure, respiration, body temperature, and blood picture of the animals was recorded. The author concludes from his observations that denervation of the burned extremity does not modify the general syndrome of a burn. Phenomena related to the increase of the concentration of the blood in the capillaries are of a reflex origin.

The general syndrome of a burn is due to the entry of toxins from the burned area into the circulation. Such toxic substances affect chiefly such organs as have antitoxic functions. JOSEPH K. NARAT, M.D.

# PHYSICOCHEMICAL METHODS IN SURGERY

## ROENTGENOLOGY

Esquerro Gomez, G: Roentgenography and Tomography of the Larynx (Radiografía y tomografía laríngeas) *Bol. Clin. Méjico* 1946 8 58.

The author makes a comparison of the roentgenographic and tomographic procedures in the diagnosis of diseases of the larynx in 5 cases. He concludes that both procedures are very useful, and that their associated use gives better information than each procedure alone. WILLIAM E. RUCKERT, M.D.

Gershon-Cohen J: The Phantom Nucleus Pulposus. *Am. J. Roentg.* 1946 56 43

The author reports 3 cases in which he noted a skull-like region of decreased density within the intervertebral space between the fifth lumbar and first sacral segments and 1 case in which such a region was found also between the fourth and fifth lumbar vertebrae. He believes the appearance ascribable to a "phantom nucleus pulposus," i.e., a vacuum in the intervertebral disc resulting from loss of the nucleus pulposus as hypothesized by Knutson in 1942.

Each of these patients had sustained an injury many years earlier which had resulted at once in low back pain severe enough to incapacitate the patient for several weeks in the absence of positive neurological signs or of evidence of fracture or dislocation. Two of the patients had had occasional recurrence of the low back pain. Each of them on recent physical examination showed slight limitation of motion at the lumbosacral joint without other signs but there was roentgen evidence in each case, in addition to the phantom nucleus, of from minimal to moderate subchondral osteosclerosis localized to the lumbosacral region and associated with only slight narrowing of the intervertebral space.

The author believes that these localized hypertrophic osteoarthritic changes point to old injury in the affected region, and suggests that the phantom nucleus is another residuum of the injury at the time of which loss of nuclear substance presumably took place through a defect in the cartilage plate due to rupture of the annulus fibrosus. He believes it may prove a useful diagnostic sign of such disc injury in cases too recent to show accompanying subchondral osteosclerotic changes.

LESLIE DONALDSON, M.D.

Epstein, B. S., and Davidoff L. M: The Use of Laminagraphy with Encephalography in the Diagnosis of Midline and Subtentorial Brain Tumors. *Am. J. Roentg.* 1946 55 675.

The authors recommend the use of laminagraphy as a routine procedure in pneumoencephalographic study in the diagnosis of midline and subtentorial brain tumors. During the past 2 years over 100 laminagraphic examinations were performed. The

findings of pneumoencephalogram and of laminagraphic examinations of 30 controls and 15 cases which had tumors encroaching on the midline structures were compared in a table to demonstrate the superiority of laminagraphic visualizations over that of encephalograms. The usual standard exposure of the skull are taken before laminagraphic examination. The technique consists of taking a center or laminagraph and cuts 1 cm. to the right and 1 cm. to the left of the midline with the head positioned as for a lateral roentgenogram. Other studies are made as required by the individual patient. The structures which have been more satisfactorily visualized (Fig. 1) are the third ventricle, the aqueduct of Sylvius, the fourth ventricle, and the clisterna pontis.

The roentgenological localization of tumors of the midbrain, pons, cerebellum and adjacent structures rests on the effect of these on the midline structures as visualized by means of gas. The differential diagnosis between posterior fossa or midbrain tumors and inflammatory lesions including the aqueduct of Sylvius or the foramina of Magendie and Luschka may be very difficult, and often depends on adequate visualization of these structures. The basic criteria are filling or nonfilling of the ventricles, ventricular displacement or dilatation, and the demonstration of intraventricular shadows. Intraventricular tumors may arise from the ependymal linings (ependymomas) from the neuroglia close to the ventricle (gliomas) or from the choroid plexus (papillomas). Colloid cysts, which seem to occur only in the third ventricle, may spring from the paraphysis. Meningiomas may arise from the tela choroidea. They may manifest themselves roentgenologically as both intraventricular defects and displacement of the ventricles. Absence of filling of the third ventricle with adequate visualization of the lateral ventricle is considered strongly suggestive of intrinsic disease, but nonfilling of the fourth ventricle is much more difficult to evaluate. Lateral displacement of the third and fourth ventricles by supratentorial masses such as low parietal or temporal lobe tumors must not be confused with infratentorial or midline masses.

Tumors arising from neighboring structures may invaginate into the adjacent air filled structures. Among these are Rathke's pouch tumors, choroidal tumors, pinealomas, aneurysms of the circle of Willis or its main branches, gliomas of the basal ganglia and the quadrigeminal plate, and suprasellar or olfactory groove meningiomas. Adamantinomas completely blocking the third ventricle have been described.

Stenosis of the aqueduct of Sylvius on a congenital, inflammatory or obstructive basis must also be considered when this structure is not visualized during pneumoencephalography and when the lateral and third ventricles are dilated. Hydrocephalic dilatation of the anterior aspect of the third ven-

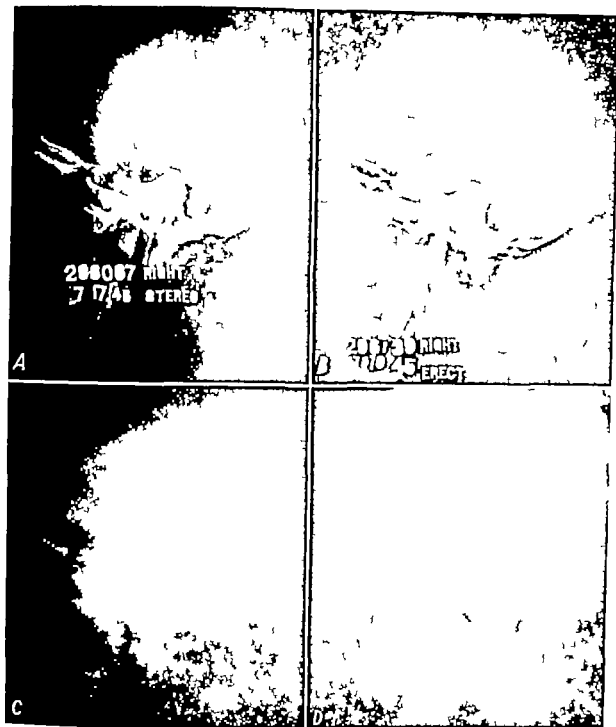


Fig. 1 (Epstein and Davidoff) A, Lateral roentgenogram of the skull reveals atrophy of the dorsum sellae. The floor of the sella cannot be identified. B, Lateral ventriculogram shows moderate dilatation of the lateral ventricles. A soft tissue mass protrudes into the cisternae chiasmaticus and interpeduncularis from the region of the dorsum sellae. The third and fourth ventricles are poorly outlined. The sella is the same as noted in A. C, The lateral midline laminogram reveals the fourth ventricle in its normal position. The third ventricle is not seen. The disappearance of the floor of the sella turcica is strikingly portrayed, and the soft tissue tumor occupying the sphenoidal sinus is readily apparent. The anterior wall and floor of the sphenoid bone are intact. D Off-center laminogram outlines the entire third ventricle and the upper aspect of the aqueduct of Sylvius. The fourth ventricle is not seen on this laminogram. A chromophobe adenoma of the pituitary was found at operation.

resulting in enlargement of the sella turcica must be borne in mind when the differential diagnosis of intrasellar tumors is considered. Inasmuch as the anterior wall of the third ventricle is thinnest,

dilatation of that structure may cause it to balloon downward and forward; it then exerts pressure on the sella and produces enlargement and atrophy. Cerebellar tumors arising from the midline, such as

hemangioblastoma may displace the aqueduct of Sylvius anteriorly. Tumors arising from its inferior aspect may produce dilatation of the aqueduct as well as of the anterior portion of the fourth ventricle while tumors springing from its superior surface may result in dilatation of the aqueduct and compression of the fourth ventricle. A shift of the fourth ventricle to either side may aid in lateral localization. Intraventricular tumors may be visualized if such the cavity is not obliterated.

Pontine tumors may be diagnosed pneumocephalographically by distal displacement of the fourth ventricle and aqueduct and narrowing of the cisterna pontis as the result of a mass within the pons. From the roentgenographic viewpoint the diagnostic tests on adequate visualization of these structures. Cerebellopontine atrophy result in an increase in the size of the neighboring cisternae. When present it may be diagnosed because of the dilatation of these structures as represented pneumocephalographically.

Six case reports illustrate the importance of visualizing both the terna pontis and fourth ventricles by laminagraphy versus the lack of visualization by encephalography were presented.

FRANK H. R. M.D.

**Scott W. G. Radiographic Diagnosis of Prolapsed Redundant Gastric Mucosa into the Duodenum, with Remarks on the Clinical Significance and Treatment. *Rad. Clin.* 4: 347**

The author believes that prolapse of gastric mucosa into the duodenal bulb is a fairly common condition.

This condition occurred in 14 (10.1%) of 137 cases in which roentgenological examinations of the upper gastrointestinal tract were made. These examinations were made in a Naval Hospital to which patients with gastrointestinal lesions were referred. Three cases were proved by operation. Additional cases not included in this series in which the condition was seen at operation are described.

The principal symptoms in these 14 cases were: flow, intermittent epigastric distress, cramping pains (14), relief from food (10), sense of fullness, belching or heartburn (9) and nausea or vomiting (4). Most of the patients had severe reflux symptoms.

All typical complications were postoperative: intestinal ileus (2), perforation (1), constipation (1), ulcer (1), and death (1).

The roentgen diagnosis consists mainly of the demonstration of the characteristic mucosal pattern, which may be filling defect in the lumen of the duodenal bulb, which must not be confused with deformity of the bulb due to ulcer.

Differential diagnosis must also be made from gastric ulcer (in clinical grounds), duodenal peptic ulcer related gastritis, and hypoplasia of the duodenum, hypertrophy of the pyloric muscle (in all types), hypertrophic gastritis, and the normal contraction of the duodenal bulb when swallowed food is in the lumen.

The recommended treatment is surgery (gastrectomy and pyloroplasty) in severe cases, especially those with bleeding or free calcarement (reflux). (Continued from 101, M.D.)

## MISCELLANEOUS

### CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

Peters, F. M. A Disease Resulting from the Use of Pneumatic Tools. *Occup. M.* 1946 2: 55

Blood vessel disturbances, affections of muscles with atrophy and injuries to the bones and joints have been observed in workers since the introduction of pneumatic tools into French mines in 1839. Vibration was found to be the primary causative factor and it has been shown that the critical vibratory rate for the onset of this condition is between 2,000 and 3,000 revolutions per minute.

The author presents a detailed study of 29 workers who developed disturbances after an average interval of 19 weeks, following the use of pneumatic tools capable of developing 25,000 revolutions per minute. Of about 1,000 people employed on the production of B 29 bombers, 116 presented themselves with symptoms which were markedly different as compared to those previously reported. Only that hand holding the tool was affected.

The pain was constant rather than intermittent and was worse in those fingers most intimately in contact with the tool. Most workers experienced radiation of pain to the arm or shoulder and all noticed a stiffness and weakness in the hand and the fingers. None noticed a change in color but most of them experienced swelling. Cold seldom accentuated the symptoms. Most of the patients exhibited various degrees of anxiety about the condition and had become nervous and hostile.

Although there were no reflex changes, most of the patients exhibited abnormal sensory and neurologic findings in that portion of the hand in closest contact with the tool. Blood pressure, arterial pulsation and oscillometric readings were all within the range of normal. The finger pulse volumes as recorded by a plethysmograph revealed abnormally low pulsations, indicating a predisposition to vasomotor disturbance. A thermocouple was used to measure the temperature and a marked lowering was discovered in the affected fingers. Microscopic study of the capillaries in the nail bed revealed morphologic changes in most instances with a decided decrease in number of capillary loops. The roentgenological and laboratory findings were practically always within the range of normal.

Medical and physical therapy have not proved encouraging, neither has preganglionic section of the thoracic sympathetic chain. Therefore prophylaxis is at present the only rational approach viz. (1) limitation of vibration under the critical level (2) dampening the vibration (3) limitation of the length of use of the tool and (4) mechanical devices to hold the tool.

The author suggests that fatigue may appear if the capillaries are subjected to many rapid repeti-

tive blows and that if these continue unabated death of the tissue itself may eventuate.

DAVID H. LYNN, M.D.

Hirsch, H. L., Feffer, H. L. and O'Neill, C. B.: A Study of the Diffusion of Penicillin Across the Serous Membranes of Joint Cavities. *J. Lab. Clin. M.*, 1946 31: 535

Many joint infections are known to be caused by bacteria sensitive to penicillin. A study was made in order to determine penicillin exchange between blood and joint fluid as a prerequisite for the treatment of purulent arthritis.

Penicillin was injected into the knee joint or administered systemically. Assays were made on joint fluid and serum in order to determine the rate of diffusion across the serous membrane of the joint. Some patients received fever treatment during this procedure. The patients studied had rheumatic fever, rheumatoid gonococcal and other pyogenic arthritides. One hundred cubic centimeters of physiologic salt solution was injected into the knee joint and reaspirated for penicillin assay. No difference was found between sodium and calcium salts of penicillin G, calcium salts of penicillin X, or sodium crystalline penicillin. Penicillin was given by mouth in tablet doses of 100,000 units every 2 hours by continuous intravenous infusion of 100,000 to 200,000 units for periods of from 6 to 12 hours and by intermittent injection of 20,000 to 80,000 units every 2 hours or 25,000 to 30,000 units every 3 hours or 50,000 units every 6 hours or 200,000 units of penicillin in 20 to 50 c.c. of physiologic salt solution were injected into the knee joint.

If 30,000 to 200,000 units of penicillin were given into the knee joint, penicillin was found present in the knee fluid in from 24 to 120 hours depending on the dose. One hour after each injection penicillin was found present in the blood and was maintained at nearly constant levels throughout the period of observation. The concentration varied from 0.095 to 3.12 units per cubic centimeter. The knee fluid concentrations for from 12 to 24 hours were from 10 to 40 units per cubic centimeter. Only patients with secondary arthralgia showed no evidence of absorption of penicillin from the knee joint.

With extra articular administration of penicillin (oral or parenteral) joint concentrations from 0.095 up to 0.078 were found. The amount of penicillin which diffused into the joint cavity was varied and independent of serum concentrations. The diffusion into the joint occurred rapidly, from fifteen minutes after parenteral injection. Fever therapy did not affect the exchange of penicillin between blood and joint. The joint fluid concentrations of penicillin obtained with systemic administration of the drug are frequently insufficient to control the infection. Similarly insufficient amounts of penicillin are ab-



sorbed from the joint space into the blood stream to care for other sites of infections. It thus appears that in the presence of pyogenic arthritis, intra-articular treatment has to supplement systemic administration.

The local effect of penicillin on serous membranes has been known to be followed by a pleocytosis, and was found to increase the white blood count in the joint fluid for a period of about 48 hours following local injection.

ARTHUR J. LEASER, M.D.

**Larsen, B. B.: Pilonidal Cysts and Sinuses: A Technique for Excision and Primary Closure**  
*A. M. S. 1946 123 1090.*

This report concerns 225 consecutive cases of pilonidal cysts operated on by the various officers and residents in Surgery at the A. F. Regional Hospital, Trux Field, Madison, Wisconsin. Since bacterial cultures demonstrated the pilonidal wounds to be sterile at the time of block excision, it was

reasonable to expect primary closure to be effective. The results are impressive.

Primary union occurred in 96.9 per cent of the cases, and only 1.2 per cent of these were accompanied by minor separation or infection. The few cases that healed by secondary union usually had presented either recent acute inflammation or profuse chronic drainage and in no instance did more than half of the wound break down. Two hundred and twenty of these cases were followed up for an average of 114 days after surgery and it was found that 87.6 per cent remained healed. None of the others presented a true recurrence of the pilonidal cyst. Moreover, the infection was readily controlled and never involved the deep portion of the wound where a "dead space" is most likely to occur.

In evolving a standardized surgical technique, emphasis was placed on several factors. Acutely inflamed cysts were allowed to "cool off" for 2 or 3 weeks under the usual conservative management. Low spinal anesthesia was used in all cases where contraindicated. Methylene blue in peroxide was injected into a sinus and the elliptical incision was carried laterally far enough to include all involved tissue. It was believed that wide defects could be closed without marked tension if the underlying subcutaneous tissue was properly built up. Undenuding of the wound edges was scrupulously avoided and the creation of muscle flaps was deemed ill advised.

Closure was performed in layers with a "slit technique" but with #40 cotton, because it produced less wound reaction as compared with catgut. Without including the sacral fascia, the deepest layer of sutures was placed at that level where the fat could be approximated without undue tension. Although this occasionally left a dead space, this was thought to be less serious than placing fat under tension. Usually 2 rows of sutures were sufficient to build up the more superficial subcutaneous fat, attention being exercised to avoid overlapping of the skin edges and to keep the topmost row of sutures from being placed too close to the skin. The skin sutures were placed carefully so as not to penetrate into the subcutaneous tissue as an additional safeguard against bacterial invasion, as this is the most likely mode of postoperative contamination. Because of its hygroscopic as well as its bacteriostatic properties, crystalline sulfanilamide was dusted on the closed incision but not into the open wound. Zinc stearate powder was frequently substituted after 72 hours.

DAVID H. LARK, M.D.

**Sirtori, C., and Zorzi, G. C.: Histogenetic Study of Adenolymphomas (Considerazioni istogenetiche sugli adenolinfomi)** *T. med., Milano, 1945, 31 62.*

Adenolymphomas are made up of epithelial and lymphoid tissue in varying proportions. They are relatively rare and various names have been given to them in cases with little lymphoid tissue and multiple cysts the name of lymphomatous adenocystoma is to be preferred. They are almost always located in the lateral region of the neck and the parotid gland.

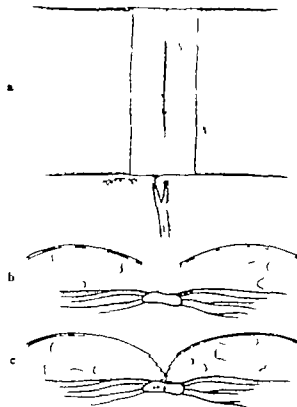


Fig. (Larsen) a, The area is draped with wet towels. The bottom towel is clipped to the skin to protect the field from contamination. b, The block excision must assure a thorough removal of the cyst. Undenuding should be avoided. c, Care is taken to place the bottom row of sutures at a level where the deep tissues can be approximated with out undue tension. The sacral fascia is never included in the deep suture layer. (Courtesy of J. B. Lippincott Co.)

are benign and grow slowly and rarely reach a very large size. They are enclosed in a connective tissue capsule and histological examination shows them to be made up of alveolotubular and cystic structures with walls of prismatic epithelium buried in abundant lymphoid tissue.

A typical case is described in a man of 40 with a tumor at the angle of the jaw which in the course of a year reached the size of a small filbert. It was sharply circumscribed with a smooth surface and a soft pasty consistency movable on the underlying tissues and painless. Histologically it showed lymphoid tissue with germinative centers and epithelial tissue forming tubular and cystic complexes. The epithelium which bordered the cystic and tubular structures was prismatic, sometimes simple but more often stratified and in rows the cells had an acidophil cytoplasm and a spherical nucleus which stained deeply. No active karyokinesis or atypical cells were seen. In the lumen of the tubes there was sometimes an amorphous substance which was markedly eosinophil and contained cellular detritus and pyknotic nuclei. The lymphoid tissue which formed the stroma of the tubules had the same structure as that of the lymph glands. The germinative centers were not very numerous. The epithelial and lymphoid tissues were distinctly separated from each other by a membrane and there was no intermingling to indicate a possible metastasis from the one form of tissue into the other.

The various theories as to the origin of these tumors are discussed. The theory that they are derived from aberrant rests of salivary glands is rejected. The author believes they are branchiogenic tumors in the broadest sense of the word with a structure similar to that of the tonsils they are derived not only from the third branchial cleft but also from the other clefts. AUDREY G. MORGAN M.D.

#### GENERAL BACTERIAL, PROTOZOAN AND PARASITIC INFECTIONS

Pupo, J. A.: Clinical Study of Leishmaniasis American of the Skin—*Leishmania Brasiliensis*—Vianna 1911 (*Estudo clinico da leishmaniose tegumentar americana—Leishmania brasiliensis*—Vianna 1911) *Rev Hosp Clin* 1946 1 113

A classification is given of the forms of leishmania. The skin forms include the initial papulovesicular the papulofollicular the tuberculous, the vegetating the nodular and the ulcerous. The mucous membrane forms affect the nose, mouth and laryngopharynx and may be propagated to the maxillary sinuses. The lymphatic forms include nodular and follicular lymphangitis and lymphadenitis. There are combined cutaneous and cutaneolymphatic forms. This disease may cause complications such as sinusitis osteoperiostitis osteolysis tropical ulcer, skin and mucous membrane myiasis erysipelas and elephantiasis nostras.

In general, the disease begins with a papule or nodule which ulcerates and becomes covered with a

crust the removal of which causes bleeding. It may extend rapidly and cause extensive destruction of tissue but it may last for years without causing serious damage to the general health. In some stages it may be confused with syphilis blastomycosis or lupus vulgaris, but differentiation is not particularly difficult. A fusospirillary infection may give the ulcers the typical picture of tropical ulcer. In this case the differential diagnosis can be made by means of the Montenegro reaction. General treatment with eparsono heals both the conditions. Local treatment for the fusospirillary symbiosis is given with solutions of sodium hypochlorite, potassium permanganate or chromic acid or bismuth salts in the form of salves associated with salol and camphor. The larvae of flies may infect the ulcers of leishmaniasis and cause great destruction of the tissue and serious complications. The myriases may be treated with salves and powdered calomel or water saturated with chloroform. Erysipelas is one of the most frequent complications of nasal leishmaniasis causing a chronic edema and elephantiasis nostras of the eyelids.

The various forms of leishmaniasis are described the descriptions being based on hundreds of cases seen by the author. Ninety nine illustrations are given which constitute a very valuable part of the article and give a clearer picture of the different forms of the disease than could be given by verbal description alone. AUDREY G. MORGAN M.D.

#### SURGICAL PATHOLOGY AND DIAGNOSIS

Roskam, J.: Bleeding Time in Human Beings; Its Utilization for Diagnostic and Pharmacodynamic Purposes (*Le temps de saignement humain. Son utilisation à des fins diagnostiques et pharmacodynamiques*) *Rev belge sc. med.*, 1945 16 157

The author used a slightly modified Duke's method of measurement of the bleeding time and gives an exact statistical evaluation of his results.

A close correlation was found between the bleeding time of the right and left ear at a room temperature of about 20°C. However the bleeding time varied



Fig. 1. (Roskam)

considerably from  $\frac{1}{2}$  minute to  $\frac{3}{4}$  minutes according to the site of the incision in the ear lobe. Therefore an average should be obtained by making 5 incisions in the ear lobe (Fig. 1).

Two hundred normal subjects were examined in this manner and the average bleeding times and statistical standard deviations were calculated. It was found that all medium bleeding times exceeding 3 minutes should be considered pathological.

ARTHUR J. LESSER, M.D.

Addis, T., Barrett, E., Law W. Poo L. J., and Others: Danger of Intravenous Injection of Protein Solution after Sudden Loss of Renal Tissue. *Arch. Int. M.* 1946 77 34.

In cases of shock there may be a sudden loss of effective renal tissue because for a time the kidney does not get enough blood more sustained deprivation sometimes occurs after transfusion reactions and there are instances of anatomic as well as functional loss, for instance when part of the kidney is destroyed by shell fragments, and when in glomerular nephritis and symmetrical necrosis of the cortex the majority of the nephrons in a short space of time may become functionless and many may be irrevocably destroyed.

For each of these situations there is a specific treatment dependent on knowledge of the causative mechanism, but in all except the most transitory instances of functional loss, the authors believe that the work demanded from the remaining renal tissue should be reduced.

After removal of three-quarters of the total renal tissue from young rats there were no deaths when no protein was taken, but as the amounts of protein consumed increased there was an increasing number of deaths from uremia.

In the survivors there were no signs of renal failure when no protein was taken, but as the consumption of protein increased the concentrations of urea and creatinine in the serum rose toward uremic levels, although at the same time the rates of urea excretion, of urea clearance, of work accomplished, and of new renal tissue constructed were all augmented. This was, therefore, not an absolute renal failure but a failure only in relation to the demand imposed.

An increased demand for work from the kidney is imposed by the parenteral injection of any protein to a degree that varies with its nature and with the conditions under which it is administered.

JOSEPH CASTER, M.D.

# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### CARCINOMA OF THE CORPUS UTERI

End-Results of Treatment in 531 Cases from 1926-1940

HOWARD C. TAYLOR Jr., M.D. F.A.C.S., and WALTER F. BECKER, M.D.  
New York, New York

CANCER of the uterus according to Bureau of Census statistics, caused the death in 1942 of 16 393 American women. Carcinoma of the endometrium is probably responsible for a fifth or more of these deaths since the ratio of corpus to cervical carcinoma has been variously estimated by different writers as 1 to 2.4 (10) 1 to 3.4 (19), 1 to 4.5 (18) and 1 to 8.2 (17). The importance of corpus carcinoma has been underestimated, partly because of its supposed infrequency, partly because of the persistent belief in its good prognosis.

Statistics on the results of the treatment of corpus carcinoma are partly responsible for the misconception about this disease. Methods of reporting cases of carcinoma of the corpus have never been standardized as they have, for instance, for cervical cancer. Too many reports have been based on cases selected for special treatment and the statistical principle of showing the results upon all cases applying to a given institute for treatment has not been followed. In the analysis of the cases to follow the attempt is to be made with the aid of data from several contributions in the literature to answer certain questions about cancer of the corpus.

The series to be reported includes all histologically proved cases of carcinoma of the cor-

pus uteri in patients admitted to the Memorial Hospital during the 15 year period from 1926 to 1940.<sup>1</sup> Only 7 patients are excluded, 5 who refused treatment and 2 who were referred back to the institution that had initiated treatment. Of the 531 patients considered, 368 had received no treatment prior to their admission to the Memorial Hospital and will be referred to as 'primary' cases. 163 had received previous treatment elsewhere and will be termed 'secondary' cases.

This report is concerned primarily with end results. Etiologic factors such as age incidence parity marital status and the menopause and symptomatology will be referred to only briefly. Pathology and therapy will be discussed in relation to end results.

#### ETIOLOGIC FACTORS

**Age.** The average age for the group of primary cases was 57.4 years, the standard deviation from the mean 8.8 years. The youngest patient was 30 years old and the oldest 79. The 5 year period of greatest incidence was 60 to 64 and 42 per cent of the patients fall in the decade between 55 and 64 years of age. The age distribution by 5 year periods is presented in Table I.

**Marital status.** Of the patients on whom data were available 88.5 per cent were mar-

<sup>1</sup>These patients were treated under the immediate direction of Dr. William F. Healy who was in charge of the Gynecological Division during the years of this report.

From the Gynecological Division of the Memorial Hospital New York.

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TABLE I.—AGE DISTRIBUTION

Age group	Number	Per cent
30 - 34 years	4	1.1
35 - 39	11	2.9
40 - 44	14	3.8
45 - 49	41	11.0
50 - 54	68	18.3
55 - 59	78	20.3
60 - 64	85	22.8
65 - 69	50	13.0
70 and older	22	5.9
Total	373	100.0

ried or widowed 11.5 per cent had never married. The figure for the single women does not differ greatly from that of a United States Census report which stated that in 1940 in the New York Northeastern New Jersey Metropolitan area, 12.1 per cent of women over 35 were unmarried (22). A report by the British Clinical Cancer Research Committee (1) in 1941 which compared the ratios of married and widowed to single women among the patients suffering from cancer with that to be expected among living women at separate age groups, showed that the liability to carcinoma of the corpus is somewhat less among married and widowed than among single women. Pack and LeFevre noted that the percentage of single women with cancer of the body of the uterus was four times as great as the percentage of single women with carcinoma of the cervix.

**Parity** The parity was recorded in the histories of 461 patients. Of these, 31.5 per cent had never conceived and all the pregnancies had never ended in abortion that is, of 3.9 per cent had never had a full term pregnancy. In 1940 in the New York Northeastern New Jersey Metropolitan area, of women 35 years old and over who had ever married 16.7 per cent had never borne a child (22). The statistics in the Memorial Hospital series indicate, then, that women destined to develop corpus cancer marry with about the normal frequency but then exhibit a relatively high degree of infertility.

While the 1930 population, for which figures are not available, would be more suitable comparison year, the proportions of single and childless women in 1940 are presumably at least as great as in 1930. Considerable differences between the corpus series and the comparative population will be understood rather than overestimated. Mrs. Ruth F. Johnston in the Statistics Department at Memorial Hospital points out that the true differences between women with cancer of the corpus and women in the general population cannot be determined until groups of similar age, income level, education, age at marriage, occupation of spouse, etc., are compared. Death rates from cancer of the corpus for single, married, divorcee and widowed women should also be compared.

TABLE II.—ONSET OF SYMPTOMS IN RELATION TO THE MENOPAUSE

	Number	Per cent
Menopause not yet reached	98	21.7
Menopause was artificially induced	23	4.7
Patient past the menopause	342	73.6
Average age of natural menopause—48.5 years		

**Menopause** The average age of the natural menopause was 48.5 years. As indicated in Table II 73.86 per cent of the patients were in the postmenopausal period, 21.17 per cent had not yet reached the menopause, and then had been an artificially induced menopause in 4.97 per cent of the cases. Data were lacking on 12.8 per cent of the patients.

**Associated primary carcinomas** Twenty-two of the patients had more than one primary carcinoma, making the incidence of double primaries 4 per cent. The frequency with which the other primary carcinomas occurred in particular sites was as follows: breast, 11; cervix, 3; vulva, 2; large bowel, 2; kidney, 1; esophagus, 1; bladder, 1; and lymphosarcoma, 1. Warren and Gates reported an incidence of 3.7 per cent in their series of 1,073 cancer autopsies. Hurt and Broders found that the frequency of multiple primary tumors among 2,124 patients with malignant tumors treated at the Mayo Clinic in the calendar year 1929 was 3.34 per cent. Among the 2,124 patients studied by Hurt and Broders, there were 71 cases of multiple malignant lesions. There were 8 cases of endometrial adenocarcinoma, and in every instance the associated lesion was in the breast or genitalia.

## SYMPTOMATOLOGY

Vaginal bleeding was a symptom in 96.6 per cent of the cases, but was usually slight, characterized by the patient as "staining" or "spotting." In those women who had not yet reached the menopause, menorrhagia of many years' duration was not an uncommon complaint although more often the bleeding was of the intermenstrual type. The commonest picture of all was, of course, postmenopausal bleeding. An associated vaginal discharge was mentioned in the histories of 57 per cent of the cases. Twenty-two per cent of the patients were complaining of pain at the time of admission to the hospital.

TABLE III.—RELATION OF DURATION OF SYMPTOMS TO END-RESULTS

Duration of symptoms in months	Cases		Five year cures	
	Number	Per cent	Number	Per cent
Less than 6	125	35.92	48	38.4
6 11	82	23.56	33	40.2
12 23	65	18.68	27	41.6
24 35	33	9.48	13	39.4
36 47	16	4.59	8	50.0
48 59	7	2.02	3	28.6
60 or more	20	5.76	10	50.0
Total	348	100.00	141	40.5

The average duration of symptoms before treatment for the primary cases was 15 months. The histones tend to confirm the opinion that carcinoma of the corpus uteri is often slow in growth and may extend beyond the uterus only after many months or years. Yet there was evidently great variability in this respect. Several of the patients who had disease in an advanced stage had experienced symptoms for only a few days while many of those whose symptoms were of several years' duration were found to have a normal sized uterus with the cancer still confined to that organ.

It was surprising also that, at least in this series, there was no evidence that the failure of treatment was directly related to the length of the symptoms. The relative success in the group of cases of long duration suggests the possibility that in some of these at least the endometrial lesion was in the beginning a benign one. Several studies have presented evidence that hyperplasia of the endometrium may be a predisposing factor to the later development of cancer. The literature also contains reports of several instances of apparent transformation of hyperplasia into carcinoma, as indicated by a change in the character of the tissue obtained in successive curettings in the same patient.

#### THE END-RESULTS IN CARCINOMA OF THE CORPUS

The end results of the treatment of all patients with histologically verified carcinoma of the uterine fundus admitted to Memorial Hospital during the period 1926 to 1940 inclusive are summarized in Table IV.

At the Memorial Hospital all of the ward patients and a majority of the private patients are treated by members of the gynecologic di-

TABLE IV.—END-RESULTS FOR ALL CASES 1926-1940

	Memorial Hospital	Gynecologic Division
Total number of cases	531	483
Indeterminate group Dead as result of other causes and without recurrence	3	3
Lost track of without recurrence	5	15
Total number of indeterminate results	8	18
Determinate group Total number minus those of indeterminate group	474	437
Failures Dead as result of carcinoma or its treatment	245	230
Lost track of with cause (probably dead)		8
Living with recurrence	7	16
Total number of failures in treatment	7	54
Successful results Free of carcinoma after 5 years	30	123
Five year end-results Successful results divided by determinate group	(30/474) 6.3%	(123/437) 28.1%
Absolute cure rate Successful results divided by total number of cases	(30/531) 5.7%	(123/483) 25.5%

A total of 5 cases are 1 the Memorial Hospital during these years were excluded from consideration because, although probably carcinoma of the corpus, there was no histologic proof. Of the group, 3 refused treatment and was referred back to the institution back had begun treatment. Among the 14 primary cases treated without histologic proof there were no cures. Among the 30 secondary cases, there were 6 cures after 5 years.

vision. About a tenth of all cases, however are managed as private cases by attendants from other divisions. For completeness, it has seemed necessary to present figures for the entire hospital but, since only the cases of the gynecologic division could be supervised from a standpoint of technique, it was also necessary to report figures for this group separately. In most of the following tables, therefore, two groups of figures appear, those for the whole hospital and those for the gynecologic division. In general, however, there is a significant difference between results in the two groups. Of the 531 patients 483 were treated in the gynecologic division and private patients treated on the gynecologic division the remaining 48 were private patients under the care of attending surgeons in other services.

Of the 531 patients 368 or 69 percent of the patients received all of the treatment.

TABLE V — END-RESULTS FOR PRIMARY CASES  
1926 — 1940

	Memorial Hospital	Gynecologic Division
Total number of primary cases	368	336
Indeterminate group		
Dead as result of other causes and without recurrence	81	80
Lost track of without recurrence	18	30
Total number of indeterminate results	99	110
Determinate group		
Total number minus those of indeterminate group	269	226
Failures		
Dead as result of carcinoma or its treatment	163	59
Lost track of with cancer (probably dead)	5	3
Living with recurrence	9	8
Total number of failures in treatment	183	70
Successful results		
Free of carcinoma after 5 years or more	147	126
Five year end-results		
Successful results divided by determinate group	( 7/330 ) 44.7%	(126/306) 44.4%
Absolute cure rate		
Successful results divided by total number of cases	(147/368) 39.9%	(126/336) 37.5%

here 163 or 30.7 per cent had undergone some treatment prior to their admission to the Memorial Hospital.

The absolute five year cure rate for the entire series including both primary and secondary cases, was 38 per cent. The 57 patients who died of other causes and without clinical evidence of recurrence and the patients who were lost track of without recurrence were considered failures in treatment.

#### END-RESULTS IN PRIMARY CARCINOMA OF THE UTERUS

In Table V, constructed according to a standard form in use for the reporting of end-results at the Memorial Hospital are shown the results in the 368 primary cases.

In this group there were 147 five year cures, giving an absolute cure rate of about 40 per cent (39.9). Since in this age group there is a considerable death rate from unrelated causes, a perhaps truer picture of the prognosis is given by accepting the figures for the determinate cases, after subtracting the cases lost

TABLE VI. — RELATION OF CLINICAL GROUP TO  
END-RESULTS PRIMARY CASES ON GYNECOLOGIC DIVISION

Clinical group	Cases Number	Per cent	Five year cases Number	Per cent
Clinical Group I				
Uterus not enlarged	50	15.10	33	66.6
Clinical Group II A				
Uterus not larger than 2½ months' gestation	156	42.09	74	47.4
Clinical Group II B				
Uterus larger than 2½ months' gestation	89	8.76	11	12.4
Clinical Group III A				
Extension of carcinoma to cervix only	37	11.18	9	24.3
Clinical Group III B				
Extension of carcinoma beyond uterus	79	23.87	9	11.3
All Cases	331	100.00	136	41.2

\*The records of 3 patients contained no data relative to clinical group.

track of without evidence of cancer and those dying of intercurrent illness. The effect of this correction is, however only to raise the apparent cure rate to about 45 per cent.

*The relationship of clinical extent of disease to end results.* A slight modification of Healy's (8) classification based on the palpable size of the uterus and the extent of disease at first examination was employed in dividing the primary cases into three clinical groups. This classification, which appears a highly practical one, is as follows:

Group I. Those cases in which there is no palpable evidence of uterine enlargement or extension of disease beyond the fundus.

Group II. Those cases showing uterine enlargement without fixation or other evidence of carcinoma elsewhere. This group was subdivided into Group IIA in which were placed those patients in whom the uterus was larger than a 2½ months gestation and Group IIB which included patients whose uterus was larger than a 2½ months gestation but still freely movable.

Group III. Patients exhibiting clinical signs of extension of cancer beyond the uterine fundus itself. Group III was further subdivided into those relatively favorable cases in which cancer had extended to the cervix only and into another group showing evidence of extension beyond the uterus into the vagina, parametria, and adnexa, and distant metastases.

The practical importance of this clinical classification is demonstrated in Table VI which

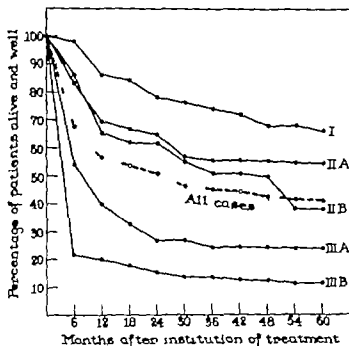
shows the relation of the clinical extent of disease to end results. Of the 50 patients in Group I, 66.6 per cent were alive and free of disease for 5 years or more. The absolute 5 year cure rate for the 136 patients with uterus enlarged up to the size of a 2½ months' gestation was 54.4 per cent. In 29 cases the uterine enlargement was greater than a 2½ months' gestation and only 37.9 per cent were 5 year cures. There were 37 patients in Group IIIA, 24.3 per cent of whom were living without evidence of recurrence at the end of 5 years. In Group IIIB were placed 79 patients with clinical evidence of extension of cancer beyond the uterus; the absolute cure rate in this group was only 11.2 per cent.

A similar plan of clinical division based on the size of the uterus was followed by Miller. His cases were divided into 3 clinical groups with the uterus normal in size in the first group, enlarged to the size of a 2½ months' pregnancy in the second, and to a 3 months' pregnancy in the third. The percentages of survival in these groups were 66.56 and 23 respectively while, had we used the same classification, our corresponding figures would have been 66.54, and 26.

The importance of the clinical extent of the disease is shown again in Graph 1 where the percentage of surviving patients is plotted at each 6 month interval after treatment was initiated. The survival curves show that the unfavorable prognosis of the more advanced cases is due especially to immediate deaths within the first 6 to 12 months after treatment. When a patient has survived the first 12 months without recurrence, her chance of survival is quite good regardless of her original condition. The survival curve is presented in the belief that it may be of aid in explaining the chances of cure to the anxious and often confused members of the families of patients with cancer of the corpus.

*The relationship of histologic type to end results.* In accordance with a plan previously employed in reporting carcinoma of the corpus from this hospital (Healy and Brown 8) the 368 cases were divided on a histologic basis into 4 groups (Table VII).

Group A—adenocarcinoma, grades I and II. This group included also cases originally diag-



Graph 1. Relation of clinical extent of disease to end results in primary cases of carcinoma of corpus uteri.

nosed as 'adenoma malignum,' a term now regarded as undesirable. Of the 199 cases with these relatively differentiated tumors the absolute 5 year cure rate was 47.2 per cent. When only cases of 'adenoma malignum' are considered the figure becomes approximately 51 per cent.

Group B—adenocarcinoma, grades III and IV and embryonal carcinoma. Of these undifferentiated tumors there were 117 cases with a 5 year absolute cure rate of 22.8 per cent, a figure less than half of the preceding group.

Group C—adenocanthoma. The results in this interesting histologic variety showed a cure rate of 51.3 per cent among the 37 cases suggesting that squamous metaplasia tends to occur in relatively differentiated growths.

Group D—miscellaneous. In this group were placed 15 cases in which inadequate microscopic preparation made classification on this basis impossible.

It appears evident that the prognosis in endometrial cancer is strongly affected by the degree of differentiation of the tumor. This is in accord with a number of previous reports (Healy and Brown, 8 Taylor etc.).

The unfavorable prognosis of the less differentiated tumors may depend on one or both of two possibilities. First, the grades III and



TABLE VII.—RELATION OF HISTOLOGIC TYPE TO END-RESULTS

Histologic type	Number of cases	Per cent of total	Five year cures	Number	Per cent
Adenocarcinoma, grades I and II	190	54.03	91	47.3	
Adenocarcinoma, grades III and IV and embryonal adenocarcinoma	7	31.79	30	2.8	
Adenocanthoma	37	10.05	0	51.3	
Miscellaneous	5	4.03	5	33.3	
Total	368	100.00	47	39.9	

IV may be more fatal on account of a greater tendency to metastasize even when the original tumors are grossly of equal size. Second a greater rapidity of initial growth may have produced at the time of treatment a larger primary tumor and so affect prognosis simply on the basis of a more extensive local disease.

Table VIII shows that the second possibility is at least one of the factors. In clinical Group I only 14 per cent of the cases are of the undifferentiated types whereas in the more extensive lesions these histologic types are several times as frequent.

*The relationship of the type of treatment to end-results.* The determination of the best method of treating carcinoma of the corpus has evaded statistical analysis. Nor has it been possible on the basis of this series to offer any final answer as to whether surgery alone or in some combination with radium or x ray is most effective.

In all series, certainly in our own cases are selected for a special form of therapy on the basis of factors which themselves affect the end results. Of the most importance is the tendency to assign the patient who is a bad surgical risk, on account of obesity age or organic disease to a program of radiation therapy. Such patients give less than the average

results among radiated just as they would among surgically treated cases.

Some favorable selection for surgery is seen in the tendency to omit radiation in the very early or unsuspected cases of endometrial cancer in order to prevent the patient's discovery of the diagnosis. Some cases having a bad outlook are however added to the surgical group in the belief that the very bulky uterus is too large for any significant effect from intracavitary radium.

In general the individualization of treatment in cases of corpus cancer appears to favor the statistics for hysterectomy alone or in combination with radiation as opposed to a program depending exclusively on radiation therapy.

In reporting the effect of treatment on the Memorial series, the question of surgery, radium and x ray will be considered first upon the entire series then with relation to the clinical extent of the disease and finally to the histologic type of tumor.

A few points may be noted about the techniques employed with the various therapeutic measures.

1. Radium. The standard method of treatment has been the intrauterine application of a straight applicator containing radium, individually constructed for each case so as to extend from the external os to the top of the uterine cavity. The usual initial dose has been 3600 millicurie hours. Patients to have surgery are admitted for hysterectomy 6 weeks after the radium treatment. Patients in whom surgery is contraindicated and for whom it is hoped radiation will suffice are now recurred after a 4 month interval and further radium inserted or the risk of a hysterectomy is then accepted if cancer is still present. In the earlier part of the period reported, however patients treated by radiation alone were simply observed unless bleeding recurred.

2. X ray. Roentgen therapy was at first given with massive doses of 750 r each to 4 or 6 portals (14 by 21 cm.) using a 200 kilovolt machine at 70 centimeters with 0.5 millimeter copper filtration. More recently 250 kilovolt roentgen rays have been used, still with 4 to 6 pelvic ports, but with a divided dose each field receiving 8 treatments of 250 r each. Roentgen therapy is now given rou-

TABLE VIII.—RELATION OF HISTOLOGIC TYPE TO CLINICAL GROUP

	Group I Per cent	Group II A Per cent	Group II B Per cent	Group III A Per cent	Group III B Per cent
Adenocarcinoma, grades I and II	80.70	58.43	43.33	49.09	40.73
Adenocarcinoma, grades III and IV and embryonal adenocarcinoma	4.03	29.85	46.66	42.11	38.27
Adenocanthoma	3.51	10.88	10.00	7.89	8.64
Miscellaneous	75	1.35	0.00	0.00	12.34

tinely after the radium in patients treated by radiation only and less regularly after hysterectomy, but in the years of the series being reported x ray when given was almost with out exception the initial therapeutic procedure.

3 Surgery The surgical operation employed has almost without exception been a total abdominal hysterectomy with removal of both adnexa. The cervix has been removed with only a small cuff of vagina and no attempt has been made to dissect out the lymph nodes or parametria.

In Table IX are presented the 5 year end results according to the method of treatment without regard to stage of the disease or histologic type. The figures are at first glance entirely in favor of the surgically treated cases. This is best shown by the figures in the summary indicating that of all cases in which a hysterectomy was performed 51.1 per cent survived 5 years without recurrence whereas among the cases with treatment limited to radium with or without x ray only 36.8 were alive and well after 5 years.

Perhaps the best evidence for the need of a hysterectomy is the frequency with which residual viable cancer is found in excised uteri following large doses of preoperative irradiation. Of the 119 patients of this series who were subjected to hysterectomy after having received as a rule 3600 millicurie hours of intrauterine radium 59 or 49.6 per cent, had microscopic evidence of viable cancer in the excised uterus. The absolute 5 year cure rate in the cases without residual carcinoma in the irradiated excised uterus was 73.8 per cent while only 44.1 per cent of the patients whose uterus harbored residual cancer survived 5 years.

Among 70 of the patients recently reported by Corscaden, treated by hysterectomy after intrauterine application of radium residual carcinoma was found in 50 per cent of the uteri. The possibility remains that an applicator more perfectly adapted to the varying sizes and shapes of the uterine cavity might result in a destruction of the carcinoma in a higher percentage of the cases treated.

*Treatment in relation to the clinical stage*  
Further analysis of the series by dividing into stages according to the gross extension of the

TABLE IX —RELATION OF TREATMENT TO  
END RESULTS

Method of treatment	Number of cases	Number of 5 year cures	Percentage of 5 year cures
Radium alone	60	28	46.7
Radium and x-ray	122	39	32.0
X-ray alone	10	0	00.0
Hysterectomy and radium	31	20	64.5
Hysterectomy radium and x ray	74	33	44.6
Hysterectomy and x ray	13	5	38.4
Hysterectomy alone	17	11	64.7

Summary

All patients treated by hysterectomy	135	169	51.1
Radium with or without x ray	182	67	36.8

disease the cases in which patients were treated by each method shows that a more difficult group was assigned to radiation than to surgery (Table X).

From Table XI a condensation of Table X, it is evident that in the radium group there was twice the proportion of very advanced cases a difference in selection which might easily account for the difference in total end-results.

The better comparison is perhaps made by studying the results only in the clinical groups I IIA, and IIB which may be regarded as technically operable. There were 109 such operable patients treated by irradiation alone with an absolute 5 year cure rate of 52.3 per cent. A combination of irradiation and hysterectomy was used in the treatment of 90 similar cases with a cure rate of 56.6 per cent. Sixteen patients were treated by hysterectomy alone of whom 10 or 60.3 per cent, survived for 5 years. These differences are probably not statistically significant and it becomes difficult to explain why when surgical specimens so frequently show persistent cancer after radium, that the difference in cure rates among operable cases is not greater.

A greater contrast between surgically treated and radiated patients was recently reported by Corscaden in a report based upon 27 cases in which patients were technically operable and were treated by the intrauterine application of radium, and 25 similar cases in which patients were treated by a combination of irradiation and hysterectomy. The 5 year survival rates in the 2 groups of cases were 48 per cent and

TABLE X.—RELATION OF CLINICAL GROUP AND METHOD OF TREATMENT TO END-RESULTS—PRIMARY CASES ON GYNECOLOGIC DIVISION

Method of treatment	Clinical group I			Clinical group II A			Clinical group II B			Clinical group III A			Clinical group III B		
	No. of cases	5 year cures		No. of cases	5 year cures		No. of cases	5 year cures		No. of cases	5 year cures		No. of cases	5 year cures	
		No.	%		No.	%		No.	%		No.	%		No.	%
Radium alone	5		72.3	16	5	37.7	5		40	6		66	5		66
Radium and x-ray	9	5	55.5	43	3	47.0	5	26	30	6	30	30	4	33.3	
X-ray alone			66			66			66			66	9		66.5
Radium and hysterectomy		9	8.8	16	19	68.5			66			30			66.5
Radium and x-ray and hysterectomy	10	5	50	30		52.8	7	3	42.9	9		28	22	4	33.3
Hysterectomy alone			50	7	6	85.7	7	3	42.9			66			66.5
Hysterectomy and x-ray	3		66.6			30	4		50			66	4		66
Total	30	22	66.6	125	4	32.4	29	11	37.9	37	9	24.3	77 <sup>a</sup>	9	11

<sup>a</sup>Three group III B cases were too far advanced for treatment but were included

72 per cent respectively. Arneson collected from the literature a series of 473 cases in which patients were operable and were treated by radiation alone, and found that 53 per cent survived for 5 years.

Another important subject is the possible advantage of combining radiation with surgery in cases of carcinoma of the corpus in the hope of improving the results obtained by hysterectomy alone. Only 17 patients in this series were treated by surgery without radiation and these afford an insufficient control. The results on these few cases were, however, as good as in any group in which radiation was given in addition to surgery.

Review of several reports in the literature (Table XII) also fails to demonstrate a consistent effect on statistics when radiation is added to surgical treatment. Altogether it seems unproved that the cure rate in corpus cancer is being improved by preoperative or postoperative x ray or radium.

*Treatment in relation to histologic type.* The bearing of histologic type upon method of

treatment has been studied and the analysis of the series for this aspect is shown in Table XIII. A point of possible significance is the decided advantage evident when surgery is employed for the differentiated forms of cancer. For the adenocarcinoma of grades III and IV, however, the results for radiation alone appear to be as good as for surgery. It is possible that the radiosensitivity of these types is the determining factor and that metastasis has occurred so frequently by the time treatment is instituted that the removal of the uterus is a relatively unimportant step. The evidence for this special point is, however, still too fragmentary to base treatment upon it as a principle.

#### END-RESULTS IN PREVIOUSLY TREATED PATIENTS

The problem of the treatment of recurrent carcinoma of the corpus requires in itself a major study and it is accordingly intended to report the secondary cases in only enough detail to make this a complete statistical study of the work of the hospital on carcinoma of the endometrium.

One hundred and sixty three patients who had received prior treatment for corpus carcinoma were admitted to the Memorial Hospital during the 15 years under consideration (see Table XIV). Thirty of these women presented no clinical evidence of carcinoma on

TABLE XI.—RELATION OF CLINICAL GROUP AND METHOD OF TREATMENT TO END-RESULTS

	Total cases	Stage I	Stage II A and II B	Stage III A and III B
Radium with or without x-ray	82	3.3	45.1	40.7
Hysterectomy, with or without radiation	35	0.3	59.3	5

TABLE XII.—RELATION OF METHOD OF TREATMENT TO END-RESULTS—RESULTS REPORTED BY OTHER AUTHORS

Author	Operation			Irradiation			Irradiation and operation			Totals		
	Cases	Alive 5 years	Per cent	Cases	Alive 5 years	Per cent	Cases	Alive 5 years	Per cent	Cases	Alive 5 years	Per cent
Berman, 1931	7	3	50	8		1.6	0	5	45.5	07	80	90.0
Mason, 1934	331	103	58.3	61	3	19.8	90	87	58.0	643	313	48.6
Norris (16), 1934	5	3	60.0	8	5	53.5	5	10	66.6	40	28	57.5
Boley (6), 1934				8	18	00	20		75.0	47	4	85.0
Wright and Crossen, 1935	20	13	65	3		5	20	14	60.8	56	20	51.7
Battle 1935		0	75	5	3	8	8		5.0	33	4	40
Norris and Dornie (16) 1936	15	55	47.8	80	30	43.8					04	44.5
Boley (7), 1936										7	78	35.0
Arason, 1936	20	3	65	5	5	8		0	90.0	48	27	56.3
Collection of Arason ( ) 1936	037	530	37	008	17	37	0	55	60	20.6	957	47.4
Martin, 1937	13	0	60	14	0	27.5	18	1	66.6	6	33	52
Taylor and Becker 1945 (includes only patients receiving all their treatment at Memorial Hospital)	0		57.0	3	70	3.8	20	66	5.4	253	147	41

admission, and the diagnosis was confirmed only by the microscopic examination of the material submitted from the institution at which treatment had been initiated. These were classed as "prophylactic" cases. The remaining 133 patients were termed recurrent cases since it was possible to make a diagnosis on biopsied or curetted tissue obtained after their admission to this hospital. No attempt was made to differentiate between persistent and recurrent disease.

The standard table for reporting end results is given for completeness for all secondary cases (Table XIV). Nevertheless, the 2 groups have a decidedly different significance and require separate comment (Table XV).

*a The prophylactic group* Twenty of the 30 patients in the prophylactic group were alive and free of disease after 5 years—an absolute cure rate of 66.6 per cent. This is the figure which may be anticipated in any series of operable cases which are treated by hysterectomy.

*b The total recurrent group* This group of patients treated for the first time in other institutions and referred to the Memorial Hospital with cancer still present is a miscellaneous one. It includes the inoperable patients with fixed uteri and large abdominal masses, recur-

rences in the vaginal vault and about the hymenal ring and urethra, and finally cancer redeveloping in cervical stumps. There were 33 five year cures among the 133 recurrent cases—an absolute cure rate of 24.8 per cent. This figure indicates that even when the first effort at cure is a failure, some hope still exists for control of the disease.

One point in regard to the recurrent group is worth noting. Among the 90 patients who

TABLE XIII.—RELATION OF HISTOLOGIC TYPE TO END-RESULTS WITH RADIATION ALONE AND RADIATION COMBINED WITH SURGERY

	Radiation alone			Radiation combined with surgery		
	Number of cases	Five year cures		Number of cases	Five year cures	
		Number	Per cent		Number	Per cent
Adenocarcinoma, grades I and II	114	45	59.3	67	44	65.7
Adenocarcinoma, grades III and IV	6	14	.6	45		26.8
Adenosarcoma	9	0	47.4	6		58.7
Miscellaneous†	8	4	20.6	4		00.0
Total	137	7	31.8	122	67	47.6

Also includes so-called adenoma malignum cases (includes cases in which scanty material or other factors made histologic grading impossible).

TABLE XIV — SECONDARY CASES  
FIVE YEAR END-RESULTS

	Memorial Hospital	Gynecologic Division
Total number of secondary cases	163	146
<b>Indeterminate group</b>		
Dead as result of other causes and without recurrence		
Lost track of without recurrence	8	6
Total number of indeterminate results	19	7
<b>Determinate group</b>		
Total number among those of indeterminate group	144	99
<b>Failures</b>		
Dead as result of carcinoma	76	7
Lost track of with disease (probably dead)	8	5
Living with recurrence	8	8
Total number of failures in treatment	92	20
<b>Successful results</b>		
Free of carcinoma after five years or more	53	5
<b>Five year end-results</b>		
Successful results divided by determinate group	(53/144) 36.8%	(5/99) 5.05%
<b>Absolute cure rate</b>		
Successful results divided by total number of cases	(53/163) 32.5%	(5/146) 3.4%

TABLE XV — SECONDARY CASES  
RELATION OF CLINICAL GROUP TO END-RESULTS

	Prophylactic group		Recurrent group			
	No. of cases	Five year	No. of cases	Five year		
		Number		Percent	Number	Percent
Entire Hospital (16 cases)	36	20	66.66	33	23	82
Gynecologic Division (46 cases)	1	16	64.00	26	34	1.66

had been surgically treated before being referred to Memorial Hospital, 57 or 66.4 per cent, had received only a supracervical hysterectomy. Thirty five, or 61.4 per cent, of those women who had had a supracervical amputation of the uterus had histologically verified carcinoma in the cervical stump at the time of their initial examination here. It is obvious that entirely too many women who are suffering from vaginal bleeding are still being treated by a subtotal hysterectomy with out curettage or adequate examination of the cervix.

## SUMMARY AND CONCLUSIONS

Five hundred and thirty-one histologically verified cases of carcinoma of the corpus uteri were admitted to Memorial Hospital during the period 1926 to 1940, inclusive. The absolute 5 year cure rate on this unsorted group of cases was 38 per cent.

The primary cases of the series numbered 386 of which 39.9 per cent were alive and well at the end of 5 years. By subtracting the patients lost track of when free of cancer and those dying of intercurrent, unrelated illness, the apparent cure rate for 5 years is about 45 per cent.

Of the secondary cases, there were 30 patients who came to the Memorial Hospital without clinical evidence of cancer and of these there were 20 five year cures. The patients admitted to the service with recurrences numbered 133 and, of these 24.8 per cent were alive and well after 5 years.

The prognosis in carcinoma of the corpus depends on 3 factors (a) the gross extent of the disease (b) the histologic type and (c) the type of therapy employed. Analysis of the present series was made to evaluate these points.

The effect of the gross extent of the disease is shown by the 5 year end results in 5 specified groups as follows. Group I uterus not enlarged, 66.6 per cent. Group II A, uterus not larger than a 2½ months gestation, 54.4 per cent. Group II B uterus larger than a 2½ months gestation, 37.9 per cent. Group III A, extension of carcinoma to cervix, 24.3 per cent. Group III B extension of carcinoma beyond uterus, 11.2 per cent.

The effect of histologic type is shown by the 5 year end-results in 3 classifications as follows adenocarcinoma, grades I and II 47.3 per cent adenocarcinoma, grades III and IV 22.8 per cent adenocanthoma, 51.3 per cent.

The relation of type of treatment to end-results is more difficult to evaluate. In the cases in which hysterectomy was performed a 5 year cure rate of 51.1 per cent was shown, while in the group of patients treated only by radiation the figure was 36.8 per cent. The group with treatment limited only to radiation contained, however more patients in a relatively advanced stage of the disease.

The question of whether the cure rate from hysterectomy is increased when radiation is given in addition could not be answered on the basis of the analysis of this material

## REFERENCES

1. Annual Report British Cancer Campaign, 1943
2. ARMEDON, A. N. *Am. J. Roentg.* 1936, 36 461-475
3. BEATTIE, J. *J. Obst. Gyn., Brit. Empire* 1935 40 768-791
4. BURNHAM, C. F. *Ann. Surg.* 1931 93 436-442
5. CORBRADEN, J. A. *J. Am. M. Ass.*, 1944, 126 1134-1138
6. HEALY W P. *Surg. Gyn. Obst.*, 1934, 58 452
7. Idem. *Am. J. Surg.*, 1936, 33 474-477
8. HEALY U P., and BROWN, R. L. *Am. J. Roentg.* 1939, 41 798-803
9. HURT, H. H., and BRODERS, A. C. *J. Lab. Clin. M.* 1933 18 765
10. MAHLE, A. E. *Surg. Gyn. Obst.*, 1923 36 385
11. MASON, J. C. *Surg. Gyn. Obst.*, 1934, 58 453-455
12. MILLER, N. F. *Am. J. Obst.* 1940, 40 791-801
13. MORTON, D. *Am. J. Roentg.*, 1939, 41 789-797
14. NEWELL, Q. U., and CROSSIN, H. S. *Am. J. Obst.* 1935, 29 326-334
15. NORRIS, C. C. *Surg. Gyn. Obst.* 1934, 58 458-459
16. NORRIS, C. C. and DUNN, F. S. *Am. J. Obst.* 1936 32 982-989
17. PACK, G. T., and LEFEVRE, R. G. *J. Cancer Res.*, 1930, 14 2
18. SMITH, G. V. S. SMITHWICK, R. H., and ROGERS, H. JR. *Am. J. Obst.*, 1928, 15 637
19. TAYLOR, HOWARD C., JR. *Am. J. Cancer* 1931 15 2522
20. Idem. *Am. J. Obst.*, 1932 23 309
21. WARREN S. and GATES, O. *Am. J. Cancer* 1932 16 1902
22. U. S. Census Bureau, Sixteenth Census of the United States, 1940 Population, Fourth Series, Characteristics by Age. New York, Washington, D. C. U. S. Government Printing Office, 1943

# THE EXCRETION AND CONCENTRATION OF PENICILLIN AND STREPTOMYCIN IN THE ABNORMAL HUMAN BILIARY TRACT II HEPATIC BILE

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**I**N a previous paper the results of studies of the excretion and concentration of penicillin and streptomycin in the human gall bladder were reported (6). We now wish to present our findings relative to the excretion and concentration of these antibiotic agents in the hepatic bile of the abnormal human biliary tract. The reader is referred to the previous paper for introductory remarks and for a review of the literature.

## METHOD OF STUDY

Twenty three patients, each of whom had undergone exploratory choledochostomy and insertion of a T tube in the common duct, were selected. Sixteen of these were used to study the excretion of penicillin 15 to study the excretion of streptomycin. Eight patients were tested only for excretion of penicillin 7 only for excretion of streptomycin and 8 for both. Therefore, on 8 occasions the results with penicillin could be compared with those for streptomycin.

Within a 3 day period after operation each patient was given a single intramuscular injection of either 15 000 units of penicillin or 100 000 units of streptomycin. When both substances were studied in the same subject, a single injection of each was given separately on the same day. Usually 6 to 8 hours were allowed to elapse before study of the second antibiotic agent was undertaken. Specimens of bile were collected from the T tubes at intervals of one-half hour to 1 hour up to 3 hours after injection of the antibiotic agent. Specimens of blood were obtained at the same time

from 4 patients who were given penicillin, and from a similar number given streptomycin. The antibiotic activity of all specimens was determined in the same manner as was done in the previous study (6). Within a 3 week period the study was repeated for penicillin in 5 cases and for streptomycin in 8 cases, in order to determine any change that might have occurred in the ability of the liver to excrete the antibiotic agent.

When the patient was jaundiced at the time of operation it was noticed whether the jaundice was increasing, stationary or subsiding as shown by estimations of the serum bilirubin level. In addition in most cases either an oral hippuric acid test or a sulfobromophthalein hepatic function test was done during the stay in the hospital. The former was performed in the presence of an elevated serum bilirubin level the latter in its absence. These observations were made in an attempt to correlate hepatic function tests with the ability of the liver to excrete antibiotic agents. An excretion in the urine of 3 grams of benzoic acid or its equivalent in hippuric acid is a normal value for the hippuric acid test, and retention of dye, "grade 0" in the blood serum is a normal value for the sulfobromophthalein test.

## RESULTS

*1 Penicillin* The results are collected in Tables I and II and are represented in Figures 1 to 3 inclusive. Table I states briefly a few pertinent facts in the history and the essential laboratory studies of the individual patients. Table II indicates the levels of penicillin activity in the bile in the initial study done within the first 3 days after operation. Reference to Figure 1 shows the similarity of the blood levels of the 4 patients studied. It is very likely that, had the other patients been so

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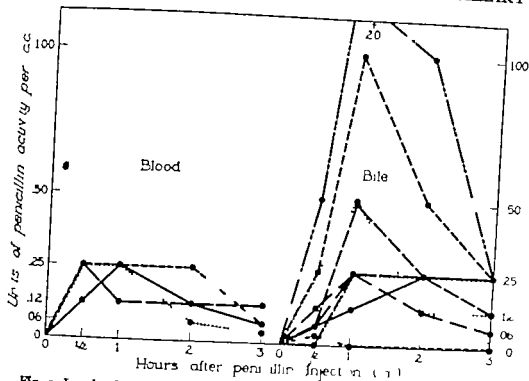


Fig. 1. Levels of penicillin activity in blood serum and hepatic bile after 15,000 units of penicillin had been given intramuscularly. Four patients were used for the blood curves and 16 for the bile curves. Of the latter 5 failed to excrete penicillin into the bile. The graph demonstrates the similarity of the curves of the levels in blood and dissimilarity of those in bile.

studied, similar curves would have been obtained. On the other hand a composite graph of the levels in the bile shows great variation in the height and shape of the curves. It is the purpose of this study to determine the factors responsible for this variation. In addition it is noticed that the levels of activity are higher in the bile than in the blood, indicating that the liver concentrates penicillin.

The patients were divided into three groups, on the basis of their ability to excrete the penicillin on initial study: those who failed to excrete penicillin, those who excreted it in very small amounts, and those who excreted it in high concentration. An arbitrary figure of 0.24 unit per cubic centimeter was decided on to separate those who excrete small from those who excrete large amounts, because in a previous study (6) it was observed that the smallest concentration of penicillin in gall bladder bile obtained within the first 4 hours after injection was at least 0.24 unit per cubic centimeter. Since all persons but one in that investigation had presumably normal hepatic function, it was assumed that that level was representative of the lowest limit of excretion in a normal subject.

It is realized that the volume of bile excreted during the 3 hour period for each study is not the same for all patients. However the amounts excreted during 24 hours were usually quite similar: 250 to 350 cubic centimeters. While it is conceivable that if one patient excretes 50 cubic centimeters over the 3 hour period of study, whereas another excretes 20 cubic centimeters, the first patient may dilute any antibiotic agent excreted and mask the results, this was not usually the case. Often the highest levels of penicillin were found among patients excreting relatively large volumes of bile at the time of study, and the lowest levels among those excreting small amounts of concentrated bile. Generally speaking, however, this factor was of little importance, since most patients excreted similar volumes of bile.

Group 1: no excretion of penicillin. Five patients failed to excrete penicillin within the 3 hour period of observation (Table I). In several cases the observations were repeated the following day with similar results. A short résumé of the history and laboratory findings in these cases follows.

CASE 1. The patient gave a history of recurrent colic in the upper part of the abdomen, often with



TABLE II.—EXCRETION OF PENICILLIN IN HEPATIC BILE FOLLOWING INTRAMUSCULAR INJECTION OF 100,000 UNITS (SUMMARY OF LEVELS ON INITIAL STUDY)

Group	Case	Penicillin level, units per c.c. of bile			
		1/2 hr.	1 hr.	1 1/2 hrs.	3 hrs.
	3				
	4				
	5				
	6		23		
	7	66			66
	8	66	5	12	66
	9	66		12	5
	10		5	5	
			5		66
1			15	5	5
	11	12	5		
	12	66	5	5	
	13	5		5	5
	14	5			5
	15	5			5
	16	5			5

CASE 3 The patient had undergone cholecystectomy previously. For 1 month he had continuous jaundice and acholic stools, but no chills, fever or pain. Exploratory choledochostomy was performed. No obstruction was found, and it was the surgeon's impression that the patient had intrahepatic jaundice. The preoperative serum bilirubin levels varied from 50.1 milligrams per 100 cubic centimeters to 55.5 milligrams per 100 cubic centimeters direct and from 1.8 milligrams per 100 cubic centimeters to 2.38 milligrams per 100 cubic centimeters indirect. A preoperative hippuric acid excretion test showed severe impairment of hepatic function since only 5.63 grams of hippuric acid (or 1.79 gm. of benzoic acid) was excreted in the urine. On the fourth postoperative day there was no excretion of penicillin in specimens of bile collected over hourly periods. Postoperatively, the serum bilirubin levels remained high, and the patient was dismissed from the clinic with his T tube in place.

CASE 4 The patient had had recurrent colic in the right upper quadrant of the abdomen for 1 year and had been icteric for 3 weeks. The serum bilirubin level was 4 milligrams per 100 cubic centimeters direct and 1 milligram per 100 cubic centimeters indirect. Following an oral hippuric acid test of hepatic function, it was reported that only 2.04 grams of benzoic acid had been excreted in the urine (normal, 3 gm.). Two cultures of bile from the common duct were reported as positive for *Escherichia coli*. No

penicillin was excreted in the bile on the fourth postoperative day. The patient's jaundice cleared rapidly and he had no immediate postoperative difficulty.

CASE 5 The patient was admitted with a history of intense jaundice for several months. The serum bilirubin level was 60.6 milligrams per 100 cubic centimeters direct and 4.3 milligrams per 100 cubic centimeters indirect. The oral hippuric acid test of hepatic function was reported as giving normal results. At operation a carcinoma of the gall bladder with a local metastatic growth obstructing the common duct was found. The duct was opened, "white" bile was obtained, and a T tube was inserted. On the fifth postoperative day there was no excretion of penicillin into the bile. The patient was dismissed unimproved on the eleventh postoperative day.

It is interesting to observe that in 4 of the 5 cases there was persistent jaundice before operation and in 2 of these cases "white bile" was obtained from the bile ducts at operation. However, even when color returned to the bile in 1 of the cases, indicating that some of the function of the liver was returning, penicillin was still not excreted in the bile. In 4 of the 5 cases there was impairment of hepatic function as shown by the usual tests of hepatic function. In 1 case, in which the patient was not icteric preoperatively, jaundice, chills, and fever developed soon after operation. During this time no penicillin was excreted, but as the cholangitis cleared, parenterally given penicillin was recovered in the bile.

Group 2 excretion of small amounts of penicillin

CASE 6 The patient had had intermittent chills and fever for 3 months and intermittent jaundice for 10 months. The serum bilirubin level on admission was 10.6 milligrams per 100 cubic centimeters direct and 2.1 milligrams per 100 cubic centimeters indirect. Operation was performed 10 days later when the jaundice was definitely subsiding. Cholecystectomy and choledocholithotomy were performed and a T tube was left in place. On the third postoperative day penicillin that had been administered parenterally was excreted in a concentration of 0.03 unit per cubic centimeter of bile in the 1 hour specimen, but all the other specimens up to 3 hours showed no activity.

CASE 7 The patient had had a biliary fistula since cholecystectomy had been performed 4 months before. The serum bilirubin level varied from 2.6 milligrams per 100 cubic centimeters to 3.2 milligrams per 100 cubic centimeters direct. A stone was removed from the common duct and a T tube was inserted. On the second postoperative day all specimens of bile collected up to 3 hours showed a maximal penicillin level of 0.12 unit per cubic centimeter after parenteral administration of penicillin.

TABLE III—EXCRETION OF STREPTOMYCIN IN HEPATIC BILE FOLLOWING INTRAMUSCULAR INJECTION OF 100,000 UNITS (SUMMARY OF PERTINENT DATA OF 15 CASES)

Case	Duration of jaundice	Hepatic function test		Preoperative serum bilirubin, mgm per 100		Maximal excretion of streptomycin, units per of bile		
		Sulfobromophthalein†	Hippuric acid‡	Direct	Indirect	Initial study	First repeat study	Second repeat study
	mos.		26	23.0	8		(1 wk later)	(3 days later)
7	3 mos.		30	55	3			
12	Recurrent (icterus)	Grade	51	5.6	0.1		(3 wks later)	
19	?		53	0	6	7		
20	3 wks.		3.06	5.1	3.41	6	(3 wks later)	
7	Recurrent (icterus)			1	7	4	(50 da later)‡	
	None	Grade			4	10.2		
14	None	Grade	1.84		8	5.1		
3	None	Grade	6	1	1	5	(1 da later)	(1 wk later)
	9 days		64	5.1	7.1	5		
	Recurrent (icterus)		45	0.1	0.1	5.5	79 (6 days later)†	
9	yr. (recurrent)			0.1	8.1	8.1	(15 days later)‡	
8	mo. (recurrent)		3.3	1.1	55.1	1	(14 days later)†	
1	3 wks.		3	1	1	1.1		
16	7 days (first attack)		8	8.1	1	8.7		

\*The amount of bile excreted in 4 hours varied from .50 to .350 for 11 cases

†Reported as degree of retention (grades 1-4)

‡Reported here as grams of benzoic acid excreted on oral hippuric acid test; normal, 3 gms.

§Level of serum bilirubin falling when study was made

¶Normal serum bilirubin when study was made

In both of these cases there was a history of chronic icterus and recurrent episodes of cholangitis. Both patients were apparently recovering from acute obstructive episodes when the study was made.

Group 3 excretion of large amounts of penicillin. The remaining 9 patients excreted penicillin in a concentration of at least 0.25 unit per cubic centimeter of bile. Five of these had no previous history of jaundice and in 4 of the 5 cases the maximal concentration of penicillin in bile varied from 0.5 unit per cubic centimeter to 2 units per cubic centimeter (Cases 13 to 16 inclusive). In the one nonicteric case (Case 12) in which the level did not exceed 0.25 unit per cubic centimeter it was persistent at this concentration in all except the half hour specimen. The remaining 4 patients (Cases 8 to 11 inclusive) gave a history of rather recent onset of jaundice and at the time of study they gave evidence of subsiding icterus. Two of these showed impairment of excretion of hippuric acid.

In general the highest levels of excretion of penicillin were found among those patients who had no history of recent or past jaundice and who exhibited good hepatic function as shown by the tests employed. With a history of persistent jaundice and with impairment of hepatic function less penicillin was excreted until in 5 cases none was excreted in the bile.

Excretion studies were repeated a week after the initial tests in 5 cases (Table I). Two of these have been described in detail in the previous paragraphs (Cases 1 and 7). It was seen in Case 1 that after 12 days of T tube drainage penicillin was excreted in a concentration of 0.12 unit per cubic centimeter where initially there was no excretion. After 7 weeks the patient in Case 7 was still unable to excrete penicillin. The 3 other patients followed showed a definite increase in ability of the liver to excrete penicillin (Cases 7, 8 and 9) as indicated in Figures 2 and 3. One of these patients (Case 7) who had an excretion level of 0.1 unit per cubic centimeter initially,

TABLE IV — EXCRETION OF STREPTOMYCIN IN HEPATIC BILE FOLLOWING INTRAMUSCULAR INJECTION OF 100 000 UNITS (SUMMARY OF LEVELS ON INITIAL STUDY)

Group	Case	Streptomycin level, of bile			
		1/2 hr	1 hr	1 1/2 hrs	2 hrs
1	7				
	8				
	9		5	7	< 5
2	10			6	6
	7		< 0.5		6
			Slight		30
3	14		5		
	3			5	5
			5	5	
	Trace				15
	9		8	8	
	8		25		
			64	5	44
	6	Trace		8	64

showed an increase to 1 unit per cubic centimeter in the half hour specimen. The patient in Case 8 excreted 0.25 unit per cubic centimeter soon after operation and 0.5 unit per cubic centimeter 5 days later. This was a patient who had recurrent jaundice of 1 month's duration and good hepatic function as shown by the oral hippuric acid excretion test. The patient in Case 9 excreted 0.25 unit per cubic centimeter at first, and 0.5 unit per cubic centimeter later.

Consequently it is noted that in 4 of the 5 patients followed there was a definite increase in the ability of the liver to excrete penicillin after a variable period of T tube drainage. Also from this it would appear that the lower limit of excretion 0.25 unit per cubic centimeter is an index of impaired excretion since in all 3 cases in which hepatic function was not seriously impaired a level of at least 0.5 unit per cubic centimeter was obtained on the second determination after a week of drainage. While this group is small the results are suggestive. In addition these results support a previous finding that the patients without jaundice or hepatic damage excreted at least

0.5 unit per cubic centimeter on the first determination soon after operation (Cases 13 to 16 inclusive) as well as the finding that in 2 cases in which the cystic duct was patent the level after 45 minutes was at least 0.5 unit per cubic centimeter in spite of possible dilution in the gall bladder (6).

**2 Streptomycin** The results are collected in Tables III and IV and are represented in Figures 4 to 7 inclusive. Table III states briefly a few facts in the history and essential laboratory findings. Table IV indicates the levels of streptomycin activity in the bile on initial study done soon after operation. Reference to Figure 4 demonstrates the constancy of the height and persistence of the curves of streptomycin activity in the blood serum of each of the 4 patients so studied. A similar curve might be expected in all the other subjects were blood serum levels determined for them. As was true with penicillin however the streptomycin levels in hepatic bile varied in most of these cases. In addition the levels of activity in the bile were generally less than in the blood suggesting that the liver did not concentrate streptomycin.

Here too it is well to divide the patients into 3 groups according to their ability to excrete streptomycin in the bile on initial study soon after operation. An arbitrary figure of 1 unit per cubic centimeter of bile was chosen to separate those who excreted small from those who excreted large amounts. This figure corresponds to 0.24 unit per cubic centimeter of bile chosen for penicillin, and was arrived at in the same manner (see the section on penicillin).

**Group 1** no excretion of streptomycin. Three patients failed to excrete streptomycin in the bile during the 3 hour period observed. One of these has been described previously in detail in the section on excretion of penicillin (Case 2). A brief history of the other 2 patients follows.

**CASE 17** The patient had a history of dark urine, light stools, and jaundice for 3 months. A serum bilirubin level a week before operation was 1.55 mg. per 100 cubic centimeters direct and 2.5 mg. per 100 cubic centimeters indirect. The hippuric acid test of hepatic function showed definite impairment. At operation cholecystectomy and choledocholithotomy were performed, and a T tube

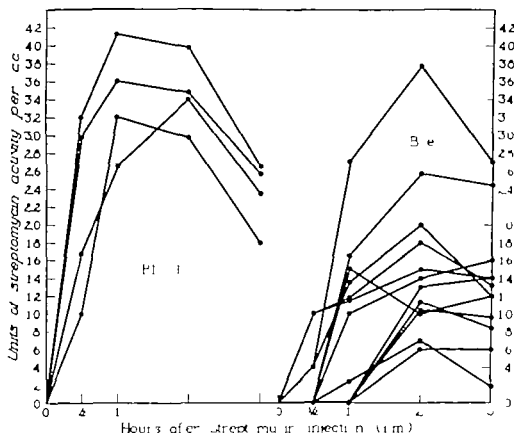


Fig. 4. Levels of streptomycin activity in blood serum and hepatic bile after 100,000 units of streptomycin had been given intramuscularly. Four patients were used for the blood curves and 15 for the bile curves. Of the latter 3 failed to excrete streptomycin in the bile. The graph demonstrates the similarity of the curves of the levels in blood and bile.

was inserted. Two days after operation no streptomycin was excreted in the bile. This patient was not studied further.

**CASE 18** A biliary fistula developed following cholecystectomy done 3 months before the patient came to the clinic. On several occasions when the fistula became obstructed she had chills, fever, and jaundice. On admission her serum bilirubin level was 8.9 milligrams per 100 cubic centimeters direct and 0.9 milligram per 100 cubic centimeters indirect. Several days later the common duct was reconstructed over a T tube. Studies of excretion of streptomycin on the third postoperative day showed no excretion in the bile, in spite of the fact that the serum bilirubin level was almost normal and the hippuric acid test of hepatic function gave definitely normal results. All studies were repeated 3 weeks later with the same results.

**Group 2** excretion of small amounts of streptomycin. Two patients excreted a maximal concentration of less than 1 unit per cubic centimeter of bile.

**CASE 19** Operation was performed because of chronic dyspepsia with recurrent bouts of colic in the right upper quadrant of the abdomen for several years. A functioning gall bladder with stones was found on roentgenographic examination. At opera-

tion greatly dilated common and cystic ducts were found and the liver was reported as showing "hepatitis, grade 1+." Cholecystectomy and choledochostomy were performed. The following day a streptomycin excretion study was made. The maximal level attained was 0.7 unit per cubic centimeter in the 1½ hour specimen. A serum bilirubin level the following day was 9.1 milligrams per 100 cubic centimeters direct and 1.6 milligrams per 100 cubic centimeters indirect. A hippuric acid test of hepatic function done 3 days later showed severe impairment. It was impossible to repeat the streptomycin excretion study since little material was obtainable from the T tube after the fourth day. However on the ninth postoperative day the serum bilirubin level was 3.6 milligrams per 100 cubic centimeters direct and 0.8 milligram per 100 cubic centimeters indirect.

**CASE 20** Cholecystectomy and choledochostomy had been performed in 1943. The patient was well until 2 weeks before his present admission when pain in the right upper quadrant of the abdomen, fever, dark urine, and jaundice developed. The serum bilirubin level 4 days before operation was 5.1 milligrams per 100 cubic centimeters direct and 3.4 milligrams per 100 cubic centimeters indirect. The hippuric acid liver function test gave normal results. Choledocholithotomy and choledochostomy were performed. On the second postoperative day the pa-

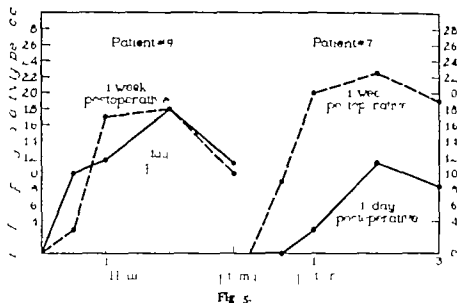


Fig. 5.

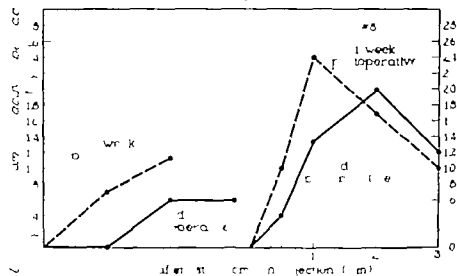


Fig. 6.

Figs. 5, 6, and 7. Effect of relief of biliary obstruction on streptomycin excretion in hepatic bile. Definite increase of excretion to 3 weeks after operation over that 1 to 3 days after operation.

tient failed to excrete more than 0.6 unit of streptomycin per cubic centimeter of bile. However, when the study was repeated 3 weeks later, at which time his serum bilirubin level was 2.4 milligrams per 100 cubic centimeters direct and 0.9 milligram per 100 cubic centimeters indirect, the streptomycin activity of the 13½ hour specimen of bile was 1.12 units per cubic centimeter.

In résumé, one patient (Case 2) failed to excrete either streptomycin or penicillin in separate studies. This fact suggests that the excretion of these antibiotic agents is subject to the same factor of adequate hepatic func-

tion. As with penicillin 2 of the 3 patients who failed to excrete streptomycin in the bile had a history of persistent jaundice before operation and both showed impairment of response in the hippuric acid excretion test. The results found in the third patient (Case 18) are somewhat difficult to explain. Although her hippuric acid excretion test and sulfobromophthalein hepatic function test gave normal results, she failed to excrete streptomycin on 2 occasions, 3 weeks apart. The results of the first study done soon after operation might be ex-

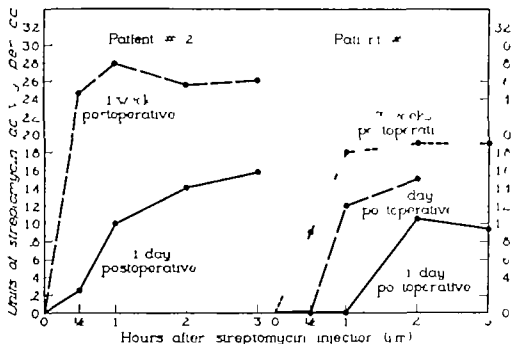


Fig 7

plained on the basis of a recent episode of obstructive jaundice which had temporarily impaired some of the hepatic functions (such as streptomycin excretion). However after 3 weeks when her jaundice had completely subsided it was expected that she would excrete streptomycin. It would appear that the excretion of streptomycin is a hepatic function quite apart from all the others since it is well known that many hepatic functions may be normal while others are definitely impaired.

Of the 2 patients who excreted small amounts of streptomycin in the bile one had definite hepatitis, as shown by the surgeon's operative note corroborated by a definitely impaired hippuric acid excretion test. The other patient was studied soon after the onset of an episode of obstructive jaundice due to a stone in the common duct. The serum bilirubin was elevated at this time. However in a repetition of the study 3 weeks later when jaundice had subsided, he excreted a concentration of streptomycin twice that found on primary investigation. This was in the presence of good hepatic function as shown by the hippuric acid excretion test.

Group 3: excretion of large amounts of streptomycin. Ten patients excreted more than 1 unit per cubic centimeter on initial study. In 2 cases the serum bilirubin levels were normal at the time of examination. In

the other 8 cases the jaundice was definitely subsiding. The level of streptomycin activity in all of these cases varied from 1.05 units per cubic centimeter to 3.8 units per cubic centimeter.

As with penicillin the highest levels of streptomycin activity were among those patients who had no history of jaundice and had normal hepatic function. With persistent jaundice and impairment of hepatic function streptomycin was excreted in lesser amounts until in 3 cases none was excreted.

In all cases but one where the hippuric acid excretion test gave normal results and no jaundice was present at the time of study the excretion level was more than 2 units per cubic centimeter. However in the one exception a healthy robust man with no previous history of jaundice and with good hepatic function excreted only 1.5 units per cubic centimeter. This then must be considered a normal level.

After a lapse of 1 to 3 weeks the studies were repeated for 8 patients (Table II). Two of these failed to excrete streptomycin even after a period of prolonged jaundice (Cases 2 and 18). They have both been described fully elsewhere. In all the other cases there was a definite increase of excretion that in several the level in the bile was doubled (Cases 7, 8, 9, 20, 22 and 23). After

period of T tube drainage, regardless of the primary condition the minimal excretion level in those tested was 1.8 units per cubic centimeter compared to 1.05 units per cubic centimeter on initial examination. It would appear then, that the lower limit of excretion chosen as normal namely 1 unit per cubic centimeter is an index of some impairment of ability to excrete streptomycin, since in all cases in which the studies were repeated later a higher level of excretion 1.8 units or more per cubic centimeter was found. In 3 weeks the patient in Case 20 doubled his ability to excrete streptomycin and although the level was only 1.12 units per cubic centimeter it is quite possible that, were the studies repeated again, the level would have been higher. Further repetition of the studies was not practicable in this case since the T tube was removed several days later.

In 8 cases studies were carried out with both penicillin and streptomycin (Cases 2, 7, 8, 9, 10, 12, 14, and 16). Reference to Tables I and III demonstrates how both substances are excreted quite similarly by the same patients. As mentioned previously 1 patient (Case 2) failed to excrete either penicillin or streptomycin. When a large amount of one was excreted a large amount of the other was usually also excreted. In 3 cases studies were repeated at a later date. In all cases there was an increase in the excretion of both antibiotic agents, and to a similar degree. This small series indicates the similarity of their excretion in hepatic bile.

#### COMMENT

In general the concentration of an antibiotic agent excreted in the hepatic bile is roughly inversely proportional to the degree of hepatic damage. In any case of obstructive jaundice as the obstruction persists more and more evidence of hepatic damage appears. The ability to excrete penicillin or streptomycin seems to be a rather sensitive index of hepatic damage. Early in the course of one case of cholangitis (Case 1) no penicillin was excreted but, as soon as the symptoms and signs of infection subsided penicillin was excreted into the bile. In all cases of long persistent obstructive jaundice no antibiotic

agent was excreted. In less prolonged obstruction there was some excretion. However in all cases but one in which excretion studies were repeated after one or more weeks of mechanical drainage with relief of obstruction penicillin was present in greater amounts than initially. The significance of this is obvious. It has long been recognized that the condition of patients who have cholangitis of greater or lesser degree improves with mechanical drainage. Hepatic function returns to normal, and very often the cholangitis is overcome. As is true with other regions of enclosed infection surgical drainage is necessary to institute resolution and repair.

As a result of this study it appears that a minimal level of 0.5 unit of penicillin activity per cubic centimeter of bile within a 3 hour period after an intramuscular injection of 15,000 units of penicillin is indicative of a relatively normal liver. The same is true for a level of 1.5 units of streptomycin per cubic centimeter of bile after an intramuscular injection of 100,000 units of streptomycin. Levels less than these suggest some impairment of hepatic function. The facts supporting this conclusion are first, that the few normal patients studied excreted at least those levels second that all patients who excreted less than these levels initially were able to excrete at least these levels 1 or more weeks later.

One patient had intrahepatic jaundice. He was unable to excrete penicillin. In view of our previous observations, this was not surprising. In intrahepatic jaundice, hepatic canalicular damage and obstruction of the biliary processes in the hepatic cells are present. This combination appears to prevent penicillin from entering the extrahepatic bile ducts.

The clinical application of these findings is worthy of consideration. In many cases cholangitis is treated conservatively. All the agents which might combat the infecting organisms are employed. Until recently the sulfonamides were administered with the hope that they might prove useful. No references to the excretion of these drugs into the bile in cases of cholangitis were found. The few reports of cases in the literature are rather contradictory

and are usually based on clinical observation (1-5) It is known that in many cases cholangitis goes into long periods of quiescence in the absence of any active treatment. The cures attributed to the sulfonamides under these circumstances are open to question particularly in view of the findings in the present study While it cannot be said that the sulfonamides are excreted into the bile in the same manner as are the antibiotic agents, the few reports available suggest that they do behave similarly

Generally speaking in the presence of definite cholangitis whenever possible it is considered good treatment to institute drainage. While at times this may be medical more often it is surgical This is so because such cases are usually associated with obstruction in the biliary tract. It is the usual surgical experience that in these cases the response to such measures is good

While obstruction to the biliary tract is still present the antibiotic agents do not appear to get into the bile. In addition the antibiotic agents, in greater or lesser amounts were excreted in the bile in all cases in which the jaundice was subsiding and as the serum bilirubin levels returned to normal the antibiotic levels in the bile increased

Infection in the hepatic parenchyma itself presents still another problem In normal dogs it has been shown that there is a high concentration of penicillin in the liver after parental administration of penicillin Whether this is the case in the obstructed and infected liver is open to question While an antibiotic agent will reach the hepatic cells through the blood stream its ability actually to enter or bathe the diseased cell is as yet unknown That it will keep a localized infection in one part of the liver from spreading to other regions in the parenchyma is very likely That it will keep an infection still localized in the extrahepatic bile ducts from spreading up to the hepatic cells is also possible. Unfortunately the clinician usually sees the patient who has cholangitis when the process has already invaded the liver itself However in the absence of evidence to the contrary in cases of cholangitis administration of antibacterial agents would seem indicated in order to protect the liver it

self with the hope that the infection had not yet reached the intrahepatic canaliculi

The problem of ridding the biliary tree of an infecting organism is not as hopeless as may appear from some of the foregoing remarks Any patient who has a history of recurrent cholangitis should first be rid of the contributing factor if it is at all possible. This will include removal of stones, repair of strictures or an attempt to sidetrack the food stream in biliary intestinal anastomoses When this is done it may be expected that the antibiotic agents will get into the biliary tree If the responsible organism is known the appropriate antibacterial agent may be given Within a reasonable period the infection should be overcome While it may be possible to overcome the organism in a case of recurrent obstructive cholangitis during a period when the inflammation has subsided (for antibiotic agents often do get into the bile in effective concentration) the process is apt to repeat itself unless the etiologic mechanical factor is removed

#### CONCLUSIONS

1 After the intramuscular injection of 15 000 units of penicillin or 100 000 units of streptomycin

a. The antibiotic agent is excreted in high concentration in the hepatic bile of normal patients

b. A minimal level of 0.5 unit per cubic centimeter for penicillin activity or 1.5 unit per cubic centimeter for streptomycin activity in hepatic bile within 3 hours is indicative of normal liver. Lower levels suggest impairment of excretion

c. The level of penicillin activity in the bile exceeds that in the blood within the first hours indicating that the liver concentrates this antibiotic agent.

d. The level of streptomycin activity in the bile is less than that in the blood within the first 3 hours indicating that the liver does not concentrate this antibiotic agent.

2 In the presence of obstructive jaundice the ability of the liver to excrete the antibiotic agent is impaired.

3 The greater the degree of hepatic damage the less is the amount of antibiotic agent present in the hepatic bile



period of T tube drainage regardless of the primary condition the minimal excretion level in those tested was 1.8 units per cubic centimeter compared to 1.05 units per cubic centimeter on initial examination. It would appear then that the lower limit of excretion chosen as normal namely 1 unit per cubic centimeter is an index of some impairment of ability to excrete streptomycin since in all cases in which the studies were repeated later a higher level of excretion 1.8 units or more per cubic centimeter was found. In 3 weeks the patient in Case 20 doubled his ability to excrete streptomycin and although the level was only 1.12 units per cubic centimeter it is quite possible that, were the studies repeated again the level would have been higher. Further repetition of the studies was not practicable in this case, since the T tube was removed several days later.

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One patient had intrahepatic jaundice. He was unable to excrete penicillin. In view of our previous observations, this was not surprising. In intrahepatic jaundice, hepatic cellular damage and obstruction of the biliary canaliculi resulting from degenerative processes in the hepatic cells are present. This combination appears to prevent penicillin from entering the extrahepatic bile ducts.

The clinical application of these findings is worthy of consideration. In many cases cholangitis is treated conservatively. All the agents which might combat the infecting organisms are employed. Until recently the sulfonamides were administered with the hope that they might prove useful. No references to the excretion of these drugs into the bile in cases of cholangitis were found. The few reports of cases in the literature are rather contradictory

# THE EFFECT OF RADIATION ON VAGINAL CELLS IN CERVICAL CARCINOMA

## 1 Description of Cellular Changes

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THE effect of roentgen rays on carcinoma of the cervix has long been of great interest to both radiologists and gynecologists. Since most cervical carcinomas are treated by irradiation any additional knowledge either concerning the radiosensitivity of cervical tumors or the ultimate prognosis would be of value. Any advance in the treatment of this disease by roentgen therapy will depend on further knowledge of the effect and the efficacy of the treatment as it is used at the present time.

The vaginal smear method presents a unique opportunity to study the effects of radiation on cervical malignancy. The vaginal smear is obtained with such ease by merely taking a sample of the vaginal secretion that a patient may be followed as often or as long as desired. The method has the further advantage that a representative group of all the cells both normal and malignant of the vaginal and cervical mucosa are seen not a limited portion as in serial biopsies. We have attempted to determine the effects of x ray and radium on cervical carcinoma by means of the vaginal smear. We are stating here only the effect of radiation on individual cells. The possible prognostic significance of the method will be discussed in a subsequent publication.

In 1921 Frankle and Amreich studied a series of cases of carcinoma of the cervix by means of biopsies during treatment with radiation. They describe marked swelling of the cells during x ray and radium treatment. Vacuolization of the malignant cells was also seen as a distinct part of the response to x ray treatment (2).

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Dustin in 1927 studied 7 cases of epidermoid carcinoma in radiated patients by means of serial biopsies. He has divided the changes seen into four phases. The first phase is that of pyknosis of the nuclei and a decrease in the number of mitoses. The second phase is an increase in the number of atypical mitoses. The third phase represents such an increase in atypical mitoses that no normal mitotic figures were seen. The fourth phase he calls a rise in normal division of cells.

In 1930 Meigs and Parker (6) reported on 5 cases of epidermoid carcinoma on which daily biopsies were done during treatment. The number of both normal and abnormal mitoses was determined. They mention the increase of atypical mitoses on the fourth day after radium treatment and the eventual disappearance of atypical division.

Frola in 1933 reported 47 cases of cervical carcinoma studied by means of serial biopsies during treatment. Forty four cases were of epidermoid carcinoma and 3 of adenocarcinoma. He described the atypical mitoses as increasing and then disappearing. The complete disappearance of the malignant cell took place from the eleventh to the fortieth day of treatment. Pyknosis of the nuclei was a prominent feature of the reaction. Degeneration was variable. The sclerosis of blood vessels showed great variation. The connective tissue was infiltrated with polymorphonuclear leucocytes, lymphocytes and occasionally plasma cells. Almost half of the cases showed foreign body giant cell reaction at termination of treatment. He speaks of maturation evolutive in which the undifferentiated malignant cells mature to become large cells whose nuclei show a sharp nuclear border and are poor in chromatin. There is keratinization and hyalinization of the cells with formation of pearls. Frola also en-

4 In the presence of long persistent obstructive jaundice no antibiotic agent is excreted in the bile.

5 As the level of serum bilirubin falls following relief of obstruction of the common duct, more and more of an antibiotic agent is excreted in the bile.

6 Penicillin and streptomycin will probably not be useful in treatment of acute or chronic obstructive cholangitis.

7 The etiologic mechanical factor should be removed in all cases of obstructive jaundice with cholangitis before streptomycin or peni-

cillin can be expected to overcome the infecting organism

#### REFERENCES

- 1 CLEVELAND W. H. *Proc. Mayo Clin.*, 1939, 14: 660-682.
- 2 MORRISON L. M., SWALM, W. A., BOWRETT, W. E., KONTZEMANN F. W. and SPAULDING, E. J. *Gastroenterology* 1943, 11: 573-582.
- 3 OTTENBURG, REUBEN and BERCK, MAURICE J. *Am. M. Ass.*, 1938, 31: 1374-1375.
- 4 PETERSON, O. L., DEUTSCH, EMMANUEL, and FIDLAND, MAXWELL. *Arch. I. t. M.*, 1943, 72: 504-62.
- 5 REIFURTS, M. E. *Gastroenterology* 1945, 4: 13-14.
- 6 ZARLOW JERRY, COUGHLIN, V. S., and HELLMAN, F. R. *Surg. Gyn. Obst.* 94:7 84-6



Fig. 4.

Fig. 4. Two groups of small histiocytes showing irregularity in shape of nuclei.



Fig. 5.

Fig. 5. A foreign body giant cell showing peripheral arrangement of nuclei.

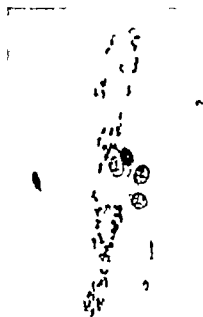


Fig. 6.

Fig. 6. A group of 4 undifferentiated malignant cells of epidermoid carcinoma of the cervix.

staining deeply basophilic with large active nuclei. The outer layer basals are larger cells having a nucleus similar to that of the inner layer basal cell. Their size increase is due to an increase in cytoplasm rather than nucleus (Fig. 1). The basophilic cytoplasm of the outer layer basal is not so deeply staining and is more transparent. The basal cells are vacuolated occasionally but the vacuoles are usually quite small and quite evenly distributed or as in the case of the cervical basal cells there is one large vacuole with the nucleus pushed to one side—the signet ring type of cell (Fig. 2). It is important to emphasize that the nuclei of these vacuolated cells of the basal series appear normal in both size and appearance.

The next layer of the vaginal mucosa is composed of precornified cells. This layer is intermediate between the basal layer and the superficial vaginal epithelium. These cells have abundant lightly staining basophilic, transparent cytoplasm. The cytoplasmic nuclear ratio is greatly increased in comparison to that of the basal cells. The cytoplasm may be wrinkled or granulated and the cell borders are often irregular due to the folding over of the cytoplasm (Fig. 3). The nucleus is small and smoothly granular in appearance.

The cells of this type are very rarely if ever vacuolated.

The superficial layer of the vaginal mucosa is composed of cornified cells. These cells are similar to the precornified except for two distinct differences i.e. the nucleus is small and pyknotic and the cytoplasm is acidophilic (Fig. 3). The same statements concerning wrinkling, folding and granulation of the cytoplasm apply to these cells of the superficial layer.

Leucocytes are seen very often in the vaginal secretion. In positive smears they are to be more numerous than in normal smear. The clumping of leucocytes in tight groups even more frequently associated with the presence of malignant cells. The greatest majority of the leucocytes are polymorphonuclears but lymphocytes do appear.

Histiocytes are present in normal smear. Phagocytic histiocytes are not as common as the small histiocyte. These cells are smaller than the inner layer basal cell. Their nuclei are seldom perfectly round usually being either oval or crescent shape. They have finely vacuolated cytoplasm whose cell borders are often indistinct (Fig. 4). Foreign body giant cells are included in the group of histiocytes seen in the vaginal secretion. They (

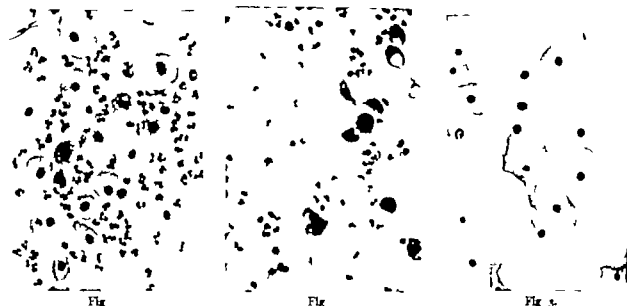


Fig. 2 Group of normal basal cells, showing variation in size of cells, but little variation in size of nucleus

Fig. 3 Signet ring type of basal cell in upper right.

Fig. 4 Normal precornified and cornified cells.

phasizes the metaplasia of the cells lining the cervical mucous glands during radiation.

In 1935 Arneson and Stewart described the response of tumor to irradiation as swelling of the tumor cells, ballooning degeneration or pyknotic degeneration and fragmentation of the nuclei, progressive cytoplasmic opacity and acidophilia, a tendency to cornification and finally necrosis and leucocytic infiltration often followed by foreign body giant cell reaction.

#### MATERIAL

The material for this study comes from three sources: the Tumor Clinic of the Massachusetts General Hospital, the private practice of Dr. J. V. Meigs, and the Pondville Hospital of the Massachusetts State Department of Public Health. We are reporting 206 cases of cervical carcinoma treated by x ray or radium or both and studied by means of vaginal smear. The cases include patients recently treated and followed during treatment and also those who had treatment from 6 months to 15 years before the first vaginal smear was taken. The group is divided pathologically into 27 cases of adenocarcinoma and 179 cases of epidermoid carcinoma. The majority of the epidermoid carcinomas are classified as grade III, although the study includes cases from all 4 grades.

The radiation in these cases necessarily varies since the group includes patients treated over the past 15 years, and both the amount of x ray and radium given and the method of administering the dose has changed considerably during this length of time. Most of the patients were considered to have had full therapeutic doses except for a small number who were given palliative therapy. In the recent cases with rare exceptions the patients have been treated with the 1200 kilovolt x ray machine.

The effect of radiation on the cells of the cervical and vaginal mucosa in patients with carcinoma of the cervix is striking. However, to appreciate fully the changes seen in the vaginal smear it is necessary to have a working knowledge of the cytology of the normal vaginal smear and also the cytology of the malignant cells as seen in the vaginal secretion. It will be helpful perhaps to describe again the cells of the normal vaginal smear. For a more detailed description the reader is referred to the monograph of Papanicolaou and Traut and to our previous publications (7, 8).

The basal cells come from the deepest layer of the vaginal mucosa. They vary in size depending on their position in the basal layer. The inner layer basals are small round cells,

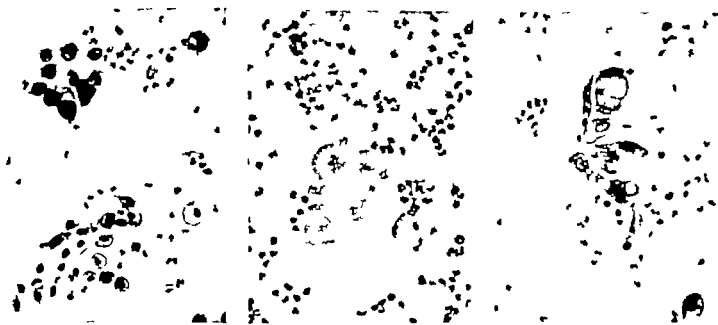


Fig. 10

Fig. 11

Fig. 12.

Fig. 10. Group at top typical, unirradiated, undifferentiated, malignant cells. Group at bottom shows pyknosis of basal cells. Basal cell at right of malignant group demonstrates karyorrhexis of nucleus.

Fig. 11. Group of enlarged basal cells. Note proportionate increase in size of nucleus and cytoplasm. Compare with Figure 1.

Fig. 12. Abnormal vacuolization of basal cells.

and 30 of epidermoid carcinoma of the cervix. One patient received only radium therapy and 8 only x ray. The remaining 26 received both x ray and radium and in every instance the radium was preceded by a course of x ray. The x ray treatment was given to 25 by 1200 kilovolt therapy and to 9 by 200 kilovolt therapy. One patient received only 4800 r from the 1200 kilovolt machine, the remainder receiving a dose of approximately 6000 r.

Two cases of bladder carcinoma with no uterine neoplasm have been included in this group as controls. The x ray fields used in the treatment of carcinoma of the bladder are similar to those used for cervical carcinoma. Thus, we were able to study the effect of radiation on the normal cells of the vaginal and cervical mucosa uncomplicated by the presence of malignant cells.

The patients followed during radiation treatment fall into 2 distinct classes. Class 1 shows definite radiation reaction in all cells. Class 2 shows very little effect in any type of cell either normal or malignant. The possible prognostic significance of these differences will be discussed in a subsequent publication.

The changes in the cellular constituents have been noted from day to day following

the beginning of treatment. The first patient studied had daily vaginal smears. However as the study progressed it was obvious that smears taken at 3 day intervals gave an adequate picture of the changes which occurred. The days indicated in the paragraphs below are counted from the beginning of radiation treatment.

*Class 1—Radiation Changes* In the vagina smear the first effect of radiation is seen in the normal cells. The basal layer of the vagina and cervical mucosa is affected before any of the other cells show changes. The basal cell, both inner and outer, become aberrant (Fig. 9). They lose their characteristic round appearance and become elongated. These cells must be differentiated from the malignant fiber cell. The nucleus in these aberrant basal cells is still a perfectly normal vesicular nucleus. The malignant fiber cell contains an abnormal hyperchromatic nucleus with very distinct clumps of chromatin. This change the basal cells is occasionally seen as early as the second day of x ray treatment but usually not marked until the 9th or 10th day.

An effect which is seen at the same time as the change in the shape of the basal cells is change in their staining reaction. Many of the

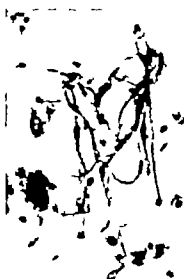


Fig. 7

Fig. 7. Group of differentiated fiber cells from epidermoid carcinoma of the cervix.

Fig. 8. Group of undifferentiated malignant cells from



Fig. 8

adenocarcinoma of the cervix.

Fig. 9. Group of basal cells showing beginning elongation of the cells.



Fig. 9

cur more infrequently than either of the other two types. They are large cells approximately the size of precornified cells, which have many oval smoothly granular nuclei arranged peripherally (Fig. 5).

The malignant cells as encountered in epidermoid carcinoma of the cervix are of two types, differentiated and undifferentiated depending on how adult the tumor is. The undifferentiated cells are usually smaller than the inner layer basal cell. They have a hyperchromatic nucleus which shows an apparent increase in chromatin material. The cytoplasm consists either of a very narrow rim or an indistinct background. If seen in groups the nuclear size variation is great, and the cellular borders indistinct (Fig. 6). The differentiated cells assume bizarre shapes. They may be the so called tad pole form which show a long thin tail of cytoplasm and a distinct head containing the nucleus. This type is seen rarely. Another type is the fiber cell. This cell is extremely elongated and thin. The nucleus still appears hyperchromatic but it is elongated. These cells closely resemble muscle fiber cells except for their nuclei which are distinctly abnormal (Fig. 7). In the differentiated cells the cytoplasm is usually adequate but it is abnormally distributed.

The malignant cells seen in adenocarcinoma are undifferentiated. They usually occur in tight groups in which the individual nuclei are piled upon one another. Definite cellular borders are difficult to distinguish. Their cytoplasm is a thin rim which may contain vacuoles which are usually small (Fig. 8).

In attempting to study the changes seen in the vaginal smears of women treated with radiation for carcinoma of the cervix the cases have been divided into four groups. The first group includes those patients who were studied by vaginal smears during their x-ray and radium therapy. The second group includes those with follow ups beginning from 1 to 6 months after treatment. The third group is composed of those patients whose follow-up began at 6 months to a year following treatment. The fourth group are those patients whose treatment took place a year to fifteen years before the first vaginal smear was taken.

#### THE EFFECT OF RADIATION ON CELLS AS SEEN IN THE VAGINAL SMEAR DURING TREATMENT—FIRST GROUP

Thirty five patients with cervical carcinoma have been studied during their course of radiation treatment. There are 4 cases of adenocarcinoma, one of undifferentiated carcinoma



Fig 16.

Fig 16. Tremendously elongated cell showing degenerative changes in the nucleus.



Fig 17

treatment had been carried out.

Fig 18. Superficial cell showing polymorphonuclear nuclei in the cytoplasm.



Fig 18

not marked until the fifteenth day and increases progressively after that. The cells contain tremendous vacuoles which almost completely fill the cell (Fig 12). Some of the cells may have smaller vacuoles containing polymorphonuclear leucocytes in the vacuole. This sequence is not so commonly seen in the basal cells, however as in the precornified.

The last change to occur in the cells of the basal layer is the appearance of very bizarre forms. The cells may be almost any shape. They are usually of the blown up type so the shape is even more striking (Fig 13). This change is much more pronounced than in the aberrant forms mentioned earlier. The cells may assume dumbbell shape, elongated forms and tadpole forms. These cells must also be distinguished from the differentiated malignant cell. The nucleus is the distinguishing characteristic. It is large but is smoothly granular and not hyperchromatic, or is very small and pyknotic.

It is important to point out that the changes in the basal cells here noted are seen only if the control smear before treatment presented basal cells as part of the cell population. If the woman is premenopausal few basal cells are found and the radiation changes seen first are in the precornified cells to be described.

The precornified cells also exhibit change after radiation. The first reaction to occur in this layer of cells is an increase in size. They become two to three times the size of a normal precornified cell. The cytoplasm and the nucleus increase correspondingly so that the cytoplasmic nuclear ratio is undisturbed (Fig 14). This effect has been seen as early as the third day of radiation and as late as the forty-fifth. However on the average it is apparent about the fifteenth day of treatment.

At about the same time as this increase in size takes place there are beginning changes in the nuclei of the precornified cells. At first the only change is one of size, but very soon the chromatin structure of the nucleus begins to show degenerative changes. Their nuclei become dark, wrinkled with little structural detail. The nucleus has a dead pyknotic look despite its abnormal size. The nuclear borders are not smooth but very irregular and often the nucleus has contracted sufficiently to leave a space previously occupied by the full sized nucleus. Occasionally although it is not so often as in the basal series the nuclei will become fragmented and will appear only as small dark particles. The nuclear borders have completely disappeared. Two three or four nuclei are not uncommon in these p





Fig. 3



Fig. 4

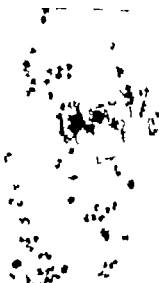


Fig. 5

Fig. 3. Cell showing one of the bizarre shaped basal cells after radiation.

Fig. 4. Cell at bottom shows tremendous size increase of precornified cell. Compare with Figure 3. Cell at the

top shows polymorphonuclear leucocytes on precornified cell.

Fig. 5. Precornified cell with three nuclei showing abnormal vacuolization of the cell.

cells of the basal layer change from a basophilic stain to a brownish stain<sup>1</sup>. This does not occur in all the cells but is a frequent enough occurrence to be a distinct effect. This difference in staining reaction is probably an early sign of degeneration of the cell.

The subsequent changes are primarily in the nucleus of the basal cells. The nuclei become very degenerate. The nucleus may appear as one small pyknotic dot. Often the nuclear membrane disappears and the nuclear material is collected into discrete black clumps, an actual karyorrhexis of the nucleus (Fig. 10). This type of degeneration will occasionally be mistaken for mitoses if care is not taken. A cell in mitosis shows chromatin in fine threads or very small clumps rather than three or four structureless dots. These degenerative changes usually take place from the 10th day of treatment and increase throughout the course of treatment. It should be noted that this reaction in the nuclei of the basal cells is not characteristic of radiation alone. The same degeneration is often seen in advanced atrophy of the genital tract.

Beginning usually around the twelfth day the most striking effect of radiation on the

cells of the basal layer is seen. There is a great increase in the size of the cells. They become three to four times their normal size. The change is similar to the ballooning of cells which has been described in histological sections following radiation treatment. It is important to realize that these "blown-up" cells show no change in the cytoplasmic nuclear ratio. It remains constant. The nucleus and the cytoplasm, have increased in the same proportion (compare Figs. 1 and 11). The nucleus in one of these large cells is even more finely granular than in the normal. It has a very smooth, speckled appearance in most instances. One should be careful that cells of this kind are not called normal precornified cells. The total size of the cell is often that of precornified cells. Two criteria point to their origin in the basal layer. First, the cytoplasm does not have the true transparency of precornified cells; second, the nucleus is much too big for a normal precornified cell. We have never seen this tremendous ballooning of cells except in smears from a radiated patient.

Another specific change in the basal cells is abnormal vacuolization of the cytoplasm. This usually occurs in cells which have increased in size and is a late effect. It is usually

<sup>1</sup>All smears were stained by Papancolou's method. The directions for staining and the construction of the stain may be found in the monograph by Papancolou and Treat or in our first publication.

gated in some instances stretching across a high dry field. Others may assume tremendous tadpole shapes. Some have long fibers stretching out from the cell almost resembling pseudopodia (Fig. 17).

The last change to occur in the precornified layer is the appearance of polymorphonuclear leucocytes in the cells. This takes place usually around the 20th day of treatment. It has been seen as early as the 10th and as late as the 31st. It is important when looking for this change to be sure that the polymorphonuclear leucocytes are in the cells and not merely on top of the cells. The leucocytes are very numerous often in postradiation smears and often they clump on a cell almost obscuring the cell beneath them. This takes place early in the course of treatment. However the actual inclusion of leucocytes within epithelial cells is a later change (Fig. 18).

The cornified cells exhibit all the evidence of postradiation reaction which are seen in the precornified cell except for the changes in the nuclei. Since the nuclei of cornified cells are originally pyknotic very little change takes place there. The other changes noted apply to the cornified cells as well as to the precornified cells. It should be noted that in radiation smears the precornified cells do not always have a basophilic staining cytoplasm. They very often take an acidophilic stain. As in normal cells the nucleus is the distinguishing characteristic.

A great increase in polymorphonuclear leucocytes is seen very often in the immediate postradiation smears. In all but 3 of the cases the leucocytes increased markedly. In some cases they increase so much that interpretation of the smear is quite difficult since the leucocytes obscure much of the picture. In 3 cases the increase was due to lymphocytes rather than to polymorphonuclear leucocytes. The increase in leucocytes is variable in the time it appears. It may occur immediately after treatment is instituted or it may not occur until much later.

There is some literature on the occurrence of eosinophils in sections of cervical carcinoma. Gill in 1944, reported that 77 per cent of all epidermoid carcinomas of the cervix had a marked eosinophilia in the tumor. He

believes this may be regarded as of favorable prognostic significance. Unfortunately in vaginal smears the polymorphonuclear leucocytes are so seldom completely preserved that differentiating between types is usually impossible. One of the cases followed during treatment showed a tremendous number of eosinophils. In all other instances no differentiation could be made as to the type of leucocyte.

An increase in small histiocytes usually follows the increase in leucocytes. The time factor is variable but they appear usually 3 to 5 days after the increase of leucocytes. This increase in small histiocytes was seen in all but 3 of the cases. The response of the phagocytic and foreign body giant cells is variable. A marked response of the phagocytic type was seen in 3 cases and foreign body giant cell reaction in 2.

Evidence of some blood is usually seen in positive smears before radiation. It is a variable factor after treatment is instituted. In some cases the bleeding will stop and the smear be free of any blood. Others show fresh blood fibrin or blood pigment.

#### *Class 1 Radiation Effect in Malignant Cells*

The malignant cells show pronounced radiation effect as well as do the normal cells of the vaginal and cervical mucosa. The time of the appearance of definite radiation reaction in these cells varies from patient to patient. The malignant cells all show radiation changes usually by the eleventh day of treatment but occasionally the cells will appear radiated as early as the 8th day. Other cases may not show the complete effect until as late as the 17th day of radiation.

Radiated malignant cells show a good many changes similar to those seen in the normal cells. They increase in size, occasionally as much as four times. Their cytoplasm becomes vacuolated. This vacuolization is especially striking in the small undifferentiated tumor cells which have little cytoplasm. The thin rim of cytoplasm becomes puffed out eccentrically with vacuoles which in some instances are larger than the nucleus (Fig. 19). The radiated malignant cells often contain more than one nucleus, and in many cases may appear as giant cells with 6 to 7 nuclei pro-

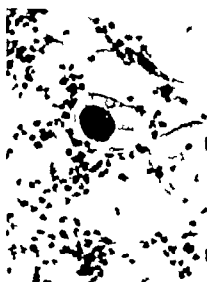


Fig. 9.



Fig. 20.

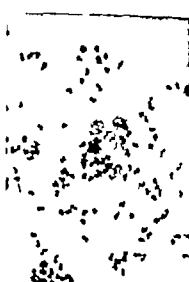


Fig. 1.



Fig. 2.

Fig. 9. Radiated malignant cell showing increase in size of cell and nucleus and abnormal vacuolization.

Fig. 20. Group of radiated malignant cells showing giant cells and abnormal vacuolization.

Fig. 2. Smear showing enlarged degenerate basal cells.

Fig. 22. A smear of basal cells seen when vaginal smear is difficult to obtain.

cornified irradiated cells. These multinucleated cells may have the blown up vesicular type of nucleus or a degenerate one. The presence of more than one nucleus is probably evidence of an amitotic division stimulated by radiation.

At the same time that nuclei begin to exhibit signs of degeneration the cytoplasm also shows evidence of degeneration. The first degenerative sign in the cytoplasm is the appearance of very fine fibers which may occur in concentric circles around the nucleus or may run from the nucleus to the cell border.

The most striking effect is the vacuolization. The vacuoles may be very large, occupying the greater part of the cell (Fig. 15).

An effect which occurs immediately after the increase in size of the cells and the change in the nuclei is the appearance of precornified cells of queer shape. These bizarre cells are seen occasionally as early as the 6th day of treatment but usually do not appear until later around the 18th day. The cells are even more striking than the bizarre basal cells due to their size (Fig. 16). They also may assume any shape. Some become tremendously elongated.

The number of cells showing increase in size vacuolization bizarre shape and invasion of the cytoplasm by leucocytes rapidly diminishes. Two months after treatment an occasional cell showing these changes is seen. By 3 months such cells are even more difficult to find and in many instances the specific effects of radiation have disappeared by this time. The cornified and precornified are either completely normal or occur in groups without clear nuclear borders. As might be expected the nonspecific changes seen in the basal series persist for a much longer period. No definite time limit has been found for this effect to disappear. The basal cells have large active vesicular nuclei and often a vacuolated cytoplasm. They may have a normal round contour or be aberrant, assuming an elongated form. Leucocytes and histiocytes may or may not be present but usually the smear has a much cleaner appearance than seen earlier.

Thirty-two patients (27 with epidermoid carcinoma, 4 with adenocarcinoma and 1 with adenocanthoma) showed little or no reaction to radiation in the epithelial cells of the vaginal smear. The response in the malignant cells was variable. Fourteen patients showed a disappearance of the malignant cells while the remaining 18 showed persistent cancer cells. The smears usually show perfectly normal or degenerate cornified and precornified cells and a rare active basal cell. This is similar to that seen in the first group class 2.

#### THE EFFECT OF RADIATION ON CELLS AS SEEN IN THE VAGINAL SMEAR SIX MONTHS TO A YEAR AFTER TREATMENT—THIRD GROUP

The 19 patients included in this group are those whose follow up by vaginal smear began 6 months to a year after radiation treatment was finished. This group necessarily overlaps the previous group somewhat in time element.

Eleven (10 epidermoid carcinoma and 1 adenocarcinoma) out of this group show the expected picture. The vaginal smear consists of perfectly normal or degenerate (cellular borders not distinct) cornified and precornified cells, and aberrant basal cells with active vesicular nuclei. Small histiocytes and leucocytes are present but in variable numbers. Four patients showed foreign body giant cell

reaction. All the specific effects of radiation have disappeared by this time.

Four patients (3 with epidermoid and 1 with adenocarcinoma) show no reaction of any kind. The smears are perfectly normal ones and any distinguishing characteristics are absent.

There are 4 patients (3 with epidermoid carcinoma and 1 with adenocarcinoma) who showed aberrant basal cells increase in polymorphonuclear leucocytes evidence of blood and malignant cells. These of course are postradiation recurrences. It is difficult to see any difference between these 4 and the rest of the group except for the presence of malignant cells. The epithelial cells in these smears are aberrant basal cells with active vesicular nuclei.

#### THE EFFECT OF RADIATION ON CELLS AS SEEN IN THE VAGINAL SMEAR FROM ONE TO FIFTEEN YEARS AFTER TREATMENT—FOURTH GROUP

The 102 patients included in this group have been followed by vaginal smear beginning at 1 year to 15 years after treatment by radiation. It is in this group that the radiation has varied more than in previous ones since the time interval is of much longer duration. Radiation treatment has varied considerably during the past 15 years so necessarily the cases are not exactly comparable to the first three groups described. However they are an interesting group in which to study the prolonged effects of x-ray and radium on the cells of the vaginal and cervical mucosa.

Twenty-nine of these patients were given radium alone and these include all those whose follow up is longer than 10 years. These are included in the groups to be described since they show no distinguishing characteristics.

This group of cases falls into three separate categories if divided by the type of cell found in the smear. Approximately one third of the cases show only basal cells, one third precornified cells and basal cells, and the remainder cornified precornified and an occasional basal cell. This is not an age difference since the three groups do not differ significantly in age.

ably again evidence of abnormal division stimulated by radiation (Fig 20). The appearance of the nucleus is not that of the heavy granular unirradiated malignant cells but rather it is one of complete pyknosis. The nuclei appear dead rather than active. Usually no nucleolus can be made out.

It is often very difficult to say whether a radiated cell was originally malignant or benign. This is especially true of the differentiated malignant cells seen in cervical epidermoid carcinoma. The bizarre cells of both the basal and intermediate layer still have more cytoplasm surrounding the nucleus than do the true differentiated malignant cells. The nuclei of the bizarre basal and precornified group are much more apt to have a washed out smooth appearance than a hyperchromatic pyknotic one.

Nearly half of the cases described in this group showed an increase of malignant cells after radiation had begun. The time of the increase varied from 3 to 21 days and averaged 9. The remainder of the cases showed a progressive decrease in malignant cells until their final disappearance. It is perhaps interesting to note that 1 of the 2 cases of adenocarcinoma of the cervix in this group showed persistence of malignant cells although they did appear radiated. The cells did not disappear until radium treatment was given. On the average however the malignant cells have disappeared by the 24th day after radiation has begun.

*Class 2—Little Radiation Change.* Not all cervical carcinomas treated by radiation show the change described for the class 1 type of patient. Of the 22 cervical tumors included in this group followed during x ray treatment, 8 showed a different picture. Six cases were epidermoid carcinoma of the cervix: 1 a papillary adenocarcinoma, and 1 an undifferentiated carcinoma.

Two patients were given palliative doses of x radiation (4200 r and 2800 r) and no radium. As might be expected these patients showed very little change in any of the cells. Typical unaffected cells persisted during treatment. They showed little evidence of having been affected by x ray. One of these patients given only palliative therapy showed

no effect of radiation at all in the normal cells, and the other only a very slight response at the end of 22 days.

One patient was treated by radium alone (4700 mgm hrs). The smears from this patient did show a disappearance of the malignant cells but no change in the normal cells.

The remaining 5 cases had over 6000 r of x ray and in addition at least 2400 milligram hours of radium. Of these cases 2 show persistent unirradiated malignant cells, while 3 had carcinoma cells persisting longer than usual and none of these cells showed any definite change. The smears from these patients contain only a rare normal cell showing radiation reaction though in these cases the therapy was adequate.

As a control the vaginal smears of 2 cases of bladder carcinoma treated by radiation and uncomplicated by any uterine neoplasm have been studied. The normal cells in the vaginal smear show the same radiation changes as described for the class 1 type of case, and the changes took place at approximately the same time.

#### THE EFFECT OF RADIATION ON CELLS AS SEEN IN THE VAGINAL SMEAR IMMEDIATELY AFTER TREATMENT TO SIX MONTHS—SECOND GROUP

The 50 patients included in this group are those whose follow up began immediately after treatment or within 6 months. None of these patients were followed during their treatment and for this reason they have been segregated from the first group though a good many of the changes described previously are seen in this group also.

Eighteen cases (15 of epidermoid carcinoma and 3 of adenocarcinoma) presented moderate to marked reaction to radiation as shown by the cells in the vaginal smear. A reaction was considered as moderate if over half the epithelial cells showed radiation change and the malignant cells had disappeared. A reaction was called marked if it was difficult to find any cells not showing radiation reaction. The reaction is identical with that described for the class 1 type in the first group.

The striking effect of radiation on the cells of the vaginal secretion is not a lasting one.

encountered after irradiation. A good many of the normal cells also show division of the nucleus with no division of the cell.

Frola emphasizes the fact that after radiation there is a subsequent maturation of the undifferentiated cells to mature cells with sharp nuclear borders. We have not interpreted any cells in this light. The bizarre shaped cell, which in an untreated carcinoma might be classified as a differentiated malignant cell, has been interpreted rather as a normal cell which has been so affected by radiation as to be almost indistinguishable from an unirradiated differentiated malignant cell. This may be a mistake in interpretation but it is made on the basis that the cases of bladder carcinoma showed these bizarre cells although there were no malignant cells present in the genital tract. We have concluded that their unusual shapes, nuclear and cell size increase and in occasional instances, the hyperchromatic but pyknotic appearance of the nucleus is due rather to radiation effect on normal cells than to any maturation process stimulated by radiation. It is for this reason that it has become the policy of our laboratory not to call postirradiation smears positive unless typical healthy undifferentiated malignant cells are seen. To one unfamiliar with radiation changes the bizarre cells and the queer pyknotic, huge nucleus of the irradiated normal cells will often be confusing and lead to an error in diagnosis.

Frankle and Amreich have described the swelling of cells during radiation therapy. This is very evident in vaginal smears. The size increase of cells both normal and malignant is very conspicuous. These same authors mention vacuolization of the cells. This effect is also seen in vaginal smears. It is one of the responses seen in marked reaction of the cells to irradiation. Frola, and Arneson and Stewart mention the increased leucocytic reaction and the foreign body giant cell response of the cervical tissue to roentgen therapy. These reactions have both been described here as they are seen in the vaginal secretions from irradiated cervical malignancy.

It is evident that the correlation of the numerous changes seen in the past in the study of irradiated cervical cancer by biopsy

and the changes seen in the vaginal smear are quite comparable. The pyknosis and degeneration of the nuclei, the swelling and vacuolization of the cytoplasm, the evidence of abnormal mitoses and finally the leucocytic infiltration and foreign body giant cell reaction are all seen in the vaginal secretion as they are in the biopsy material. The vaginal smear is a much simpler way of studying the reaction of both tumor and normal cells. It is difficult to do serial biopsies on treated patients. Toward the end of treatment the biopsy may show only necrosis and no viable tissue thus making interpretation impossible. The vaginal smear on the other hand is obtained with great ease as often as desired, for the whole course of treatment. It has the additional advantage of giving possibly a more accurate picture since the entire cell population of the cervix and vagina is represented, not merely that of one specific area. The vaginal smear represents a unique and possibly important method of studying radiation reaction in cervical carcinoma.

#### SUMMARY

Two hundred and six cases of cervical carcinoma in which patients were treated by radiation have been studied by vaginal smear. Both immediate and late changes in the cells in the vaginal secretion have been described. Correlation with studies by biopsy have been discussed. The applicability of this method for study of radiation effect in cervical carcinoma has been suggested and emphasized.

#### REFERENCES

1. ARNESON, A. N., and STEWART, F. W. *Arch. Surg.* 1935, 51: 542.
2. DUTTEN, A. P. *Bull. Acad. Roy. Med. Belg.* 1937, 7: 237.
3. FRANKLE, D. O. and AMREICH, I. *Surg. Gyn. Obst.* 1931, 163: 169-173.
4. FROLA, G. *Arch. Internat. Méd. Exp. Path.* 1933, 8: 28.
5. GILL, A. J. *J. Lab. Clin. Med.* 1944, 29: 820-824.
6. MITOS, J. V., and PARKER, F. JR. *N. England J. Med.* 1930, 203: 247-253.
7. MITOS, J. V., GRAHAM, R. M., FREMONT-SMITH, P., KAPFICK, L., and RAWSON, R. W. *Surg. Gyn. Obst.* 1943, 77: 449-461.
8. MITOS, J. V., GRAHAM, R. M., FREMONT-SMITH, P., JAMNICK, L., and NELSON, C. B. *Surg. Gyn. Obst.* 1945, 81: 337-345.
9. PAPANTICOLAOU, G. N., and TRAUT, H. F. *Diagnosis Uterine Cancer by Vaginal Smear*. New York: Commonwealth Fund, 1943.

The smears which show basal cells alone have three variations. They may consist entirely of enlarged degenerate cells sometimes seen in normal atrophic smears of menopausal women (Fig. 21). These are basal cells whose nuclei are degenerate and large. The staining reaction of the nuclei is not even and often has a blotchy washed out appearance. The cytoplasm also stains irregularly. This is not diagnostic of radiation but is seen as well in the atrophic smears from normal postmenopausal women. Another type of smear seen is one in which all the cells are aberrant and have large vesicular nuclei. The cells have elongated forms occasionally with rather long tails. It is often difficult to find any normal round basal cells. These queer forms are one of the most difficult types to distinguish from malignant cells. The nuclei of these cells, though active are rarely as hyperchromatic as malignant nuclei. The third type is a smear in which sheets of basal cells are seen. The cells do not shed singly but come off in great clumps. These may be very confusing since at first glance especially when cell borders are indistinct, they are not unlike cancer cells except for their regularity in size (Fig. 22). These cell groups usually occur when the smear has been difficult to obtain. If an attempt is made to secure a vaginal smear when the mucous membrane is very dry and atrophic, the pipette is apt to aspirate cells from the mucosa directly and not those cells which have been shed previously. This smear is not representative of the vaginal secretion. A small percentage of patients after radiation have no vaginal secretion. If secretion cannot be obtained with ease it is perhaps better not to attempt to get a smear.

Of this fourth group approximately one-third show only precornified cells and basal cells in the vaginal smear. The cells may appear perfectly normal or they may be degenerate with indistinct cellular borders. Cornified cells may also be present. However it is very rare (3 of the smears of this group) to see a normal smear of precornified and cornified cells thus long after radiation.

Leucocytes are seen in this group of post radiation smears, but their numbers are variable. Small histiocytes occur frequently. No

evidence of foreign body giant cell reaction was seen. Fresh blood is encountered occasionally and is probably due to the breaking of small adhesions in the vagina. Blood pigment is a much more infrequent finding.

Eight of these 102 patients represent recurrence of their original disease. Five show typical undifferentiated carcinoma cells with no evidence of radiation reaction in the normal cells. Three show undifferentiated malignant cells and very active basal cells. The malignant cells are as those described for unirradiated undifferentiated cells. They show no evidence of having originated from a tumor previously radiated.

#### DISCUSSION

The changes seen in the individual cells, both normal and malignant, which are desquamated into the vaginal secretion are quite comparable to those previously described by many authors in the study of biopsy specimens from irradiated patients. Of course there are some differences since in a study of the vaginal smear a representative group of all types of cells is seen, while a biopsy is limited to that area which has been removed. Another distinguishing factor between the two methods is that the vaginal smear deals only with the cells on the surface while the biopsy shows the changes much deeper.

Dustin, Frola, and Arneson and Stewart all have described the pyknosis of the nuclei of the cells in biopsy material from patients with carcinoma of the cervix. Pyknosis of the nuclei is marked in the radiation response as seen in the vaginal smear. The cells from the basal layer show a marked pyknosis which often is one of the prolonged effects and among the last to disappear.

Dustin, Meigs and Parker (6) and Frola emphasize the atypical mitoses which occur in the malignant cells during treatment. Mitoses are rarely seen in the vaginal smear. This is true not only of the irradiated cases but untreated cases as well. Whether cells in mitosis go on to complete the division after being desquamated or whether the majority of the cells in mitosis are deep and not likely to slough is not known. Evidence of abnormal mitoses is seen in the vaginal smear in the abnormal malignant giant cells which are often

encountered after irradiation. A good many of the normal cells also show division of the nucleus with no division of the cell.

Frola emphasizes the fact that after radiation there is a subsequent maturation of the undifferentiated cells to mature cells with sharp nuclear borders. We have not interpreted any cells in this light. The bizarre shaped cell, which in an untreated carcinoma might be classified as a differentiated malignant cell, has been interpreted rather as a normal cell which has been so affected by radiation as to be almost indistinguishable from an unirradiated differentiated malignant cell. This may be a mistake in interpretation but it is made on the basis that the cases of bladder carcinoma showed these bizarre cells although there were no malignant cells present in the genital tract. We have concluded that their unusual shapes, nuclear and cell size increase and in occasional instances, the hyperchromatic but pyknotic appearance of the nucleus is due rather to radiation effect on normal cells than to any maturation process stimulated by radiation. It is for this reason that it has become the policy of our laboratory not to call postradiation smears positive unless typical healthy undifferentiated malignant cells are seen. To one unfamiliar with radiation changes the bizarre cells and the queer pyknotic, huge nucleus of the irradiated normal cells will often be confusing and lead to an error in diagnosis.

Frankle and Amreich have described the swelling of cells during radiation therapy. This is very evident in vaginal smears. The size increase of cells both normal and malignant is very conspicuous. These same authors mention vacuolization of the cells. This effect is also seen in vaginal smears. It is one of the responses seen in marked reaction of the cells to irradiation. Frola, and Arneson and Stewart mention the increased leucocytic reaction and the foreign body giant cell response of the cervical tissue to roentgen therapy. These reactions have both been described here as they are seen in the vaginal secretions from irradiated cervical malignancy.

It is evident that the correlation of the numerous changes seen in the past in the study of irradiated cervical cancer by biopsy

and the changes seen in the vaginal smear are quite comparable. The pyknosis and degeneration of the nuclei, the swelling and vacuolization of the cytoplasm the evidence of abnormal mitoses, and finally the leucocytic infiltration and foreign body giant cell reaction are all seen in the vaginal secretion as they are in the biopsy material. The vaginal smear is a much simpler way of studying the reaction of both tumor and normal cells. It is difficult to do serial biopsies on treated patients. Toward the end of treatment the biopsy may show only necrosis and no viable tissue thus making interpretation impossible. The vaginal smear on the other hand is obtained with great ease as often as desired for the whole course of treatment. It has the additional advantage of giving possibly a more accurate picture since the entire cell population of the cervix and vagina is represented not merely that of one specific area. The vaginal smear represents a unique and possibly important method of studying radiation reaction in cervical carcinoma.

#### SUMMARY

Two hundred and six cases of cervical carcinoma in which patients were treated by radiation have been studied by vaginal smear. Both immediate and late changes in the cells in the vaginal secretion have been described. Correlation with studies by biopsy have been discussed. The applicability of this method for study of radiation effect in cervical cancer has been suggested and emphasized.

#### REFERENCES

1. ARNESON, A. N. and STEWART F. W. Arch Surg 1935 31: 542
2. DUBOIS A. P. Bull. Acad. Roy. Med. Belg. 1927 7: 237
3. FRANKLE, D. O. and AMREICH, I. Surg. Gyn. Obst. 1921 162: 162-163
4. FROLA, G. Arch. Internat. med. exp. per. 1933 8: 230
5. GILL, A. J. J. Lab. Clin. Med., 1944, 29: 820-824
6. MEIOS, J. V. and PARKER, F., JR. N. England J. M. 1930, 203: 247-253.
7. MEIOS, J. V., GRAHAM, R. M., FREMONT-SMITH, M., KAPRICK, L., and RAWSON R. W. Surg. Gyn. Obst. 1943 77: 449-461
8. MEIOS, J. V., GRAHAM, R. M., FREMONT-SMITH, M., JAMEN L., and NELSON C. B. Surg. Gyn. Obst., 1945 81: 337-345.
9. PAPANICOLAOU G. N. and TRAUT H. F. Diagnosis of Uterine Cancer by Vaginal Smear. New York Commonwealth Fund, 1943



# THE EFFECT OF RADIATION ON VAGINAL CELLS IN CERVICAL CARCINOMA

## II The Prognostic Significance

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A SIMPLE method of determining what effect radiation has on carcinoma of the cervix during and immediately after treatment would be of great practical value. The present methods of evaluating results are exceedingly cumbersome. Most advances in roentgen therapy of this disease have been determined on the survival rates of a certain group of patients as balanced against another group treated differently. If a method could show that at the end of treatment a satisfactory or unsatisfactory result could be expected, instead of the necessity of waiting for a 5 year survival rate the number of cures might be appreciably increased by modification of the present methods of treatment. We believe that the study of the response of cervical tumors to radiation treatment by means of vaginal smear may represent a method of practical value in the early prognosis of cervical cancer.

Many studies have been done in an attempt to correlate biopsy data with possible prognostic value. In 1936 Warren Meigs, and associates published a series of 70 cases of carcinoma of the cervix studied by means of repeated biopsies during radiation treatment. They found that if the tumor showed marked radiation effect and there were changes in the stroma consistent with radiation reaction the survival rate was increased. If however the tumor showed little effect and the stroma little or none the patients did very poorly.

Other authors have attempted to correlate the grade of tumor with the clinical response. Stewart and Farrow in 1940 reported that there was a marked difference in the response to x ray and radium of the same grade tumors. In their opinion single biopsies were not very valuable in judging the actual response. They conclude that a more satisfactory prognosis can be made on the basis of the clinical type of

tumor i.e. the cauliflower growth does much better than the crater like type of lesion.

An interesting study has been reported recently by Glucksmann and Spear. They have attempted to quantitate the radiation response in treatment. The authors emphasize that great care be taken to secure the tissue for biopsy from the growing edge of the tumor. These biopsy specimens were sectioned and areas which showed papillary projections growing into normal tissue were the ones chosen for study. Quantitative counts were done on four types of cells in these areas (1) the cells in mitosis (2) resting carcinoma cells, (3) differentiating cells (4) degenerating cells. The cells in mitosis disappeared soon after treatment was instituted the resting carcinoma cells persisted longer than the cells in mitosis, but these too gradually disappeared. The differentiating cells increase, finally disappearing after treatment is ended. The degenerating cells increase throughout the treatment and persist for sometime afterward. Thus if the degenerating cells and carcinoma cells are plotted against the days of treatment a graph is obtained in which the two lines cross since as the degenerating cells increase the carcinoma cells disappear. In an unfavorable response the carcinoma cells both in mitosis and those resting remain, and the degenerating cells do not increase giving a graph where the lines are parallel.

In a previous publication the effect, both immediate and prolonged of radiation on the cells seen in the vaginal secretion of patients with carcinoma of the cervix has been described. In this paper an attempt has been made to correlate these findings with the clinical picture and the end result of treatment.

Of the 206 cervical carcinomas studied in the previous paper only 73 whose follow ups were of sufficient length of time (first and

second groups) are included in this study. The changes seen during and immediately following treatment are the important ones as far as any prognostic value is concerned. As yet no correlation has been obtained in the appearance of the vaginal smear months or years after treatment.

In our first paper on the changes due to radiation as seen in the vaginal smear we described the cases followed during and immediately after treatment as falling into two definite classes. The first class is that which shows the following changes. The normal cells the basal cells first increase in size then show signs of degeneration and toward the end of treatment, show marked degenerative changes such as vacuolization of the cytoplasm and marked pyknosis or karyorrhexis of the nuclei. The precornified cells show the same changes though these occur later than those seen in the basal layer. The degeneration of the nucleus is not as prominent in the precornified cells as in the basal. The nuclei of the precornified cells often have a smooth washed out appearance. The cornified cells increase tremendously in size and there is much cytoplasmic degeneration but since the nuclei of these cells are originally pyknotic there is no

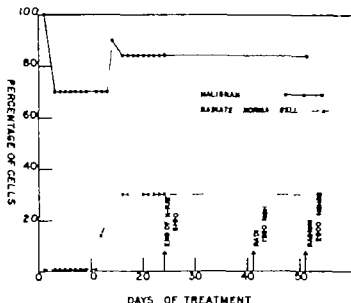


Chart 2. A poor response to radiation (Case 19 in Table IV). There is very little diminution in the number of malignant cells seen and the normal epithelial cells show only a slight response to radiation.

change there. The smears usually show a progressive leucocytosis and an increase in small histiocytes. Occasionally phagocytic histiocytes appear and in a few cases foreign body giant cells were seen. Malignant cells these usually persist until the tenth or eleventh day of treatment. They sometimes increase in numbers and then disappear but more often show a gradual decrease. The time of their disappearance is unimportant. More important is the gradual decrease. The malignant cells of class I show pronounced radiation changes. They are often multinucleated giant cells probably evidence of amitotic division. They show the same degenerative changes as described for the normal cells: increase in size, vacuolization and finally a smooth washed out appearance to the nucleus, pyknosis or a complete breaking up of nuclear material.

Chart I shows a typical case which falls into class I. The approximate percentage of normal cells showing radiation reaction and the approximate percentage of malignant cells present whether healthy or irradiated are plotted against the days of treatment. It is important to note that the chart is *approximate* and does not represent absolute quantitative data. It is difficult to do accurate cell counts on vaginal smears since many fields are too thick to count individual cells and only thin areas could be used. The chart merely

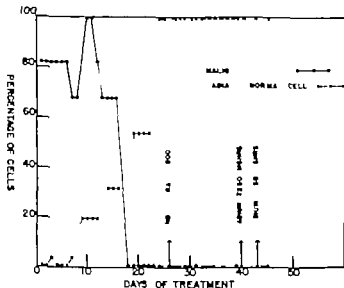


Chart 1. A good response to radiation (Case 6 in Table III) showing a complete disappearance of malignant cells by the 18th day and a maximum radiation effect in the normal cells by the 33rd day. It should be noted that the percentage of malignant cells is based on a scale in which 100 per cent equals the maximum incidence of these cells encountered in any of the smears on this case, while the radiation effect is based on 100 per cent equaling a response in all normal epithelial cells.

SURGERY GYNECOLOGY AND OBSTETRICS  
 TABLE III—GOOD RESPONSE GROUP—Continued

Patient	Age	Symptoms	Type and grade of tumor	Stage of disease	Treatment	Biopsy of the treatment	Vaginal smear response	Follow up
47 M.B. 44675	46	Bleeding wk	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Dead 7 mos
48 M.B. 641 (9)	45	Postcoital bleeding	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
49 L.B. 7400	43	Irregular bleeding	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
50 W. 41 S	43	Spotting between periods	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
51 P. 7401	40	Bleeding 6 mos	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
52 D.C. 11866	41	Spotting 6 mos	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
53 M.F. 47101	66	Profuse watery discharge	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
54 L.B. 30821	43	Bleeding mo	Epi III	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
55 K.L. 7308	67	Spotting yr	Epi II	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos
56 O.W. 45117	61	Right lower quadrant pain	Epi III	ad	Acute 4000 mg/ml	Acute inflammation	Good	Well 19 mos

good results. Of these 28 patients are living and well with no evidence of persistent disease or recurrence. Five patients are dead. We have been unable to follow 3 patients. We show the good response group divided by clinical stage of disease.

Thirty-seven cases were classified as poor responses. Of these 26 are dead, 8 have persistent disease or recurrence and 3 are living.

Of these 3 have not been examined during the past year but they are known to be alive. Whether they have persistent disease or not is of course in doubt but we have classified them as well. Table II shows the poor response group divided by clinical stage of the disease.

If Tables I and II are compared it will be readily seen that there is correlation between the prognosis by vaginal smear and the clinical stage of the disease. Both the groups in stage I and stage IV are too small to be of a great deal of significance. However, they are reversed as to prognosis both by vaginal smear and clinical response. Stage II shows a majority of the cases in the good response groups, and in stage III the cases in the poor response group are in the majority. Tables III and IV give in detail the cases included in this study. The age, duration of

symptoms type and grade of tumor stage of disease amount of treatment biopsies after radiation response by vaginal smear and follow up are all listed.

Though in a series as small as this, statistics of error are not of very great value it is perhaps of interest to point out that if the cases with no follow up are excluded from the series the prognostic accuracy of the vaginal smear in carcinoma of the cervix is 88 per cent. Glucksmann reported an accuracy of between 80 per cent and 86 per cent in a longer series by means of quantitative counts of biopsy material.

It should be mentioned that the follow up on this series is not as long as would be most desirable in a study of this kind. The longest follow up is 3 years and several patients have been followed up less than a year. It is fairly obvious that there may be patients who have been classified as good responses who may yet have recurrences. However the results in the poor response group are such that the length of time of the follow up is less important. This fact for the time being at least would seem to indicate that a greater importance be attached to a poor response than a good response.

TABLE IV—POOR RESPONSE GROUP

Patient	Age	Symptoms	Type and grade of tumor	Stage of disease	Treatment	Biopsy after treatment	Vaginal smear response	Follow-up
1. M.E. 456497	55	Bleeding 4 mos.	Epl. IV	3d	6000r 4350 mghrs.		Poor	Dead 8 mos. after treatment
M.D. 350150	5	Vaginal bleeding. Recurrence of disease treated by radium-033	Undifferentiated	rd	6000r 500 mghrs in 044		Poor	Dead 5 mos. after treatment
3. L.S. 438376	46	Vaginal bleeding 3-4 wks.	Epl. III	rd	6000r 3900 mghrs		Poor	Dead 7 mos. after treatment
4. A.W. 4 2476	48	Bleeding 3 wks. Wertheim operation 043. Recurrence 1044	Epl. III	rd	6000r 5900 mghrs		Poor	Dead 4 mos. after treatment
5. M.B. 450436	53	Pain in hip mos. No bleeding	Epl. II	3d	4500r 4400 mghrs	Necrosis	Poor	Dead
6. M.H. 446955	40	Bleeding 6 wks.	Epl. IV	rd	6000r 4 00 mghrs	Acute and chronic inflammation	Poor	W II 8 mos. N follow-up since
7. D.S. 453843	47	Bleeding mo.	Epl.	?	6000r 4670 mghrs		Poor	Dead mos. after treatment
8. B.S. 350809	40	Bleeding 6 yrs.	Epl. III	3d	7300r 4400 mghrs.	Acute chronic inflammation	Poor	Dead mos. after treatment
9. M.E. 445937	41	Bleeding 4 mos	Epl. III	rd	4000r 4500 mghrs	Acute inflammation	Poor	Dead 7 mos. after treatment
10. K.D. 39977	47	Bleeding 4 mos. Recurrence of disease treated by -ray I 038	Epl. carcinoma	3d	6300r in 038 300r in 044		Poor	Dead 5 mos. after treatment
1. M.R. 445 95	54	Bleeding 3 yrs.	Epl. III	3d	6000r 3800 mghrs	Acute and chronic inflammation	Poor	N exam but known to be alive 7 yrs. after treatment
2. R.K. 44387	43	Severe attacks of vomiting. N bleeding	Epl. III	3d	6000r 4070 mghrs.	Acute and chronic inflammation	Poor	Dead 5 mos. after treatment
12. M.C. 451643	30	Bleeding 3 mos.	Epl. III	rd	6000r 4500 mghrs		Poor	Dead 9 mos. after treatment
4. L.B. 464748	37	Bleeding mos	Epl. III	rd	6000r 4500 mghrs	No diagnostic abnormality	Poor	Persistent disease present 7 mos. after treatment
5. A.M. 40913	4	Bleeding wks.	Epl. II	4th	6000r 4300 mghrs	Acute inflammation	Poor	Persistent disease present 6 mos. after treatment
6. C.T. 346999	5	Spotting 7 mos	Epl. III	4th	6000r 3700 mghrs		Poor	No evidence of disease 7 yrs. after treatment
7. A.D. Pr. pt. 0614	70	Bleeding	Adenocarcinoma	3d	300r 3700 mghrs.	N. evidence of malignancy	Poor	Recurrence of disease 7 yrs.
8. H.D. 4 5 74	40	Bleeding 6 months. Wertheim operation 043. Recurrence 045	Epl. III	3d	6400r 4 mos. post-operatively		Poor	Persistent disease present
9. R.K. 446757	30	Bleeding 6 mos	Epl. II	3d	6300r 3900 mghrs	Acute and chronic inflammation	Poor	Dead mos. after treatment
10. M.F. 43333	60	Bleeding mo	Adenocarcinoma	3d	4000r	Adenocarcinoma	Poor	Dead 1 mos. after treatment
E.P. 453600	56	Bleeding 6 mos	Epl. IV	3d	4 00r		Poor	Dead 3 mos. after treatment
N.T. 491797	67	Bleeding 4 mos	Adenocarcinoma	4th	6000r 4500 mghrs.	N. evidence of malignancy	Poor	Dead
3. V.C. Pr. pt. 0607	37	Bleeding mo.	Epl. II	3d	6000r 4968 mghrs.		Poor	Died 8 mos. after treatment
14. D.A. Pr. pt. 0606	34	Bleeding 6 mos.	Epl. carcinoma	3d	3300r 3 5 mghrs.	N. evidence of malignancy	Poor	Dead 4 mos. after treatment
5. E.T. Pr. pt. 10006		Bleeding 4 mos.	Epl. III	4th	-ray ? wasn't 4000 mghrs.		Poor	Recurrence 6 mos.

Pr. pt. private patient

SURGERY GYNECOLOGY AND OBSTETRICS  
TABLE IV—POOR RESPONSE GROUP—Continued

P. Hist.	Age	Symptoms	Type and grade of tumor	Stage of disease	Treatment	Response after treatment	Vaginal smear response	Follow-up
16 D V pr. nec.	5		Epi III	4th			Poor	Dead
17 M M 453007	77	Bleeding 6 mos	Epi III	3d	6000 4500 mg/m <sup>2</sup>	Chronic inflammation	Poor	Recurrence after treatment
18 D T 491040	34	Bleeding 4 mos	Epi III	3d	6000 3000 mg/m <sup>2</sup>		Poor	Dead 5 mos after treatment
19 B H 65	28	Bleeding 8 mos	Epi IV	3d	6000 540 mg/m <sup>2</sup>		Poor	Dead 3 mos after treatment
20 S B P 40031	6		Epi II	3d	6000 3000 mg/m <sup>2</sup>		Poor	Dead 3 mos after treatment
21 P G. 4024	5	Severe pain lower back and pelvis	Adenocarcinoma	3d	6000 540 mg/m <sup>2</sup>		Poor	Dead 3 mos after treatment
22 C V 920	74	Bleeding yrs	Epi II	Unknown	6000		Poor	Dead 3 mos after treatment
23 M P 1340	37	Vaginal discharge	Adenocarcinoma Undifferentiated carcinoma	3d th	6000 6000 4500 mg/m <sup>2</sup>		Poor	Dead 3 mos after treatment
24 M W 433006	40	Bleeding mos	Undifferentiated	4th	6000	Marked radiation reaction of uterus and lower sigmoid response of uterus, poor effect on tumor	Poor	Dead 3 mos after treatment
25 B T	30	Discharge 3 mos	Epi III	3d	6000		Poor	Dead 3 mos after treatment
26 M H	43	Bleeding 3 mos	Adenocarcinoma	3d	6000		Poor	Dead 3 mos after treatment
27 G P	7	Bleeding yr	Epi III	3d	6000 3000 mg/m <sup>2</sup>		Poor	Dead 3 mos after treatment

## DISCUSSION

Many authors have shown that a correlation between radiation response and prognosis could be obtained by studying radiated tissue Glucksmann and Spear's recent work on biopsies from the growing edge of tumors which have been irradiated confirms the impression that the radiation response in normal and malignant cells is of great importance in the evaluation of the final result of radiation treatment.

The method of biopsy in the study of radiation response is both time consuming and expensive. It is impossible from a practical standpoint in most clinics to make biopsy studies of patients once a week during their entire course of therapy. Furthermore as treatment progresses biopsies are difficult to obtain and during the later part of treatment may show only necrotic tumor if care is not

We feel that the vaginal smear method represents a more practical method for follow

ing patients during radiation therapy. The vaginal smear is easy to obtain. Technicians can be taught easily to take satisfactory smears. Smears may be taken daily if desired. Another distinct advantage of the vaginal smear is that a representative group of all the cells, both normal and abnormal of the vaginal and vaginal mucosa are seen. For this reason the total effect of radiation reaction can be perhaps more accurately determined.

The results as shown by our figures in this series of 73 cases are significant enough in our opinion to suggest to the clinician the vaginal smear as a practical approach to the problem of radiation response of cervical carcinomas. If by a study of the vaginal secretion the immediate response of the tumor to radiation can be determined, the treatment of cervical carcinoma may be made more effective. If a case is a borderline surgical risk and has shown no response to radiation better results might be obtained by re-evaluating the case after radiation and considering radical sur

gery One third of the stage II cases showed no radiation response This is certainly a group of cases in which the salvage rate might be appreciably increased by surgery Some patients may require more radiation to bring about the desired effect, and these could be followed by means of vaginal smear to see if additional treatment would produce reaction in normal and malignant cells

We feel that the study of the radiation response of cervical carcinoma by means of the vaginal smear represents a practical method which will aid in evaluating the effect of treatment on the tumor and will be a useful tool in the prognosis as well as the treatment of this disease.

#### SUMMARY

Seventy three cases of cervical carcinoma have been studied by means of the vaginal smear during and immediately after radiation treatment for possible prognostic significance They have been classified as good or poor responses The prognostic accuracy is 88 per cent The practical application of the method has been discussed

#### REFERENCES

1. GLOCKEMANN A., and SPEAR F. G. *Brit. J. Radiol.* 1945, 18 313-322
2. PACK, GEORGE T. and LIVINGSTON, E. M. *Treatment of Cancer and Allied Diseases*. Vol. 1 pp. 98-143 New York Paul B Hoeber Inc 1940.
3. WARREN SHIELDS, MEIGS, JOE V. SEVERANCE, ALVIN and JAFFE, HENRY L. *Surg. Gyn. Obst.* 1939, 69:645.

# PATHOLOGICAL PHYSIOLOGY OF BILIARY DRAINAGE

## The Use of a New Type of T Tube and the Criteria for its Removal

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THE importance of exploring the common bile duct at the time of cholecystectomy and of subsequent T tube drainage has been firmly established by many authorities. Prolonged T tube drainage decompresses the biliary tree permitting recovery from cholangitis and pancreatitis. In addition to the therapeutic benefits, the T tube affords a means for studying the pathologic physiology of the biliary and pancreatic systems. These studies are (1) roentgenological (2) manometric, and (3) chemical. Roentgenologically one may detect the presence of hydrohepatosis, a missed stone stricture duodenal spasm or pancreatitis. By pressure studies one is able to determine the degree of cholangitis pancreatitis, ampulla edema or spasm. By chemical tests of the T tube bile one can determine the degree of liver damage present. By such means therefore the progress of recovery of the biliary system may be checked periodically and the exact time at which the T tube should be removed can be determined. Previously roentgenograms taken in the anteroposterior position have usually been considered adequate. We however have taken roentgenograms in the lateral position also and have found to our surprise that the type of T tube ordinarily used tends to pull out and a kinking of the common bile duct results. In some cases the common duct was so sharply kinked that obstruction to the flow of bile resulted. Accordingly we have developed a new tube for biliary drainage which avoids kinking of the common duct. It is with the presentation of

this tube and its comparison with the standard type that this paper is chiefly concerned.

### REVIEW OF LITERATURE

Lahey has written forcefully of the necessity for exploration of the common bile duct. In 1938 he reviewed his cases over a period of 28 years and showed that while the frequency of exploration increased from 15 to 50 per cent, the incidence of common duct calculi apparently increased from 8.4 to 18 per cent. In other words the more he looked for stones the more he found. He also found that in 39 per cent of the cases in which common duct stones were found at operation there was no history of jaundice. An even higher incidence—up to 30 per cent of all of gall bladder stone cases—of calculi in the common duct as well has been reported by others. Data published by Allen and by Walters have been confirmatory. Cutler and Zollinger (4) explored the common duct in 40 per cent of a series of cholecystectomy cases and found common duct calculi in 22 per cent. In a series of cases of choledocholithiasis reported by Judd a history of intermittent colicky pain was found in 98 per cent jaundice in 65 to 75 per cent. Bile was obtained on duodenal drainage in 83 per cent of these cases. These and many other surgeons have stated that there is little or no increase in mortality when choledochotomy is added to the cholecystectomy operation. Among present day indications for exploring the common bile duct may be listed the following (1) a history of chills and jaundice (2) palpable common duct calculus (3) dilated common duct (4) thickening of the head of the pancreas (5) multiple small calculi or sand in the gall bladder when the cystic duct is large in size (6) a history of calculi recovered from the stools.

A part of the work of this paper was done in Doctor Francis Henderson, Laboratory Fourth Surgical Service, Boston City Hospital, Boston, Mass.

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While the necessity of common duct drainage has been generally accepted, the duration of the drainage has remained a matter of debate. There is no general agreement as to the proper length of time the T tube should be left in place in any given type of case. Carter found on questioning 6 eminent authorities that there were no established criteria for the removal of the drainage tube. Opinion ranged from 2 weeks in uncomplicated cases to 2 months in cases showing marked cholangitis and evidence of marked obstruction at the time of operation. Few surgeons left the T tube in for longer periods. Some believed that prolonged drainage predisposed to development of persistent biliary fistula or stricture of the common duct. Evidence is accumulating that these conditions very rarely occur in otherwise uncomplicated cases. In the cases which we have studied we have found no evidence of any complications from the use of the T tube. The biliary fistula healed promptly after removal of the T tube in each case provided there was no stricture and the T tube was not removed prematurely. Previously then the optimum time for removal of the common duct T tube has been a matter of personal experiences and opinion therefore a matter for debate. Within recent years we have developed certain physiological tests which we have found useful in determining the optimum time for the removal of the T tube, and we have outlined these tests in previous communications (10-12). They consist of roentgenologic and pressure studies for determination of patency of the common bile duct and the presence or absence of cholangitis. Briefly the T tube is left in until the lower end of the common duct is patent and the cholangitis has completely subsided.

In the presence of obstruction preventing the normal emptying of the biliary tree dilatation occurs throughout the entire system as demonstrated so clearly by Counsellor and McIndoe who have shown that the changes involved even the finest biliary radicals resulting in a diffuse process of 'hydrohepatosis.' In previous communications (10-13) we have shown that these anatomical changes have their physiological counterpart as may be demonstrated by the disturbed intrabiliary

pressure relationship. By means of a water manometer previously described (11) we have measured two types of pressure: (a) the resting intrabiliary and (b) the perfusion pain level. (a) The resting intrabiliary pressure, an index of patency of the lower end of the common bile duct, should be 30 millimeters of water or less. (b) The perfusion pain level, an index of common duct sensitivity and hence inflammation, is the lowest pressure at which the common duct can be perfused with saline before discomfort is experienced by the patient. A patient with a common duct free of inflammation can tolerate up to 500 millimeters of water without pain. When there is any obstruction to the flow of bile into the duodenum the resting intrabiliary pressure will be found to be increased. If there is cholangitis present, the patient may experience pain on perfusion with pressures as low as 100 millimeters of water or less. Pressure readings are made 2 weeks postoperatively at which time the resting pressure is frequently found to be elevated and the pain level is often considerably decreased. As a result of the decompressing effect of continued T tube drainage these disturbed pressure relationships slowly change toward normal unless the damage to the liver and ducts has been very severe. This return to normal values may not occur for a long period after relief of obstruction, even as long as 3 months or more.

The injection of a radiopaque substance by way of an inlying T tube to obtain an exact representation of the contour of the biliary tree has been reported by Mirizzi and others. He reported a series of 400 cases collected over a period of 5 years. His method included the injection of lipiodol at the time of operation into some portion of the bile duct system for the purpose of obtaining an x-ray at once immediate cholangiography. Should an anatomical defect be found Mirizzi explores the common duct. Robins and Hermanson reported 25 cases in which they had made use of this procedure at the operating table preferring lippuran because they found it less irritating. Other series of cases reported not only confirmed the value of this procedure as a determinant for or against common duct exploration, but also called attention to its



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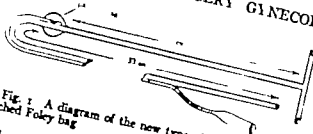


Fig. 1. A diagram of the new type of T-tube with attached Foley bag

value postoperatively the so-called delayed cholangiography. By these procedures it is possible to demonstrate and differentiate residual calculi strictures spasm of the duodenum, pancreatitis with swelling malignancy of the bile ducts ampulla of Vater or the head of the pancreas. The progress of the biliary tree in its return to normal caliber by decompression of the hydrohepatosis, by relief of obstruction and T tube drainage may also be accurately followed. Various radiopaque substances including thorotrast diodrast brominolipiodol, hippuran and sklodan have been used for cholangiography. We (11) have used sklodan or diodrast injection 15 to 25 cubic centimeters at body temperature into the T tube stopping the injection as soon as the patient notices a sense of fullness or distress. It is essential that no delay occurs in taking the x ray picture after the injection. By use of this cholangiographic technique the beneficial effect of amyl nitrite or nitroglycerin in the relaxation of the smooth muscles of the sphincter mechanism of the biliary tract has been demonstrated (10 11 13).

Graham pointed out two decades ago that hepatitis is a constant accompaniment of cholecystitis. Snell has co-ordinated the degree of disturbance of liver function with the anatomical changes demonstrated at an operation. Gray Nettroeur Bollman and one of us (McGowan) (6 7) have shown that in many cases of gall-bladder disease bile acid concentration was diminished in T tube bile. The decrease of bile acids was found to parallel the degree of hepatic damage. In addition to the liver damage resulting from the biliary disease there was evidence of marked temporary inhibition of liver function as a result of conditions associated with the operative procedure. This temporary inhibition of liver

function became progressively worse until the fourth to sixth postoperative day when the liver began to recover. In cases in which evidence of permanent liver damage was slight, recovery from temporary postoperative inhibition of liver function was rapid a matter of days. In other cases in which there was evidence of marked permanent liver damage, the postoperative recovery of liver function was slow in some cases requiring several months. It was found also that a moderately damaged liver does not completely regain its function of concentrating bile acids a fact indicating a limit of repair after injury. This tests appears to be reached usually at the end of the second week after operation, although improvement may be demonstrated for a longer period especially in cases of severe damage. This recovery was delayed by pre-mature clamping of the T tube. It was felt that T tube drainage should be continued until the recovery of liver function had reached its maximum for that particular case that is until the bile acid concentrating power had ceased to improve.

## METHOD OF STUDY

The T tube described is the same as the standard type used except that an inflatable bag is attached approximately 18 centimeters from the cross limb of the "T" according to illustration in Figure 1. This bag is inflated by means of a second tube which is built into the first the arrangement being similar to that used with the Foley tube.

Fourteen patients requiring drainage of the common bile duct were studied.

Criteria which we have used for exploration of the common duct were essentially the same as previously referred to. The common duct was opened longitudinally just below the cystic duct. The size of the incision made should not be greater in length than the diameter of the duct. The lower end of the common duct is usually gently dilated by means of a dilator or catheter. Forceful efforts at dilatation are avoided. Zollinger (18) has shown that forceful dilatation of the ampulla of Vater may result in postoperative edema followed by fibrosis and stricture.

The T tube is inserted by the method shown in Figure 2. The bag is then inflated with sterile saline solution. Two weeks after operation the following tests are made (1) pressure studies (a) resting intrabiliary pressure and (b) perfusion pain level, and (2) roentgenogram of the biliary tract. Clamping of the tube is then started beginning with 1 hour twice daily. This period is gradually increased by a half hour twice daily until the tube is clamped off all the time. If the studies show elevated resting pressure or a low pain level the clamping of the tube is delayed until pressure levels approach normal. After the T tube has been clamped off continuously for 3 weeks it may be removed provided that (1) the resting intrabiliary pressure is 30 millimeters of water or less (2) the pain level is 500 millimeters of water or better (3) the cholangiograms show absence of pancreatitis stricture or stone. By the technique and apparatus previously described (10 11 12) intrabiliary pressure studies were made starting on the 14th postoperative day in all cases reported. Fourteen cases were studied in all. The new type of T tube was used in 6 cases and the standard type of tube in 8.

### RESULTS

Of the 14 cases reported stones were found in 6 (43%) pancreatitis in 1 and common duct pathology consisting of a stricture in 1 case. One showed a stricture of the ampulla of Vater with regurgitation of bile into the pancreas producing pancreatitis which secondarily produced more obstruction of the common duct and jaundice. Of the cases in which the old type of the T tube was used cholangiograms taken in the lateral position showed kinking of the common bile duct in each case (Figs. 3 and 4). This kinking varied from one of slight degree to one of a very acute type. In 1 case in which kinking of the common bile duct was extreme there was an elevation of the intrabiliary pressure. This pressure increased as the kinking became greater. The patient complained of considerable pain. The tube finally came out of its own accord in spite of all attempts to keep it in place by means of silk thread. In all cases in which the new type of T tube was used roentgenograms

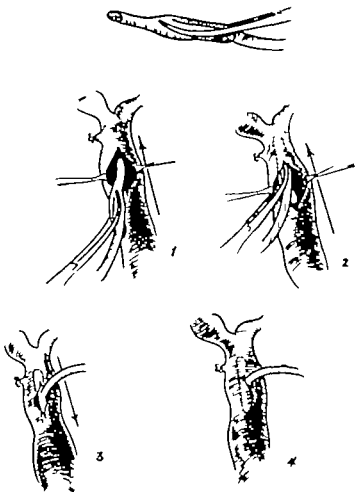


Fig. 2. This shows the method of introduction of the T tube into the common bile duct. At the top is shown the manner in which the tube is grasped with a curved hemostat. 1 The margin of the opening into the common duct is grasped on each side with Judd Allis forceps. 2 The T tube is then introduced into the common duct and pushed upward toward the liver until the edge of the lower limb has past the margin of the opening in the duct. 3 The cross-limb of the tube is then pushed toward the duodenum until the "T" is completed. 4 The defect in the common duct is then sutured on the duodenal side of the T tube.

showed slight or no kinking of the common bile duct (Fig. 5). In the patients drained with the old type tube there was a slight discharge around the tube due probably to continuous friction of movement between the abdominal wall and the tube. In the cases in which the new tube was used the skin healed completely around the tube and there was freedom from discharge or excessive granulations. In addition the intrabiliary pressure readings were in general lower than in the patients drained with the conventional tube. In 2 cases roentgenograms showed the presence of a small stone in the common duct which had escaped detection at the time of

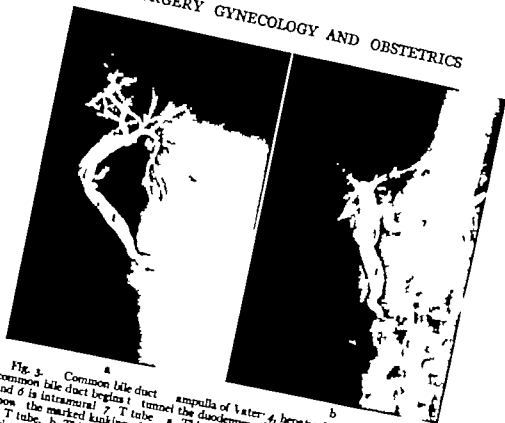


Fig. 3. Common bile duct. ampulla of Vater: *a*, hepatic duct; *b*, point at which common bile duct begins to tunnel the duodenum. The portion of the duct between *a* and *b* is intramural. *c*, T tube. *d*, This cholangiogram taken in the lateral position shows the marked kinking of the duct by means of tension of the lateral position of T tube. *b*, This is the same patient with a roentgenogram taken in the anteroposterior position. The usual position in which cholangiograms are taken. There is no evidence in this view of the marked kinking of the duct noted in the lateral view.

operation. In each case the stones were made to pass by applying the following procedure: the pressure apparatus was connected to the common bile duct and the perfusion pressure was slowly raised to 700 millimeters of water. The patient was given four deep inhalations of amyl nitrite. This procedure was repeated several times. Subsequent roentgenograms showed that the stones had passed. Of the patients in whom the standard type of T tube drainage was used, 1 made a good recovery, 1 developed a pneumonia postoperatively, 1 made an uneventful convalescence but was later admitted because of severe pain and died from pancreatitis and left ventricular failure. The remainder made an uneventful convalescence. In 1 patient with a stricture of the common bile duct which was drained by the standard tube the tube was pulled out gradually. In the cases of the new type of T tube drainage there were no postoperative complications. In those cases in which the T tube was left in place until all the criteria

referred to were satisfied, there have been no tendencies to fistula formation. On the contrary the wound healed promptly and in no case was there any biliary drainage after 24 hours. Further there has been freedom from late symptoms of biliary dyskinesia or the so-called postcholecystectomy syndrome.

#### DISCUSSION

Recurrence of symptoms after cholecystectomy are frequently reported. One of the reasons for this is due to the fact that the surgeon while he may pay a great deal of attention to the gall bladder often fails to realize that the biliary tract and the pancreas are frequently involved as part of the same disease. The cholecystectomy should be considered as only a part of the treatment and prolonged biliary drainage should be confirmed when indicated. Drainage should be continued until the chemical, manometric, and roentgenological studies show maximum benefit has been obtained. The resting intrabiliary

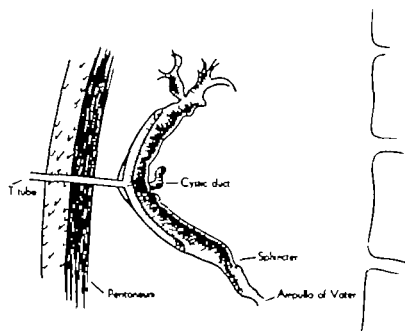


Fig. 4 This diagram, drawn to scale from the cholangiogram in Figure 3, shows the marked kinking of the common duct associated with the use of the standard type of T tube.

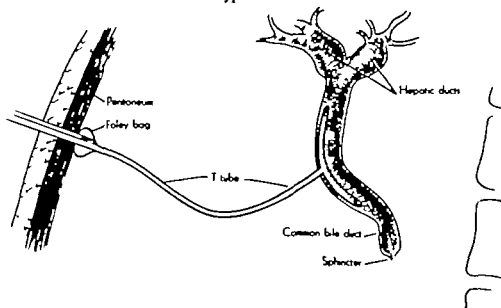


Fig. 5 This diagram, drawn to scale from a roentgenogram of an actual case, shows the new type of T tube in place with no distortion of the common duct.

pressure determines the patency of lower ends of the common duct. The perfusion pain level is an index of the amount of inflammation within the biliary passages. It is really internal palpation. In external palpation we determine the degree of inflammation by applying pressure to the involved parts directly with the hand. In internal palpation of the biliary tract we use the amount of water pressure which the patient can stand as an index of the degree of inflammation in the duct.

#### SUMMARY

1 Cholecystectomy should be considered as only one phase of the treatment of a disease complex which may involve the gall bladder, bile ducts, liver and pancreas at the same time. Exploration of the common bile duct should be performed in approximately 40 per cent of cases in which cholecystectomy is being performed.

2 Choledochotomy should always be followed by drainage of the common bile duct by

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means of a T tube. The T tube is used for diagnostic and therapeutic purposes. Diagnostically one is able to determine the presence of a missed calculus cholangitis pancreatitis stricture ampulla edema, or duodenal spasm. The diagnostic tests used are pressure studies cholangiograms, and chemical analysis of the bile. Therapeutically T tube drainage is continued until cholangitis pancreatitis or ampulla edema has subsided. When T tube drainage has been continued until maximum benefit has been obtained as indicated by prescribed tests there has been no tendency for further symptoms to occur such as those which take place in cases of postcholecystectomy syndrome.

3 X ray films taken in the lateral position have shown that the standard type of T tube tends to be pulled out and a kinking of the common bile duct results. To prevent these undesirable complications a new type of T tube with an attached inflatable bag is described. The benefits of this tube are (1) absence of kinking of the common bile duct (2) a clean wound with freedom from dis-

charge and (3) less tendency for the tube to be pulled out.

## REFERENCES

1. ALLEN A W. *Surg. Gyn. Obst.*, 1936, 62, 447-457.
2. CARTER, R. M. *Surg. Gyn. Obst.*, 1936, 63, 63-109.
3. COCKRELLER, VIRGIL S. and MCLENDON, A. H. *Surg. Gyn. Obst.*, 1936, 63, 777-780.
4. CUTLER, E. C., and ZOLLINGER, R. *Surg. Gyn. Obst.*, 1938, 66, 637-645.
5. GRAHAM, EVARTS A. *Surg. Gyn. Obst.*, 1918, 26, 51-53.
6. GRAY, H. K., BUTCHER, W. L., and MCGOWAN, J. M. *Arch. Surg.*, 1918, 37, 609-618.
7. GRAY H. K., MCGOWAN, J. M., BOLLMAN, J. L., and NETTROCK, W. S. *Arch. Surg.*, 1918, 37, 790-799.
8. JUDS, E. R., and MARSHALL, J. M. *J. Am. Med. Ass.*, 1930, 95, 1061-1064.
9. LARLEY F. H. *Am. J. Surg.*, 1935, 40, 209-216.
10. MCGOWAN, JOHN M. *Surgery*, 1915, 8, 470-478.
11. MCGOWAN, J. M., BUTCHER, W. and WALTERS, W. *Ind. J. M. Ass.*, 1916, 100, 2277-2290.
12. MCGOWAN, J. M., and HEMMERLICK, F. F. *N. Eng. J. M. Ass.*, 1916, 100, 948-953.
13. SNELL, A. *Surg. Gyn. Obst.*, 1918, 26, 970-98.
14. MURPHY, D. L. *Lancet, Lond.*, 1918, 66, 350-359.
15. ROWING, S. A., and HERMANSON LUTER. *Surg. Gyn. Obst.*, 1916, 6, 684-688.
16. SNELL, ALBERT M. *Surg. Gyn. Obst.*, 1916, 63, 500-502.
17. WALTERS, W. *WEEKLY, II. R. Surg. Gyn. Obst.*, 1917, 65, 605-607.
18. ZOLLINGER, R., BRANCH, L. D. and BAILEY O. T. *Surg. Gyn. Obst.*, 1918, 66, 00-04.

# CERTAIN PELVIC TUMORS ASSOCIATED WITH ASCITES AND HYDROTHORAX

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A DEFINITE clinical syndrome (Meigs syndrome) consisting of ascites and hydrothorax associated with fibroma of the ovary has been recognized in recent years (2, 6, 11-14, 29, 31, 35, 51, 54, 56, 58). Certain other benign pelvic tumors may now be identified as causing this syndrome which is of considerable importance because it presents a clinical picture usually associated with inoperable malignancy and pleural metastasis. In the group of lesions under consideration almost magical relief is afforded by surgical extirpation of the tumor.

## ANTECEDENT STUDIES

The first recorded case of the syndrome, as it is recognized today, was reported by Cullingworth in 1879. His patient a 36 year old widow, was found on physical examination to have two pelvic tumors associated with ascites and bilateral pleural effusion. She died of cachexia, dyspnea, and general collapse. At necropsy the peritoneal and left pleural cavities were filled with fluid. Bilateral tumors of the ovaries were found that on the right measured 12 by 9 by 5 centimeters and that on the left measured 15 by 12 by 7 centimeters. The pathologic diagnosis of the ovarian tumors was bilateral fibromas with cystic degeneration.<sup>1</sup> In discussing his case Cullingworth stressed the importance of the presence of ascitic and pleural effusion inasmuch as up to that time it was thought that any tumor giving rise to such effusion had to be malignant. In 1892 Tait described the syndrome in an article entitled "On the Oc-

currence of Pleural Effusion in Association with Disease of the Abdomen." He cited 2 cases. The first patient presented the typical features of malignant neoplasia with ascites and hydrothorax resulting from secondary deposits. The second by contrast was a 36 year old woman who had undergone repeated tapping for relief of ascites. At operation she was found to have a solid fibroma of the right ovary weighing 2 pounds, 2 ounces (about 1 kgm). Tait remarked, "The lesson in this case is in my opinion a very valuable indication that no set of conditions in the abdomen however apparently unfavourable are sufficient to justify us in an absolutely unfavourable condemnation in any particular case."

Kelly and Cullen in 1909 observed the combination of ascites and hydrothorax in a patient who had uterine leiomyomas. Satisfactory recovery followed hysterectomy. In 1914 Caro mentioned the occurrence of ascites and hydrothorax associated with a giant fibroma of the ovary. In 1923 Owen reported his own case of fibroma of the ovary associated with ascites bringing out the fact that hydrothorax might complicate the aforementioned combination. Two of the patients in the 55 cases of fibroma of the ovary reported by Hoon in 1923 from the Mayo Clinic had bilateral hydrothorax as well as ascites. A single case of an ovarian tumor associated with ascites and hydrothorax was reported by Leo in 1926 but the type of the tumor was not revealed. Wong in 1928 reported a case of ascites and hydrothorax associated with a twisted ovarian cyst. At operation the abdomen of the patient was found to be filled with blood stained fluid. A large hemorrhagic multilocular ovarian cyst, with two complete twists in its pedicle, was removed. The patient made a complete recovery.

Salmon in 1934 reported 2 cases of benign pelvic tumors, each of which was associated

<sup>1</sup>From the Division of Surgery Mayo Foundation, and the Section on Surgical Pathology Mayo Clinic.

<sup>2</sup>Abridgement of thesis submitted by Dr. Calmensen to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of M.S. in Surgery.

<sup>3</sup>Coe, in 1881, observed the frequent occurrence of edema in the tumor substance of fibromas and cystofibromas of the ovary and correlated the presence of edema with the formation of "nodules or degenerative cysts."

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with ascites and hydrothorax. One lesion was an ovarian fibroma, the other was a fibroid tumor of the uterus. In his book, *Tumors of the Female Pelvic Organs* published in 1934, Meigs (33) described 3 cases from the Massachusetts General Hospital of benign ovarian fibromas associated with hydrothorax and ascites. In 1935 another case of fibroma of the ovary with pleural effusion and abdominal ascites, with complete cure after surgical removal, was reported from the records of the Massachusetts General Hospital (5). In 1937 Meigs and Cass published data concerning 7 cases of fibroma of the ovary associated with ascites and hydrothorax. These included 7 cases from the Massachusetts General Hospital, 4 cases from the Mayo Clinic and Leo's case taken from the Italian literature. This was the classical report defining the possible coexistence of ascites and hydrothorax in the presence of benign fibroma of the ovary and emphasized the importance of recognition of this association. Curability was now offered for a condition that formerly had been thought to have a basis in hopelessly inoperable malignant neoplasia. Rhoads and Terrell, in 1937 summarized 9 cases taken from the literature, of ovarian fibroma with ascites and hydrothorax, and reported a single case of their own. They stressed the fact that this condition constituted a clinical entity and suggested that it should be called a "syndrome." Weld reported 2 cases in 1938. In 1939, Meigs (34) reviewed a total of 15 cases taken from the literature, including the original 7 contained in the report of 1937. Subsequent to 1939 reports of ovarian fibroma associated with ascites and hydrothorax have appeared in the literature with increasing frequency (3, 3, 9, 11, 12, 14, 17, 28, 35, 41). In 1943 Meigs, Armstrong, and Hamilton gave a synopsis of 27 cases of fibroma of the ovary in which evidence of signs or symptoms of fluid in the abdomen and thorax had been found. Healy, Herrick (16) and Watson, and Taylor added 3 other cases in the discussion of the aforementioned synopsis. Since 1940 other benign ovarian tumors associated with hydrothorax and ascites have been reported. Vogt noted a case of granu-

losa-cell tumor of the ovary associated with hemoperitoneum and hemothorax. Traut and Marchetti, in a study of 54 ovarian tumors of the theca-granulosa cell group, stated that in 1 case hydrothorax was a prominent symptom, and that at operation abdominal fluid had been found. MacFee reported a case in which a multilocular cystadenoma of the left ovary weighing 17 pounds (7.7 kgm.) was found to be associated with hydrothorax and ascites. Kelemen recently reported a case in which Meigs syndrome had been caused by a Brenner tumor of the ovary. Perlmutter and Mendel and associates reported a similar case. Rubin and Shell recently reported a case in which pseudomucinous multilocular cystadenoma of the ovary was associated with hydrothorax and hydrothorax. Meigs and his co-workers did not include either benign tumors (other than ovarian fibromas) or cancers in their reported series, but stated that when such lesions were found to constitute a large enough group they should be included in the syndrome. Benign tumors as enumerated previously now comprise a sizable group and in some cases cancer also has been reported to be associated with the syndrome. Schenck and Eis reported a case of papillary cystadenocarcinoma of the ovary and Anderson observed Meigs syndrome in a patient who had a malignant cystadenoma of the ovary. Both of the patients in these latter 2 cases recovered after surgical removal of the tumors, indicating that the malignant nature of the tumors in itself was not the cause of the ascites and hydrothorax.

## METHOD OF PRESENT STUDY

Records from the files of the Mayo Clinic from 1910 to 1945 were carefully examined for instances of pelvic tumor associated with ascites and hydrothorax (Meigs syndrome). Nine examples of this condition were found among approximately 20,000 records of surgically removed pelvic tumors. An approximate classification of the lesions removed in these 20,000 cases is as follows: 16,000 uterine fibromyomas; 500 ovarian fibromas (this did not include all the smaller fibromas); 1,100

cystadenomas and teratomas and 1 500 carcinomas of the ovary. This gives a total of 19 100. The rest of the tumors constituted a miscellaneous group which included granulosa-cell tumors and other lesions. The incidence of occurrence of this syndrome in this series was 0.05 per cent.

Pathologic material was secured. The tumors were studied in gross detail for pertinent data. Multiple blocks of tissue were then cut from the tumors and placed in a 10 per cent solution of fresh formalin. Sections were cut at a thickness of 10 microns on a freezing microtome and stained routinely with hematoxylin and eosin. The latter provided the material for the microscopic study.

In the present inquiry the 9 cases in question will be reported; then the clinical features will be considered; next the pathologic data will be analyzed; finally the end results of treatment will be presented, followed by comment on the condition in general and by conclusions. The first 3 cases reported in the present paper also were reported by Hoon in 1923. The seventh case was reported by Masson and one of us (9) (Dockerty) in 1944.

#### REPORT OF CASES

**CASE 1.** A 36 year old married woman entered the clinic on July 3, 1917, complaining of bloating of the abdomen. Examination of the thorax revealed dullness and a decrease in fremitus more marked on the left side. The abdomen was distended and a fluid wave was demonstrable. Thoracentesis was performed once. A large mass was attached to the uterus. Roentgenologic examination of the thorax revealed the presence of fluid bilaterally. A large ovarian fibroma about 18 centimeters in diameter was removed surgically.

**CASE 2.** A 53 year old married woman entered the clinic on November 26, 1920, complaining of bloating of the abdomen and some degree of interscapular pain. Thoracentesis had been performed twice before she visited the clinic. There were physical signs of fluid in the right side of the thorax. This was confirmed by roentgenologic examination. Abdominal ascites was present. Thoracentesis was performed twice more before the patient was operated on. Surgical exploration revealed a large fibromyoma of the right ovary which weighed 510 grams.

**CASE 3.** A 59 year old married woman entered the clinic on September 19, 1929, complaining of progressive enlargement of the lower part of the abdomen of 1 year's duration. Physical examination revealed evidence of fluid in the left part of the thorax. A large pelvic tumor occupied the abdomen and ex-



Fig. 1. Photomicrograph of a section of the ovarian fibroma in Case 3. Marked separation of the tumor cells by edema fluid is shown (hematoxylin and eosin  $\times 60$ ).

tended to the umbilicus. Roentgenologic examination of the thorax showed the presence of fluid on the left side. Abdominal exploration disclosed considerable free fluid in the peritoneal cavity. A solid cystic ovarian fibroma measuring 19 by 10 by 8 centimeters was removed. The tumor weighed 835 grams. A section of it is seen in Figure 1.

**CASE 4.** A 42 year old single woman entered the clinic on May 1, 1931, complaining of abdominal enlargement and a nonproductive cough of 6 months' duration. Signs of fluid were present in the lower part of the thorax on the right. The abdomen was large and distended. A fluid wave and shifting dullness were demonstrated. Abdominal paracentesis was performed, 13 000 cubic centimeters of clear straw-colored fluid was removed. Pelvic examination revealed an enlarged freely movable uterus. Roentgenologic examinations of the thorax disclosed fluid in the right base. Surgical exploration revealed a large degenerating fibromyoma of the uterus. This was removed. The uterus was not removed. The tumor was 12 centimeters in diameter.

**CASE 5.** A 49 year old single woman entered the hospital on March 27, 1933, complaining of dyspnea of 2 months' duration. Prior to this entry to the hospital she had been hospitalized elsewhere for 3 weeks. Fluid was found in the right side of the thorax. Thoracentesis had been performed 4 times previously. Examination at the Mayo Clinic showed that fluid was still present in the right part of the thorax. The abdomen was markedly protuberant and shifting dullness was demonstrated. Roentgenologic examination of the thorax showed pleural effusion to be present on the right side. Abdominal exploration revealed a large degenerating tumor of the right ovary measuring 20 by 10 centimeters. Histopathologic examination demonstrated the lesion to be a mixed cylindroid and folliculoid type of granulosa-cell tumor of the right ovary.

**CASE 6.** A 50 year old married woman entered the clinic on April 26, 1940, with the report that a tumor



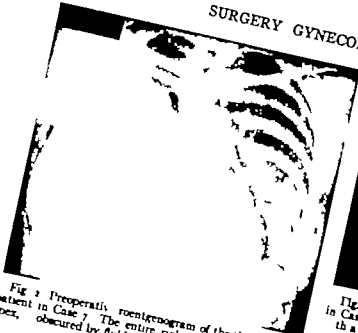


Fig. 2. Preoperative roentgenogram of the thorax of the patient in Case 7. The entire right lung, except for the apex, is obscured by fluid.



Fig. 3. Large ovarian fibroma removed from the patient in Case 7, showing a fibrous and edematous cut surface, with a large central cystic and necrotic region.

in the uterus had been discovered 4 months previously. Physical examination of the thorax revealed nothing abnormal, but roentgenologic examination disclosed fluid in the right base. Abdominopelvic examination showed a large multilocular mass. Multiple uterine fibromyomas with diffuse pelvic inflammatory disease were found at exploration. A moderate amount of free fluid was found in the abdomen. Total abdominal hysterectomy, bilateral salpingo-oophorectomy and appendectomy were done.

CASE 7. A 43 year old married woman entered the clinic on November 11, 1943, complaining of dyspnea of 18 months duration. Roentgenologic

examination of the thorax in April, 1943, had revealed the presence of fluid on the right. Thoracentesis had been performed several times. Physical examination at the clinic disclosed signs of fluid in the right part of the thorax. This was confirmed by roentgenologic examination (Fig. 2). A large, firm, movable mass filled the suprapubic region of the abdomen. A fluid wave and shifting dullness were demonstrable. Thoracentesis was performed on the right. Surgical exploration was carried out, and a large fibroma of the left ovary, measuring 15 by 10 by 15 centimeters was removed (Fig. 3). The tumor weighed 1,370 grams. A roentgenogram made 18 days postoperatively demonstrated a decrease in the amount of fluid in the thorax (Fig. 4). A roentgenogram made 15 months postoperatively showed that the fluid had disappeared completely (Fig. 5).



Fig. 4. Roentgenogram of the thorax of the patient in Case 7 made 8 days postoperatively showing a decrease in the amount of fluid on the right.

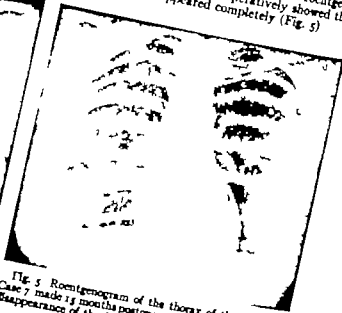


Fig. 5. Roentgenogram of the thorax of the patient in Case 7 made 15 months postoperatively showing complete disappearance of the fluid evident in Figure 2.

**CASE 8.** A 67 year old single woman entered the clinic on September 9 1944 complaining of abdominal enlargement of 6 months duration. Roentgenologic examination of the thorax showed fluid about the right base. The abdomen was enlarged and a fluid wave and shifting dullness were demonstrated. A large pelvic tumor was noted. On abdominal exploration a large fibroma of the right ovary was removed. It measured 15 by 10 by 9 centimeters.

**CASE 9.** A 41 year old married woman entered the clinic on September 27 1944, complaining of marked increase in the size of her abdomen during the preceding 3 months. Roentgenologic examination of the thorax showed that fluid possibly was present in the right base. The abdomen was large and distended. Shifting dullness was present. A mass was felt in the right lower quadrant of the abdomen. Surgical exploration was carried out. Marked ascites was found to be present. A complex teratoma and dermoid cyst of the right ovary were removed together with the right fallopian tube, uterus and the left fallopian tube and ovary. The teratoma consisted for the most part of undifferentiated thyroid tissue.<sup>1</sup>

### CLINICAL FEATURES

**Age of patients.** The average age of the 9 patients who had a pelvic tumor associated

with ascites and hydrothorax was 48 years; the age of the youngest was 36 and the age of the oldest was 67 years. Both of these patients had ovarian fibromas.

While this paper was in the process of preparation, a tenth patient whose condition demonstrated the phenomena of Meigs' syndrome was seen. The following is an abstract of pertinent data.

A 71 year old white married woman entered the clinic on April 11, 1946, complaining of weakness and shortness of breath of 4 months duration. During the previous 4 years the patient had noted some degree of dyspnea and a slight increase in the size of her abdomen. On February 15 1946 her local physician had discovered fluid in the right side of the thorax and since that date thoracentesis had been performed 9 times. She had lost 15 pounds (4.5 kgm.) since February 1946. Physical examination revealed extensive pleural effusion on the right and a large pelvic tumor with questionable ascites. Roentgenologic examination of the thorax showed pleural effusion on the right side, with fluid extending up to the level of the third rib, anteriorly. On April 7 1946, thoracentesis was performed on the right and 3,450 cubic centimeters of pale, amber-colored clear fluid was removed. The specific gravity of the fluid was 1.07. A cell count revealed no cells. Results of culture were negative. The protein count was 2.7 grams per 100 cubic centimeters of pleural fluid.

On April 11 1946, 2 cubic centimeters of clear ascitic fluid was removed from the abdomen and cubic centimeters of sterile India ink was injected into the peritoneal cavity. Two days later thoracentesis was again performed on the right and 3,000 cubic centimeters of smoky fluid containing India ink was removed, thus demonstrating the passage of fluid from the peritoneal cavity into the right pleural cavity. After thoracentesis, an abdominal exploratory operation was performed. A moderate amount of ascitic fluid was present. A large tumor about 10 centimeters in diameter was removed from the left ovary. A small fibrous-appearing tumor of the right ovary also was excised. Appendectomy was performed.

Pathologic examination of the tissues removed disclosed an edematous, degenerating, cystic fibroma of the left ovary measuring 7 by 7 by 7 centimeters. The tumor was attached to a small pedicle which apparently had undergone several twists. There was a fibroma of the right ovary 5 millimeters in diameter. The appendix showed chronic inflammation. Fluid from both the abdomen and thorax contained many pigment laden cells. Study of the peritoneal coat of the appendix demonstrated similar phagocytosis by the lining mantle of mesothelium.

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**Marriage and pregnancy.** Six of the patients were married and 3 were single. Of the married patients, 4 had given birth to 1 child or more, and 2 had no children. It was thus apparent that the parity of the patient had no relationship to the development of the syndrome.

**Complaints.** The most common symptom of which the patients complained at admission was enlargement of the abdomen. Some of the patients also noted the presence of a tumor mass. Abdominal bloating and shortness of breath were the next most common symptoms, and they occurred with about equal frequency. Pain was comparatively infrequent, usually arose from the lower part of the abdomen and was mild. Some patients had a cough in association with dyspnea. The cough usually was nonproductive. The duration of symptoms had varied from months to 5 years. The menstrual function of 4 patients was essentially normal. 3 patients had undergone the menopause. 1 had menorrhagia and 1 had metrorrhagia.

**Physical examination.** In nearly every case the triad pelvic tumor, ascites and hydrothorax was demonstrable by physical examination and roentgenograms or by roentgenograms alone. Ascites was noted clinically in all the cases. In several cases a pelvic tumor was not noted prior to operation and in several other cases the presence of pleural effusion had not been suspected prior to the routine roentgenologic examination of the thorax.

**Laboratory examination.** Results of laboratory examination did not contribute any pertinent positive diagnostic information.

**Diagnosis.** The usual common causes for ascites presented a problem in differential diagnosis to the examiners of this group of patients. Cardiac disease, renal affections, cirrhosis of the liver, tuberculosis, and malignant peritonitis were some of the conditions which had to be distinguished from the true underlying pathologic process. Malignant neoplasm of the ovary with ascites and

## SURGERY GYNECOLOGY AND OBSTETRICS

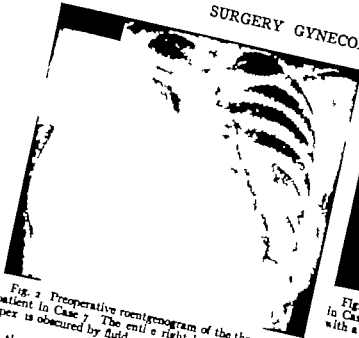


Fig. 2. Preoperative roentgenogram of the thorax of the patient in Case 7. The entire right lung, except for the apex, is obscured by fluid.



Fig. 3. Large ovarian fibroma removed from the patient in Case 7, showing a fibrous and edematous cut surface, with a large central cystic and necrotic region.

in the uterus had been discovered 4 months previously. Physical examination of the thorax revealed nothing abnormal, but roentgenologic examination disclosed fluid in the right base. Abdominopelvic examination showed a large multilocular mass. Multiple uterine fibromyomas with diffuse pelvic inflammatory disease were found at exploration. A moderate amount of free fluid was found in the abdomen. Total abdominal hysterectomy bilateral salpingo-oophorectomy and appendectomy were done.

CASE 7. A 43 year old married woman entered the clinic on November 21, 1943 complaining of dyspnea of 18 months' duration. Roentgenologic

examination of the thorax in April, 1943 had revealed the presence of fluid on the right. Thoracentesis had been performed several times. Physical examination at the clinic disclosed signs of fluid in the right part of the thorax. This was confirmed by roentgenologic examination (Fig. 2). A large, firm, movable mass filled the suprapubic region of the abdomen. A fluid wave and shifting dullness were demonstrable. Thoracentesis was performed on the right. Surgical exploration was carried out, and a large fibroma of the left ovary, measuring 15 by 10 by 15 centimeters, was removed (Fig. 3). The tumor weighed 1,370 grams. A roentgenogram made 18 days postoperatively demonstrated a decrease in the amount of fluid in the thorax (Fig. 4). A roentgenogram made 15 months postoperatively showed that the fluid had disappeared completely (Fig. 5).



Fig. 4. Roentgenogram of the thorax of the patient in Case 7 made 8 days postoperatively showing decrease in the amount of fluid on the right.

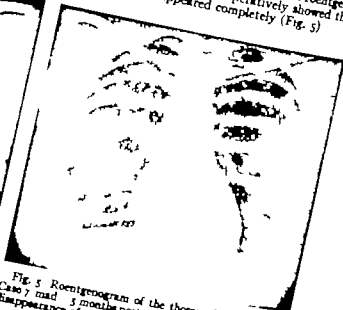


Fig. 5. Roentgenogram of the thorax of the patient in Case 7 made 15 months postoperatively showing complete disappearance of the fluid evident in Figure 2.

**CASE 8** A 67 year old single woman entered the clinic on September 9, 1944 complaining of abdominal enlargement of 6 months duration. Roentgenologic examination of the thorax showed fluid about the right base. The abdomen was enlarged and a fluid wave and shifting dullness were demonstrated. A large pelvic tumor was noted. On abdominal exploration a large fibroma of the right ovary was removed. It measured 15 by 10 by 9 centimeters.

**CASE 9.** A 41 year old married woman entered the clinic on September 27, 1944, complaining of marked increase in the size of her abdomen during the preceding 2 months. Roentgenologic examination of the thorax showed that fluid possibly was present in the right base. The abdomen was large and distended. Shifting dullness was present. A mass was felt in the right lower quadrant of the abdomen. Surgical exploration was carried out. Marked ascites was found to be present. A complex teratoma and dermoid cyst of the right ovary were removed together with the right fallopian tube, uterus and the left fallopian tube and ovary. The teratoma consisted for the most part, of undifferentiated thyroid tissue.<sup>1</sup>

#### CLINICAL FEATURES

*Age of patients* The average age of the 9 patients who had a pelvic tumor associated

with ascites and hydrothorax was 48 years, the age of the youngest was 36 and the age of the oldest was 67 years. Both of these patients had ovarian fibromas.

*Marriage and pregnancy* Six of the patients were married and 3 were single. Of the married patients, 4 had given birth to 1 child or more, and 2 had no children. It was thus apparent that the parity of the patient had no relationship to the development of the syndrome.

*Complaints* The most common symptom of which the patients complained at admission was enlargement of the abdomen. Some of the patients also noted the presence of a tumor mass. Abdominal bloating and shortness of breath were the next most common symptoms, and they occurred with about equal frequency. Pain was comparatively infrequent, usually arose from the lower part of the abdomen and was mild. Some patients had a cough in association with dyspnea. The cough usually was nonproductive. The duration of symptoms had varied from months to 5 years. The menstrual function of 4 patients was essentially normal. 3 patients had undergone the menopause. 1 had menorrhagia and 1 had metrorrhagia.

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Pathologic examination of the tumors removed disclosed an edematous, degenerating, cystic fibroma of the left ovary measuring 10 by 7 by 7 centimeters. The tumor was attached to a small pedicle which apparently had undergone several twists. There was a fibroma of the right ovary 5 millimeters in diameter. The appendix showed chronic inflammation. Fluid from both the abdomen and thorax contained many pigment laden cells. St. dy of the peritoneal coat of the appendix demonstrated similar phagocytosis by the lining mantle of mesothelium.

pleural metastasis, was the condition most often mistaken for a benign pelvic tumor associated with ascites and hydrothorax.

It is of historic interest to note that in Case 1 of the series reported herein the late Dr W J Mayo in 1917 made the preoperative diagnosis of fibroid tumor of the ovary in a patient who had ascites and hydrothorax. At operation a large fibroma of the ovary was found. Since 1937 when Meigs syndrome was recognized as an entity only 2 patients who had fibroma of the ovary with ascites and hydrothorax have been seen at the Mayo Clinic. In both of these cases the preoperative diagnosis of Meigs syndrome was made.

#### PATHOLOGIC DATA

*Types of tumors.* The lesions in the 9 cases reported herein consisted of 4 ovarian fibromas, 1 ovarian fibromyoma, 1 degenerating uterine fibromyoma, 1 fibromyoma of the uterus with pelvic inflammatory disease of the adnexae, 1 granulosa-cell tumor of the ovary and 1 complex teratoma of the ovary.

*Side of involvement.* Five of the ovarian tumors were on the right side, 1 was on the left, and the location of 1 could not be determined on the basis of the data. Both the granulosa-cell tumor and the teratoma occurred on the right side. The 2 uterine fibromyomas were not localized as to side.

*Size of tumor.* All the tumors in this series were large. The average diameter was 16 centimeters.

*Color of tumor.* The ovarian fibromas were whitish or grayish white with a fine whorled appearance on cut section. The granulosa-cell tumor was grayish brown and was encapsulated.

*Consistency.* All the tumors were of the solid variety. Of the 5 ovarian fibromas, 3 face cysts were present on the granulosa-cell of ovarian tumor in the series, and in 3 cases distention of the peripheral veins was present. In 3 of the cases adhesive tags were noted on the surface of the lesion.

*Ascites and hydrothorax.* Abdominal ascites accompanied the hydrothorax in all of the cases. Usually the fluid was considerable. In

7 of the cases pleural effusion was located on the right side, in 1 it was confined to the left pleural space and in 1 it was bilateral. Performance of thoracentesis was necessary for 4 of the patients, 3 had undergone thoracentesis more than once. Abdominal paracentesis was performed for only 1 patient (Case 4), 13,000 cubic centimeters of clear straw-colored fluid being removed. At surgical exploration the amount of fluid varied from moderate to considerable amounts as much as 3 to 4 gallons being removed from 1 patient. The fluid usually was described as being clear or straw colored. Diagnostic tests made upon fluid removed from the abdomen and thorax in these cases were of value only negatively, namely in helping to rule out tuberculosis and malignant neoplasia.

Possible contributory factors to the occurrence of ascites may be mentioned in several of the individual cases. In the case of degenerating uterine fibromyoma (Case 4) the surgeon noted that a large fibroid tumor was incarcerated tightly in the pelvis, and thought that this might have accounted for the ascites. A similar situation was noted in 1 of the cases of fibroma of the ovary. In our case of pelvic inflammatory disease and of granulosa-cell tumor twists in the pedicle were noted and were thought to have contributed to the production of ascites. Ascites frequently is an accompaniment of ovarian tumors which contain large amounts of thyroid tissue, as has been pointed out by Masson and Mueller. As previously mentioned gross edema of the tumor or its pedicle or both was present in every case of ovarian tumor in the series.

Histopathologically moderate to marked intercellular edema was noted in every case of the series and it was particularly notable in the ovarian fibromas. In these there was marked separation of the tumor cells by the edema fluid often associated with this were dilated blood vessels. Otherwise the tumors exhibited no microscopic deviations from the picture seen in other similar tumors not associated with the syndrome under consideration.

#### END-RESULTS

All the patients made uneventful recoveries after surgical treatment and the end results

were uniformly excellent. There was no recurrence of either ascites or hydrothorax in any of the patients. The longest follow up period extended over 27 years.

#### COMMENT

The incidence of ovarian fibromas varies from 1 to 5 per cent of ovarian tumors according to different authors. Masson and one of us (Dockerty) found that 312 of such tumors accounted for 5 per cent of all ovarian tumors surgically removed at the Mayo Clinic. The fibroma is one of the most common of the solid ovarian tumors. The comparatively frequent occurrence of ascites in association with ovarian fibromas has been recognized for some time, but the frequency of this occurrence has been variously reported. Peterson in 82 cases collected from the literature plus 2 of his own found that the incidence was 40 per cent. Hoon noted that ascites was present in 25 per cent of 55 cases collected at the Mayo Clinic, and in a more recent report from the same institution Masson and one of us (Dockerty) found that ascites accompanied 36 per cent of 141 fibromas the diameters of which exceeded 6 centimeters. Meigs and Cass reported the incidence of ascites to be 13 per cent in 29 cases of fibromas from the Massachusetts General Hospital.

Rubin and associates in reviewing Miller's large collection of 2 748 ovarian tumors from various sources found that ascites accompanied 6 per cent of the benign tumors and 45 per cent of the malignant tumors. The same authors noted that ascites had occurred in 30 per cent of their series of 23 theca-cell tumors of the ovary. In both Peterson's and Rubin's series, the amount of ascitic fluid was not proportional to the size of the tumor.

*Origin of ascites* Since ascites generally is present in all forms of intraperitoneal carcinoma, the association of ascites with any pelvic tumor usually leads to the clinical impression that the tumor is malignant. In such cases the ascitic fluid is produced by chemical irritation of the peritoneum, which gives rise to a serous transudate and also to the secretion of malignant implants. The presence of the ascitic fluid in most of the cases of Meigs' syndrome, however, cannot be explained on the

basis of chemical irritation of the peritoneum. Such attempts at explanation have proved entirely unsatisfactory.

Rather a direct cause-and-effect relationship is involved because removal of the tumor stops the formation of the abdominal fluid. Some have attempted to explain the origin of the ascites on the basis of Selye's alarm reaction (21, 48). The latter reaction is the response of the organism to an irritant (in this case a pelvic tumor) with the production of a typical syndrome the symptoms of which are independent of the nature of the damaging agent, and represent a response to damage as such. Among the responses is the production of pleural and peritoneal transudates. Selye regarded this stage as the expression of general alarm on the part of the organism and termed it the 'general alarm reaction'. It might be compared to other general defense reactions such as inflammation or the formation of immune bodies. After repeated insults by the irritant the organism builds up resistance and normal function returns. But after a period of months of continued trauma the resistance disappears and there then appears a histamine toxicosis or anaphylactic shock plus accumulations of peritoneal and pleural transudates.

The aforementioned hypothesis may be valid in certain experimental work but it is not logical to explain Meigs' syndrome on the basis of such experimental observations. The pelvic tumor usually associated with ascites and hydrothorax is a fibroma of the ovary. That the mere presence of the ovarian fibroma in the peritoneal cavity is not a sufficient cause for the production of ascites is attested to by the fact that uterine myomas, despite their size similarity in structure and degenerative changes cause ascites very rarely although they are much more frequent in occurrence than are ovarian fibromas. Kelly and Cullen reported 5 such cases in which ascites undoubtedly had been caused by the presence of uterine myomatous tumors and in 1 case pleural effusion was present as well. Salmon reported a similar case and 1 case from the present series (Case 4) fits into this category.

Schenck and Fis offered an interesting hypothesis in explaining the production of

pleural effusion in such instances. They considered the presence of a pelvic tumor to be the initial factor the tumor by compressing the large abdominal lymphatic channels, retards the lymph flow through them. Schenck and Eis thought that when absorptive avenues through capillaries and lymph channels are abrogated such as occurs in toxic damage to endothelium increased permeability based on anaphylaxis and obstruction to the flow of lymph fluid becomes trapped in large serous cavities and a vicious cycle results in ascites and pleural effusion and if this cycle is allowed to continue, subcutaneous edema. In reality this explanation seems to be derived from Selye's alarm reaction plus the added factor of lymphatic obstruction by the compressing effect of the tumor. The fact that most of these tumors are large lends further credence to this theory.

As has been previously stated there is insufficient evidence to explain the ascites on the basis of lack of protein in the blood. The number of serum protein determinations that have been found to be normal in this condition is insufficient to rule out such a condition as a cause. The ascitic fluid found in cases of pelvic tumor associated with ascites and hydrothorax varies in quantity from small amounts to 8 or 10 liters. In most cases, the fluid is clear and straw colored and chemically appears to represent a transudate. In some instances it is blood tinged, and in such cases there is often evidence of recent twisting of the pedicle of the tumor.

One of the more recent and more nearly adequate explanations of the etiologic basis of the ascitic fluid is that offered by Masson and one of us (Dockerty) who in a combined clinical and pathologic search for the etiologic common denominator found the following facts to be pertinent. Edema of the tumor or its pedicle or both was present in 31 of 51 cases of ovarian fibroma in which ascites was associated. This incidence of edema was twice that observed in the group of tumors not associated with ascites. Central cystic degeneration with or without edema, frequently was noted in tumors of the ascitic group, but was rare in the group of cases in which no free peritoneal fluid was observed at the time

of operation. In 30 per cent of the cases in which there was ascites, adhesions, probably resulting from ancient twists of the pedicle of the tumor also were present. Pain was an important clinical feature in this latter group. Small fibromas contained within the true pelvis were not productive of ascites.

Histopathologically the aforementioned authors found that intercellular edema correlated more often than did gross edema and formation of cysts with the clinical production of ascites. Including the cases of edema with formation of cysts, separation of tumor cells by an excess of tissue fluid was observed in 70 of the 312 ovarian fibromas examined. Significant was the fact that of 51 tumors accompanied by ascites, 49 (96 per cent) exhibited edema, usually in marked degree. This was in contrast to an incidence of 10 per cent for edema in tumors not accompanied by ascites. In no instance was epithelium of a secretory type found on the surface of a fibroma where it might conceivably have given rise to ascites.

In connection with pathologic degeneration of the ovarian fibroma as a possible cause of ascites, Rubin and associates asked why ovarian fibromas produce ascites so commonly whereas uterine fibroids do so rarely even though both tumors have a similar parenchymatous histologic structure and undergo similar circulatory and degenerative changes. The explanation of Rubin and associates was found in the fact that uterine fibroids, are, as a rule covered by a dense fibromuscular capsule and invariably by a serosal layer whereas ovarian fibromas do not have such a capsule, and, like the normal ovary have no peritoneal cover. Instead of a true serosa, ovarian fibromas are covered by a low single-layered, very vulnerable and easily permeable surface mantle which offers practically no resistance to the penetration of fluid from the ovarian tumor. A more likely explanation may be that, for purely anatomic reasons, the ovarian vessels are more vulnerable to compression by a tumor mass or to twists in the pedicle than are the uterine vessels.

*Origin of hydrothorax.* To attempt to explain the origin of ascites when it accompanies certain pelvic tumors, notably ovarian fi

bromas presents a difficult problem in itself but when there is added the concomitant occurrence of hydrothorax in some of these cases the problem becomes even more perplexing. It is well to reiterate the direct cause-and-effect relationship mentioned in connection with ascites. That is, the failure of fluid to reaccumulate in either thorax or abdomen after removal of the tumor suggests that the tumor was responsible for the effusion. It has been pointed out that pleural effusion which accompanies ascites occurs more frequently on the right side than on the left. Meigs and Cass thought that lack of drainage of the right portion of the thorax by the azygos vein might explain this phenomenon but later they did not believe this was an adequate explanation inasmuch as the effusion also was found in the left part of the thorax and bilaterally. Borg reported a case of Meigs' syndrome with bilateral fibroma of the ovaries in which the patient died without the benefit of surgical treatment. At necropsy the azygos vein was found to be very large—being twice as wide as the abdominal aorta. It is difficult to evaluate to what extent the azygos system of venous drainage was interfered with and just what role such interference might have played in the pathogenesis of the hydrothorax.

Lemon and Higgins and others (18, 19, 24, 26) have demonstrated experimentally the pathway by which lymphatic absorption of particulate matter proceeds through the diaphragm. They have shown that both surfaces of the diaphragm with the exception of the tendinous center are richly supplied with lymph vessels. Each half of the diaphragm forms its own separate area of lymphatic drainage and communicates but slightly with the other side. The lymphatic vessels on the right side are much larger and carry a greater proportion of the lymphatic flow than those on the left. Particulate matter is taken up diffusely on the subperitoneal surface of the diaphragm and passes between the mesothelial cells of the peritoneum into minute lymphatic vessels. From these minute vessels it passes to the muscle bundles until it is deposited in the subpleural lymphatic network. This transfer is rapid; it requires only 3 to 5 minutes in the normal muscle and 30 to 90 minutes in a para-

lyzed diaphragm. There are five main routes of communication between the peritoneal and pleural cavities. The first is the sternal route which is the main channel and accounts for 80 per cent of the lymphatic drainage. It consists of three to four channels which course along the diaphragm between the intercostal muscles and proceed forward parallel to the thoracic artery and vein. The second route is the pulmonary route which extends to the nodes at the hilus of the lungs. The third is constituted by vessels which run to the thoracic duct. The fourth route consists of vessels which course over the dorsal surface of the diaphragm, pierce it and empty into the lymph nodes in the region of the kidney. The fifth route is comprised by vessels that pass over the vault of the diaphragm, pierce it anterior to the aortic opening, then pass to the splenic mesentery and thence to the nodes in the region of the pancreas.

Lemon and his associates (25-27) have shown that fluids as well as particulate matter and bacteria are removed by the diaphragmatic lymphatic system in the transference from the subperitoneal to the subpleural lymph vessels and they have demonstrated that this is a one-way communication. Although particulate matter injected into the abdomen of an animal reached the diaphragmatic lymphatic vessels, particulate matter injected into the thorax did not reach the inside of the abdomen. The direction of flow thus follows the direction of the normal current toward the heart. This is dependent mainly on the normal muscular contraction of the diaphragm. Florey in his experimental work noted that an intra-abdominal pressure of 3 to 5 centimeters of water was caused by the respiratory movements of the diaphragm. Intrathoracic pressure was negative to an almost equal degree. The difference in pressure on the two sides determines the direction of flow of the lymph.

The aforementioned work has demonstrated the passage of particulate matter through the diaphragm in the experimental laboratory. Yet as Meigs and associates have pointed out, whether or not the material would be found in pleural effusion was not proved but only suggested because the experimental animal has



no fluid in the thorax such as is present in pleural effusion.

Meigs and his co-workers deserve much credit for a fine clinical investigation of 2 patients who had Meigs' syndrome and who were operated on in 1941. These authors were able to examine the diaphragms of the 2 patients to collect fluids for analysis, and to demonstrate the passage of particulate matter from the abdominal fluid into the fluid in the thorax in all probability through the diaphragmatic lymphatic vessels.

Ritvo reported a case of Meigs' syndrome in which pentoneoscopy was performed before the patient was operated on and in which air was left in the peritoneal cavity in an effort to demonstrate any passageway if such existed for air from the abdomen into the thorax. Roentgenograms were made immediately; these did not demonstrate that air found its way into the pleural space. On the basis of Meigs and Ritvo's observations then it is unlikely that ascitic fluid reaches the pleural spaces by way of an opening through the diaphragm.

Rubin and his co-workers attempted to evaluate certain factors in the experimental production of Meigs' syndrome, and suggested several possibilities as to why ascitic fluid is not found in the pleura in every case of ascites. First, they wrote the fluid entering the pleural cavity is absorbed rapidly, thus preventing accumulation of fluid in the pleural cavity. Second, the passage of fluid through the diaphragm is slow so that the fluid is absorbed by the pleura with the same speed it takes to reach it. Third, the diaphragmatic stomas are blocked or obliterated by debris or chronic inflammatory changes of the peritoneum. Fourth, the high osmotic pressure of the colloidal ascitic fluid counteracts the transudation of water.

#### CONCLUSIONS

The association of ascites and hydrothorax with pelvic tumors was described in the older medical literature but remained comparatively unknown to most of the medical profession until Meigs' classical report in 1937. The greatest credit is due Meigs for recognizing this syndrome and pointing out its

clinical importance. A condition once thought to be an inoperable malignant process is now amenable to complete surgical cure. Meigs' syndrome originally was described as the coexistence of ascites and hydrothorax with benign fibroma of the ovary. Other pelvic tumors, however, both benign and malignant, should be included in the syndrome because they are being reported in the literature with increasing frequency.

Nine cases of pelvic tumor associated with ascites and hydrothorax were found in the records of the Mayo Clinic. In a tenth case the patient was seen at this clinic after the present paper had been completed. The 9 cases included 5 ovarian fibromas, 1 degenerating uterine fibromyoma, 1 fibromyoma of the uterus with pelvic inflammatory disease of the adnexae, 1 granulosa-cell tumor of the ovary and 1 complex teratoma of the ovary. In the tenth case the lesions were ovarian fibromas. Pathologically all the tumors were of the solid variety and were large, averaging 16 centimeters in diameter. Gross edema of the tumor was noted in each of the 10 specimens. Microscopically intercellular edema was noted in each tumor. It would seem that this edema can be correlated with the clinical production of ascites in each case. A large solid tumor can readily produce partial venous obstruction, edema, and in turn ascites. Partial obstruction to the venous return also may result from twisting of a pedicle, inflammation, or adhesions. In 8 of the 10 cases, hydrothorax was situated on the right side. It was bilateral in 1 case and had occurred on the left side in 1 case. On the basis of the evidence reviewed it appears that the fluid in the thorax results from the passage of ascitic fluid through the diaphragmatic lymphatic vessels.

#### REFERENCES

- ANDERSON, H. B. *Pennsylvania M J* 944: 47 67-675
- BOWEN, E. J. and KIRKSTEN, W. J. D. *Am J Obst* 940, 40: 38-385
- BORG, CHARLES. *J Obst Gyn Brit. Empire*, 94 48: 750-755
- CARO, E. Quoted by Rubin, I. C. Novak, J. and Squire, J. *J* (45)
- Case records of the Massachusetts General Hospital. Cabot case 14. *N England J M* 935: 3 7 5-755

6 CAYLOR, H. D., and MASSON J C. *Am. J Obst.*, 1930, 19:45-53

7 COE, H. C. *Am. J Obst.* 1882 15:858-879

8 CULLINGWORTH, C. J. *Tr Obst. Soc. Lond* 1879, 21:276-286

9 DOCKERTY M B., and MASSON J C. *Am. J Obst.*, 1944, 47:741-752

10 FLOREY HOWARD Brit. J Exp. Path. 1927 8:479-490.

11 GILD, ALBERT J. *Obst. Gyn., Brit. Empire*, 1943, 50:440-442

12 GLASS MORRIS, and GOLDSMITH J W. *Am. J Obst.*, 1942, 43:1048-1054.

13. HARRINGTON, S. W. *Ann. Surg.* 1942 115:705-713

14. HARRIS, F I and MEYER, M A. *Surgery* 1941 9:87-93

15. HEALY W P. *Am. J Obst.* 1943 46:33-35

16. HERRICK, W W. *Am. J Obst.*, 1943, 46:35

17. HERRICK, W W. TYSON T L. and WATSON B P. *Arch. Int. M* 1943 71:370-376

18. HIGGINS G M. BEAVER, M G. and LEMOW W S. *Am. J Anat.*, 1939, 45:137-157

19. HIGGINS, G M. and GRAHAM, A S. *Arch. Surg* 1929 19:453-465

20. HOON, M R. *Surg Gyn Obst.* 1923 36:247-251

21. KARADY, S., BROWNE, J S L., and SELYE, H. Q. *J Exp. Physiol., Lond.*, 1938, 28:23-31

22. KELEKEM, EDWARD. *Am. J Obst.*, 1944, 47:275.

23. KELLY H A., and COLLEN T S. *Miomata of the Uterus*. Pp 30-38. Philadelphia W B Saunders Co. 1909

24. LADD, W E., and GROSS, R. E. *N England J M* 1940, 223:917-925

25. LEMOW, W S. *Am. Rev Tuberc.*, 1930, 22:685-701

26. LEMOW W S., and HIGGINS, G M. *Am. J M. Sc.*, 1929 178:536-547

27. *Ibid.*, 1931 181:697-710.

28. LEO, C. Quoted by MacFee, W F (30)

29. LOCK, F R., and COLLINS C. G. *Am. J Obst.*, 1941 41:517-519.

30. MACFEE, W F. *Ann. Surg* 1941 113:549-555

31. McILRATH, M B. *J Obst. Gyn. Brit. Empire*, 1937 44:1102-1108

32. MASSON J C. and MUELLER, SELMA C. *Surg Gyn Obst.*, 1933 56:931-938.

33. MINGO J V. *Tumors of the Female Pelvic Organs* New York The Macmillan Co 1934.

34. *Idem* *Ann. Surg* 1930, 110:731-754.

35. *Idem* *Fibroma of the Ovaries with Ascites and Hydrothorax A New Syndrome in Frank Howard Lahey Birthday Volume*. Pp 331-338. Springfield Ill:Eds. Charles C Thomas, 1940.

36. MEIGS, J V. ARMSTRONG S H., and HAMILTON H H. *Am. J Obst* 1943 46:19-33

37. MEIGS, J V. and CASS J W. *Am. J Obst* 1937 33:249-266

38. MENDEL, E. B. and TYRONI, CURTIS. *Am. J Obst.* 1944, 48:271-273

39. MILLETT JOSEPH and SHELL, JOHN. *Am J M Sc.* 1945 200:327-335

40. OWEN A W. *Lancet, Lond* 1923 1:1211-1212

41. PERLMUTTER, MARTIN. *Ann Int M* 1944, 20:132-140.

42. PETERSON REUBEN. *Tr Am Gyn Soc* 1902 27:264-290.

43. RHODES, J E. and TERRELL, A W. *J Am. M Ass.* 1937 109:1684-1687

44. RITVO MAX. *Am J Roentg*, 1942 48:152-157

45. RUBIN I C. NOVAK, J. and SQUIRE, J J. *Am J Obst.* 1944, 48:601-616

46. SALMON U J. *J Mt. Sinai Hosp N York* 1934 1:169-172

47. SCHIMCK, S B. and EIS B M. *Am. J Obst* 1930, 18:327-330.

48. SELYE, HANS. *Nature*, 1936 138:32

49. TAIT LAWSON. *Med-Chir Tr London* 1892 75:109-118

50. TAYLOR, H C. JR. *Am. J Obst.*, 1943, 46:37

51. THOMPSON R. B. *Brit. M J* 1943 1:668.

52. TRAUT H F. and MARCHETTI, A A. *Surg Gyn Obst.*, 1940, 70:632-642

53. VOGT C. J. *Am J Obst.*, 1940, 40:285-289

54. WARREN SHIELDS. *Surg Clin N America*, 1931 11:315-319

55. WATSON, D P. *Am. J Obst* 1943 46:35:36

56. WEISS, SAMUEL. *Internat. Clin.* 1930 4:102-105.

57. WILD S B. *N England J M* 1938 218:262-265

58. WIENER, SOLOMON. *Am. J Obst.* 1915 72:202-244.

59. WONG A. I. H. *China M J* 1928, 42:625-645

# SURGICAL SUBSTITUTIONS FOR LOSSES OF THE EXTERNAL EAR

## Simplified Local Flap Method of Reconstruction

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**L**OSSES of the external ear are numerous and often complicate other serious defects so that plans for rapid and simple restoration are important without the use of massive flaps or great numbers of operations. The losses result mostly from burns gunshot wounds traffic accidents and freezing. Congenital absence and loss from neoplasms account for a relatively small but important number.

When enough surrounding scalp tissue is present a fundamental plan can be used of freshening whatever is left of the stump of the ear and implanting it carefully under a scalp flap behind and above the ear. When union is firm (2 to 3 weeks) an adequate piece of costal cartilage is put in under the scalp flap in the desired shape. In another 3 to 4 weeks, when there is no swelling the flap and cartilage are dissected free of the skull so as to leave soft tissue attached to the under surface of the cartilage and to the skull. This procedure requires accurate dissection. The resultant double raw surface is grafted with a single large thick split graft. Later adjustment may be necessary. If there is not adequate flap from the patient requests it a small tubed flap from the immediate neck region can be added for the helix this however is seldom requested.

With this simple plan losses of the helix and pinna can be repaired in two operations and total reconstructions of both ears have been done in as little as three operations (Fig 1)

The patients in this series have been cared for in association with M. J. C. P. Scarborough, Captain Joseph Murray Major Byron West, Lieutenant Allyn McDowell, Lieutenant Milton Edgerton, Major Sorenson, Lieutenant Jackson.

In making an ear skin in front and behind is needed with adequate support (or armature) in between. The scalp skin that was behind the ear is brought to the front surface of the ear cartilage (preserved or fresh) forms the support, and a free graft goes in behind. It is recognized that a completely normal total ear cannot be made. There is no tissue available to make it with if it could be done. Although fresh (or preserved) ear cartilage may be used, or chips of costal cartilage may be molded into the exact shape the skin available usually will not fit into the various recesses of the concha, triangular space and curves of the helix to bring these variations of the cartilage into prominence. For these reasons, the restorations are recognized as substitutions, and size general shape and direction are concentrated on in total restorations, but a general outline and prominence may at least fail to attract notice. Many friends and surgeons have talked to the patient in Figure 1 without noticing that both external ears have been totally reconstructed.

Prosthetic ears of latex or soft plastic are used according to patients wishes. They look like normal ears at a slight distance but have the trouble of falling off and require more care than most patients want to give (Their routine use would be acceptable to most surgeons.) What the patient wants is the deciding point.

The cartilage is a problem in many ways of obtaining it, of shaping it and of having it persist as a firm support. In Figures 1, 2 and 3 preserved costal cartilage has been used. A good supply is necessary and large

Fig. 1. Total loss from exposure to cold. Substitution done in 3 operations using local flap, single large piece of preserved cartilage and free split skin graft. Both ears in same condition repaired in same manner at same operations.



Fig. 1



Fig. 1

Fig. 2. Gunshot loss with occlusion of canal that had to be opened by using flaps of the available local tissue. Reconstruction done with neck flap brought up in stages, with preserved cartilage support.

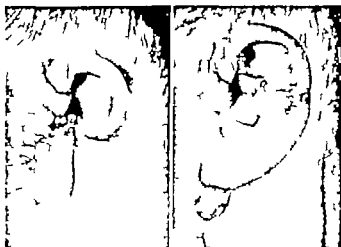


Fig. 2

pieces including the angle have to be on hand to supply a large single piece for a full ear. When large numbers of patients have to be cared for the preserved cartilage is almost entirely relied on and the opening of innumerable chests is avoided. The cartilage usually

can be obtained from the pathology department of a large hospital with proper selection of patients. It is thoroughly cleaned of all perichondrium and stored in merthiolate alcohol or other suitable chemical for use in the future.

## SURGERY GYNECOLOGY AND OBSTETRICS



Fig. 3. Loss of about  $\frac{2}{3}$  of the bulk from fire. Reconstruction with local flap preserved cartilage

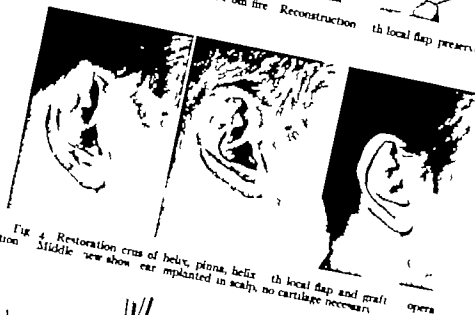


Fig. 4. Restoration crus of helix, pinna, helix with local flap and graft. Middle view shows ear implanted in scalp, no cartilage necessary. opera

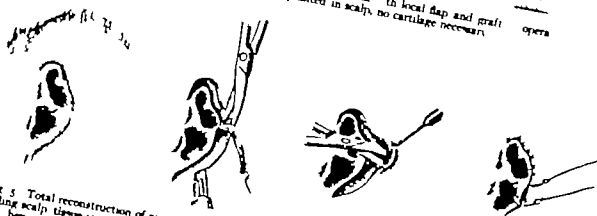
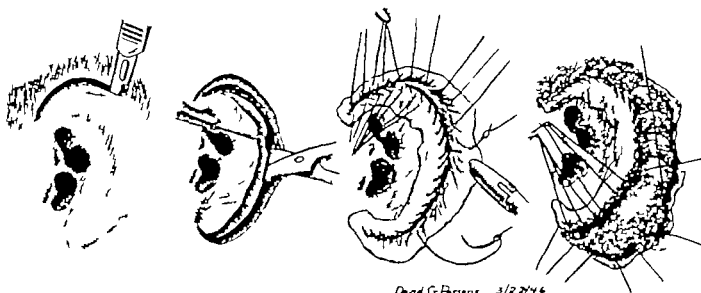


Fig. 5. Total reconstruction of auricle. The stump of the cartilage is opened by removal of edge scar. A flap of auricular tissue is raised and the stump is buried in under it. This is to provide blood supply to the flap for healing. When it is raised later



Fig. 6. After there is complete healing (3 weeks) an opening is made above and a complete tunnel made in the area. The curved portion of a costal cartilage is carefully carved to assimilate the normal contour and it is buried in the pocket.



Dand G. Parsons 3/27/46

Fig. 7. After the cartilage is firmly in place, the ear is cut loose from the scalp with careful dissection to leave viable soft tissue on both the cartilage and the skull. The double surface defect is covered with a thick split graft as shown.

Carving of the cartilage is done in the operating room with no special equipment other than knives and a board. It is put in place through an incision above into a pocket that is made with scissors. A good arm or strut is aimed down into the region of the crus of the helix to gain as much support as possible. Cartilage from other areas such as the knee and septum and from animals has been tried but for an active service using a large amount, a good source of fresh autopsy material is highly advisable. (That some other foreign substance may prove satisfactory is hoped.)

When the hairless skin around the ear is too limited or is scarred and glazy it may be necessary to do preliminary free grafting over the area or to cut away just what hair is in the way and graft this area. Then the ear will be made out of grafts in these areas the stages are necessarily slowed up and greater care is necessary in the dissection.

When there has been avulsion of all local tissue as in gunshot wounds or traffic accidents local flaps rather than free grafts may have to be supplied even to get started. Flap skin is thicker than the normal scalp in this

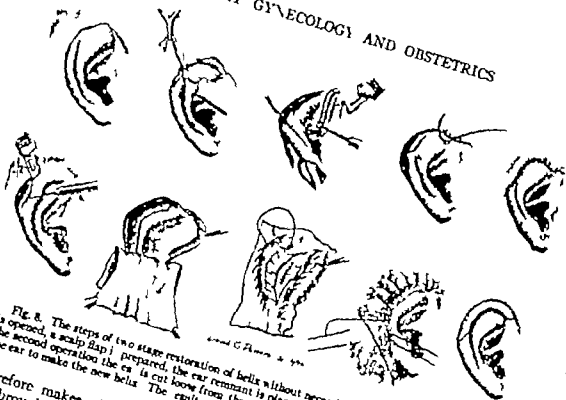


Fig. 8. The steps of two stage restoration of helix without necessity of cartilage. The edge is opened, a scalp flap prepared, the ear remnant is planted under it at first operation. At the second operation the ear is cut loose from the scalp packing up the flap that was behind the ear to make the new helix. The resultant raw defects are grafted with a thick split graft.

area and therefore makes a bulkier ear. The flap may be brought up from the chest or neck. Figure 3 shows one that has been brought up in stages that has been crumpled from chondritis in it.

Ears that are crumpled from chondritis are very troublesome because of folds and uneven surfaces. If there is marked deformity of the cartilage even though it is under good skin consideration should be given the procedure of removing the deformed cartilage first and starting with as smooth a surface as possible. Trying to dig these lumps of cartilage out later is not very successful.

Partial losses as of the helix and pinna may not seem of much importance in comparison with other widespread destruction of tissue but a thin scarred burned rim of the ear can be very uncomfortable for the patient. The repair of these defects is usually so simple and can be done so rapidly that there is little reason for not carrying out this partial reconstruction whenever requested.

The method is not routine for every patient as there may be local shifts of small long flaps or forward dissections and replacements behind but the fundamental, as stated, is to open the edge prepare a direct flap and either plant the ear under it or swing the flap into place. If cartilage is necessary it is put in from the top usually at a second operation the ear is cut loose from the scalp and the defect is grafted at a subsequent operation. The patient in Figure 1 had total restoration in 3 operations with the use of cartilage. In the one in Figure 4 just the soft tissue without cartilage was used.

Sensation is usually slow in developing but little complaint is made. It is of course necessary to protect the patient against temperature extremes.

The use of composite free grafts from the opposite ear may be considered for small losses of the ear and for restoration of the helix in total reconstructions.

# RECONSTRUCTION OF THE ESOPHAGUS BY A SKIN-LINED TUBE

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LACK of esophageal continuity may be the result of congenital defect, trauma (usually chemical) or neoplasm. Improvement in anesthesia, chemotherapy and thoracic surgical technique has made it possible to save the lives of many individuals. Advances are particularly noteworthy in the group of infants with congenital tracheo-esophageal fistula and in the carcinoma group. Survivors should be considered candidates for esophageal reconstruction.

Various practical considerations make it necessary to select cases carefully. Many infants are weak and sickly and often unfortunately have other anomalies. Stenosis of the esophagus by lye presents a particular difficulty, because of the extensive scarring especially at the upper end. This factor usually prevents deliverance of a patent upper portion of the esophagus to the skin surface of the neck. Carcinoma patients are usually older and always undernourished. One is always concerned about local recurrence or remote metastasis.

Even though life has been saved and nutrition improved these patients still present a miserable picture. A gastrostomy is necessary with all of its inconvenience, local irritation, leakage, and loss of gustatory satisfaction. In addition there is an upper esophageal fistula with copious salivary leakage, and if the leakage is prevented by stenosis at the cutaneous junction saliva and food collect in the pharynx, causing discomfort and interference with respiration. It was the problem of relieving such a stricture at the skin surface that first caused us to consider the feasibility of reuniting the upper esophageal stump with the stomach.

CASE 1 J I, a Puerto Rican widow aged 70 years first attended the clinic in June, 1937 because of hoarseness of 5 years duration. A pedunculated fibroma of the hard palate and polyp of the vocal cords were removed. Blood count, urine and stool examinations, Wassermann chest x ray films and gastrointestinal series were normal including the esophagus. On January 3, 1938 esophagoscopy was done to remove a piece of chicken bone lodged high on the anterior wall. In February 1941 she first noted pain in the chest and had difficulty swallowing anything but liquids. She returned to the clinic on April 21, 1941. Her health had been good since her

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Fig 1 Case 1 Front view December 5, 1941 Side view September 12, 1941

Fig 2 Case 1 January 5 1942



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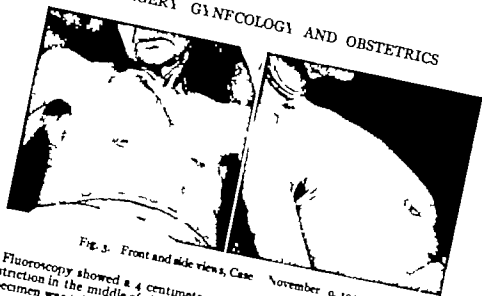


Fig. 3. Front and side views, Case November 9, 1941

last admission. Fluoroscopy showed a 4 centimeter symmetrical constriction in the middle of the esophagus. A biopsy specimen was taken from a mass arising from the posterior wall 27 centimeters from the upper gum. This tissue showed squamous carcinoma. Chest x ray pictures were normal. On May 20, 1941 resection of the esophagus was done through the right 6th intercostal space by Dr. Allen O. Whipple and Dr. Richmond L. Moore. The lower esophageal

stump was inverted and the upper end brought out through the right supraclavicular fossa and sutured to the skin of the chest. A gastrostomy was done. Microscopically the tumor was poorly differentiated and involved muscularis. It measured 4.3 by 2.4 centimeters. The postoperative course was exceedingly smooth. Temperature was not elevated above 100.2 degrees. Sutures were removed on the 8th day. The patient was walking on the 9th day and was discharged from the hospital on the 18th day. By August 15, 1941 the upper esophagus opening was entirely closed off despite attempts to keep it open. This segment remained distended and the patient was uncomfortable (Fig. 1). On September 1, 1941 the esophageal fistula was re-established. Unfortunately this fistula gradually became constricted. It was evident that a wide stoma was needed for the patient's comfort and was an essential step in any reconstruction. On December 16, 1941 the esophageal stump was freed and opened upward 2.5 centimeters, after which the skin and mucous membrane were sutured with interrupted No. 00000 plain cat gut. Primary union was obtained.

April 14, 1942 a skin lined tube 13 centimeters in diameter was formed from the right infraclavicular region to the xiphoid. The patient was sent home on the 22nd day with the tube healed, but open at both ends. A strip of xeroform gauze was replaced in the tube at intervals of 2 to 3 days. The patient continued to gain weight and there was no irritation of the skin within the tube.

August 6, 1942 the lower part of the skin tube was extended down over the xiphoid and anastomosed to the anterior wall of the stomach. A 4 millimeter white nodule on the peritoneal surface of the stomach proved to be a leiomyoma. The patient's stomach was smooth. Her highest temperature was 100 degrees F. The wound healed primarily and sutures were removed on the 7th day. On the 13th day a glass connecting tube was used to link the upper end of the skin tube with the esophageal opening (a distance of 5 cm.) and the patient was allowed to drink a glass of water. The passage was free. The patient noted a sensation of coldness. Checked



Fig. 4. Case showing anastomosis of the esophagus above and stomach below. Not V-shaped junction with gastric mucosa.



Fig 5 Case 2 April 21 1942



Fig 6 Case 2 May 1 1942



Fig 7 Case 2 November 25 1942

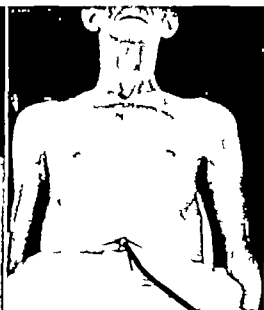


Fig 8 Case 2 March 8, 1943

fluoroscopically the lumen of the skin tube appeared larger than that of a normal esophagus. There was occasional pyloric obstruction due to the mushroom gastrostomy tube and this caused regurgitation of strongly acid stomach content. It was noted that this regurgitated material irritated the exposed skin but not the skin lining the tube. Under local novocain anesthesia the skin tube was continued upward and joined to the esophagus. Healing was uncomplicated and 10 days later the patient was allowed to eat and swallow. Food passed freely down the tube. The gastrostomy tube was withdrawn and the stoma promptly healed. The patient began to regain strength and weight.

September 2 1942 17 months after esophagegostomy the patient developed pneumonitis with signs of consolidation at the left base and a temperature of 103 degrees F. She was flushed and coughing. A week later there was effusion in the left chest and mediastinal shift to the left indicating atelectasis. After aspiration of cloudy yellow fluid showing negative cultures and no tumor cells, x ray examination showed a wide mediastinal shadow which continued to enlarge and the patient became more cachectic. She died March 19, 1943. Autopsy showed carcinoma in the tracheobronchial lymph nodes, with extension to the posterior mediastinum and occlusion of the left main bronchus. The skin

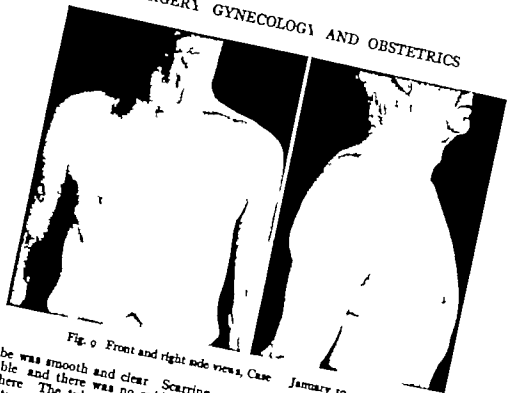


Fig. 9 Front and right side views, Case January 10, 1946

lining of the tube was smooth and clear. Scarring was not noticeable and there was no evidence of ulceration anywhere. The tube consisted of skin averaging 10 centimeters in circumference with no evidence of surrounding scar. A scarcely distinguishable suture line ran down the tube anteriorly. The juncture of the skin-lined tube with the stomach showed no scarring or ulceration, and the epidermis showed an abrupt transition to the normal gastric mucosa. The anterior wall of the stomach was adherent only at the site of anastomosis and at the obliterated gastrotomy.

CASE 2 W. R., a 61 year old man complained of dysphagia for 3 months before his admission on November 19, 1941. He had lost 40 pounds in weight, and had had trouble swallowing fluids. Chest x ray pictures were normal except for calcified bronchial nodes. Barrum studies showed esophageal obstruction just below the arch of the aorta.

Esophagoscopy showed a tumor 33 centimeters from the upper teeth. Biopsy proved squamous carcinoma. Blood count normal erythrocyte sedimentation reaction 8 millimeters Wassermann negative weight 150 pounds. Histamine test showed no free hydrochloric acid total acid 9 after 40 minutes.

December 19, 1941 esophagectomy was performed by Dr. Allen O. Whipple assisted by Dr. Richmond L. Moore. A right transthoracic approach through the 7th intercostal space was used. The pleura was found adherent and so was the esophagus in the region of the calcified nodes. It was necessary to excise the left vagus nerve with the mass. The esophageal stump was brought out just to the right of the suprasternal notch and a gastrostomy was made. The portion of the esophagus examined pathologically was 9 centimeters long and had a coo-

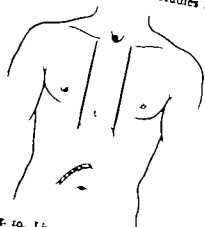


Fig. 10. Lines of incision, Case 2.

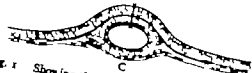
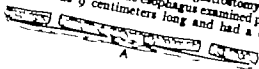


Fig. 11 Showing the formation of the skin-lined tube.

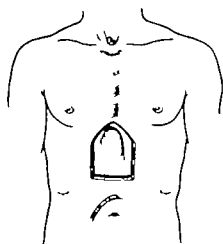


Fig. 12. First step in extending tube.

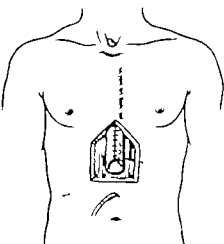


Fig. 13

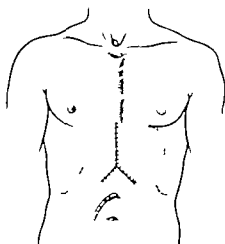


Fig. 15 Wounds sutured.

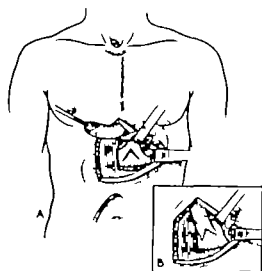


Fig. 14. Exposure of stomach and V incision. Inset shows tube sutured to stomach.

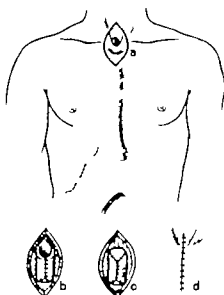


Fig. 16. Elliptical incision has been made to join esophagus and skin tube. Insets show methods of closure.

structing area of carcinoma 2.5 centimeters long. There was muscle invasion and mitosis averaged two per high powered field. The mucous membrane was much more extensively involved than was grossly recognizable. The postoperative course was stormy for 3 days because of bilateral pneumonitis. Temperature mounted to 105 degrees F. but settled to normal by the 7th day. The wounds healed well and the patient was discharged on gastrostomy feedings, on January 19, 1942, weighing 135 pounds. Upon readmission on April 20, 1942, the esophageal stoma was closed by a dense scar. This scar was excised and the stoma was enlarged (Figs. 5 and 6).

September 3, 1942, there was no constriction so a cutaneous tube 9 centimeters in diameter was formed from the sternal notch to the xiphoid. This was followed by union of the lower end to the anterior wall of the stomach (Figs. 7 and 8).

December 1, 1942, wound healing was uncomplicated and sutures were removed on the 9th day. Patient was discharged home on the 18th day.

March 9, 1943, the skin tube and esophagus were united without complication. The patient started

swallowing water on the 6th day, and soft diet was started on the 10th day. He has had no obstruction and has required no treatment. He became interested in having his teeth repaired. In order to do some chewing again and resumed his work as a sheet metal worker in a war plant. His weight has been maintained at 150 pounds.

January 11, 1946, he was in good condition. His only untoward sensation is a strong perception of heat or cold on ingested food and fluids, and in the morning an itching sensation which he relieves with a cup of strong coffee (Fig. 9).

#### OPERATIVE TECHNIQUE

*Stage 1. Formation of subcutaneous skin lined tube.* Two parallel incisions are made from just below the esophageal stoma to the xiphoid. In the first case these were 12 centimeters apart, and in the second 9 centimeters. Eight centimeters may be enough. Incisions

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were made to include the deep fascia and the lateral margins were widely undermined about 10 centimeters. The medial margins are freed about one third leaving the central third attached down the center (Figs. 10 and 11). The central layer is then rolled up skin surface in and sutures with two layers of interrupted No. 000 chromic catgut. The inner layer is tied with the knot inside the lumen and the outer layer in the fascia. The undermined lateral flaps are then closed over the chromic gut sutures being used in the fascia and interrupted dermal in the skin. A roll of this strip of gauze is passed down the tube. When fresh piece may be tied to the old one and pulled through as the old one is removed.

*Stage 3: Anastomosis to stomach* (Figs. 12, 13, 14 and 15). The tube is extended by continuing the two parallel cuts down almost to the operative field. The lowest 2 centimeters of the tube is left open. The anterior wall of the stomach is exposed through the left rectus and an inverted Y incision is made into the stomach. Each branch of the Y is 4 centimeters long. The skin of the tube is then sutured to the gastric mucosa with interrupted No. 000 chromic gut reinforced by a second layer of similar sutures between the fascia of the tube and the gastric serosa and muscularis. The linea alba needs a small vertical incision

to the xiphoid to insure against angulation of the tube. Then the wound is closed and the undermined skin is approximated. At this stage the gastrostomy needs to be kept open on bottle drainage most of the time because gastric content regurgitates freely up the tube and will excoriate the skin of the chest strangely enough however the skin of the closed tube can be seen to remain clear. Perhaps drying or oxidation is needed to activate the irritative process.

*Stage 3: Junction of esophagus and skin tube* (Fig. 16).

An elliptical incision is made vertically including the upper end of the original parallel cuts. The skin tube is then closed up to the esophageal stoma and the upper end of the ellipse turned down in the manner of an envelope flap to close the upper angle of the wound. The undermined skin margins are then closed. Liquid feedings in small amounts may be started as soon as the skin is healed.

## SUMMARY

Loss of esophageal continuity may result from congenital defect, trauma or neoplasm. Improving surgical technique permits survival of an increasing number of patients, and this leads to consideration of a means of reconstruction. Two cases are presented with a description of the method used to unite the upper esophageal segment to the stomach by means of a skin lined tube.

# SOME OBSERVATIONS ON WOUND HEALING

## A Clinical Study with a Note on Topical Chemotherapy and Secondary Closure

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THIS report is concerned with the management of wounds in a general hospital based in the United Kingdom and actively engaged in the treatment of wounded evacuated from the continent. Shortly after D Day it was necessary to outline a plan whereby a large number of wounds could be treated definitively. Where as everyone was well versed in the emergency treatment of wounds there was less agreement and precedent as to the definitive treatment. There were those who strongly advocated that all extensive soft tissue wounds with and without fractures be treated according to the principles popularized by Orr and Trueta while others postulated that in certain instances secondary closure and grafting might be utilized in the definitive treatment of open wounds after varying lengths of time. There was little agreement as to the rôle of local and systemic chemotherapeutic agents. Much information had been disseminated concerning arbitrary time intervals after which débridement and closure might be hazardous or inadvisable. Therefore it seemed that an excellent opportunity was at hand to make some observations upon the factors involved in wound healing.

*Methods of study* Approximately 6,000 patients were admitted to the surgical service in the 6 months after D Day. Between 2,000 and 2,500 wounds were secondarily closed. This is a report on approximately 725 that were treated on the general surgery section. The results have been carefully tabulated and provide the basis for this report.

The following plan was adopted. It was decided to make an earnest effort to close every wound either by secondary suture and/or graft as soon as it was reasonably certain that the

wound was not the site of active virulent infection. The closure of the wound was made the primary objective and the underlying fracture, nerve injury, foreign body, tendon injuries or muscle defect when present were a secondary consideration. This policy was predicated on the premise that the best dressing for any wound is skin and the sooner it is applied the better is the ultimate prognosis of the associated injury.

*Time interval* All wounds were closed as soon as possible. Some of the wounds were closed within 3 or 4 days and many were closed during the first week. The majority were sutured or grafted between 7 and 14 days. It was believed that if the patient had not developed clinical evidence of local or systemic infection within 48 to 72 hours after the emergency treatment had been carried out there was little reason to continue open treatment of the wound in the anticipation of infection that did not exist. It soon became apparent that the earlier the wounds were closed the better were the results.

*Early management after reception* All wounds were dressed as soon as possible after admission. Vaseline packs were removed. Many of the large wounds had been enclosed in plaster casts often with admonitions against their removal. These were likewise promptly removed. A simple wet saline dressing was applied to all wounds in order to remove the caked sulfacryl crystals, vaseline exudate and old blood. It was remarkable to see the striking improvement in the appearance of these wounds after 24 to 48 hours. All medication (sulfadiazine and penicillin) was stopped after admission and subsequently given only in those cases in which there were systemic signs of infection. In one group of 100 patients it was necessary to give chemotherapy in only 2 instances when

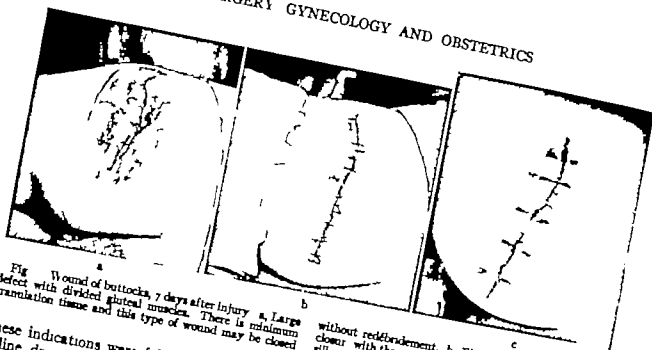


Fig. 1. Wound of buttock, 7 days after injury. a, Large defect with divided gluteal muscles. There is minimum granulation tissue and this type of wound may be closed

without redbreidment. b, Illustrates wound 7 days after closure with through-and-through mattress sutures of black silk. c, Wound at 14 days.

these indications were followed. The simple saline dressings were changed frequently in order to utilize the absorptive and capillary action of the gauze. Each time the gauze was removed and reapplied gross foreign matter was mechanically removed from the wound. Maximum benefit from the wet dressings was usually obtained in 2 or 3 days. As soon as it was felt that the wound was reasonably free of all gross particulate and organic matter closure of graft was done.

black silk sutures which traversed the skin and were subsequently removed.

Older wounds (10 days and longer) were handled in a different manner. Simple closure over granulation tissue and its fibrous base invariably gives an unsatisfactory result. The wound by this time has lost a great deal of its mobility and closure of even minor defects is difficult without rather extensive undercutting of the wound edges. Therefore small granulating wounds whenever possible were completely excised in the same manner that one would excise a nevus or skin carcinoma. An elliptical incision was made in the normal skin about the wound and the granulating area with its base removed by sharp dissection so that the wound then possessed the appearance of a fresh one. Meticulous hemostasis was observed and the wound accurately closed without drainage. This operation of secondary débridement is of prime importance when dealing with granulating wounds. Wounds have healed exceptionally well when closed in this manner and rather unsatisfactorily when simple closure was attempted without excision of the granulation tissue and fibrous base.

Large skin defects oftentimes made closure impossible. These were closed by a combination of partial suture and split thickness graft. Secondary débridement operations were consistently carried out, and the skin edges were

**Technique of closure** The skin was carefully prepared with soap alcohol ether and a mercurial antiseptic. The wound was protected during this procedure with sterile gauze. The local anesthetic, when used was introduced circumferentially into the normal skin and was not put directly into the wound. Early wounds (less than 7 days old) were simply sutured together with little undercutting redébridement seldom being necessary. These wounds did not have granulation tissue, were still mobile, and gave some of our very best results. Black silk sutures were used and only in exceptional instances were buried sutures used. When there was difficulty in obtaining dead space a large pressure dressing was put over the wound. Drains were practically never used. When large muscle groups had been interrupted it was often possible to approximate them by the use of figure-of-eight

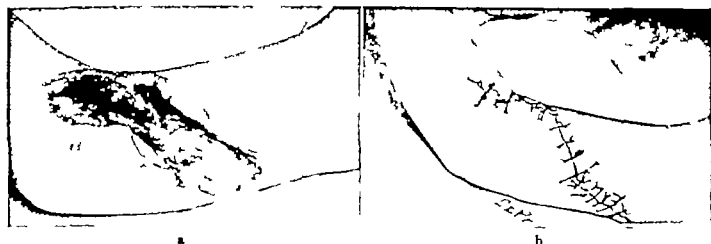


Fig. 2. Soft tissue wound of elbow 3 days after injury 3 days after debridement. a, Appearance of the wound after

24 hours of saline dressings. b, On 9th postoperative day simulates healing seen in clean operative wounds.

mobilized and sutured from the periphery in ward to render the defect as small as possible. A thin split thickness graft was then immediately sutured into the remaining defect over any exposed muscle, fascia, bone, tendon or nerves. On the thighs and legs some of these defects were enormous and the areas grafted in some instances extended from the buttocks to the knee. A successful take is almost invariably obtained when the graft is placed over these redébrided wounds, and in our experience the results are far superior to those obtained when grafts are placed over granulating surfaces.

Oral sulfadiazine (6 gm per day) was begun on the day before operation and continued for 4 or 5 days after operation to protect against an occasional spreading cellulitis. From the beginning we made a hard and fast rule that chemotherapeutic agents would not be used locally in the wound. Penicillin was employed neither systemically nor topically. We felt that if we were properly to evaluate the results it was of prime importance for all personnel to adhere rigidly to a well standardized procedure. It was originally planned to operate upon 50 patients with this technique for purposes of establishing a control. We were already convinced that chemotherapeutic agents used locally were of little value when the wound was ready for closure, and it was felt that in some instances the presence of these agents was even harmful and a deterrent to wound healing. From the beginning the results were out of all proportion to our anticipa-

tions and this policy was therefore followed in 600 consecutive cases. In an additional 125 cases a mixture of penicillin and sulfanilamide was dusted into the wound at the time of closure.

On the other hand on some of the other sections of the surgical service, notably orthopedics various types of topically applied agents were used freely. Some of the wounds were irrigated postoperatively with penicillin through tubes introduced into the wounds at the time of closure. Others had sulfanilamide alone and some were dusted with a mixture of sulfanilamide and penicillin. These wounds were followed closely; the results did not offer any convincing evidence that the local application of these chemotherapeutic agents offers any advantages, and the practice was eventually discontinued.

*Foreign bodies.* Insofar as possible foreign bodies were made a secondary consideration and wounds were frequently closed over tiny bits of shrapnel in inaccessible depths of the wound with no apparent interference in healing. After the wound was healed and if the foreign body was responsible for any symptoms, it was removed at a clean operation. This undertaking was thought to be preferable to one which would allow extensive dissections in a contaminated wound. Large foreign bodies however when they carry in segments of clothing must be removed. The cultures from these retained pieces of clothing frequently yield *Clostridium welchii* when there is no clinical evidence of gas bacillus infection.



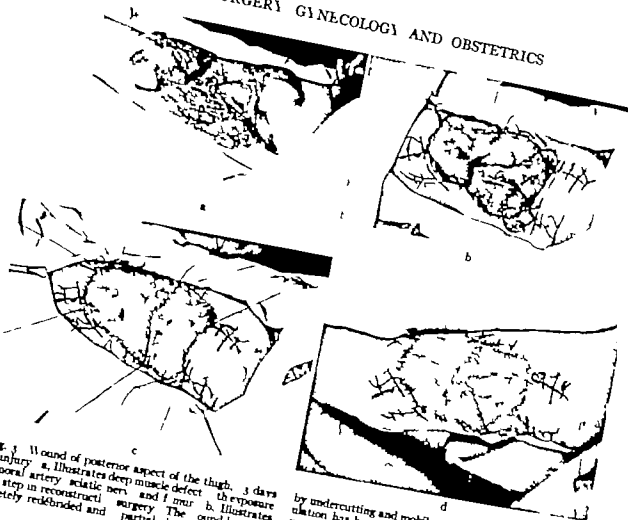


Fig. 3. Wound of posterior aspect of the thigh, 3 days after injury. a, Illustrates deep muscle defect, the exposure of femoral artery, sciatic nerve, and femur. b, Illustrates initial step in reconstructive surgery. The wound has been completely redrafted and partial closure accomplished.

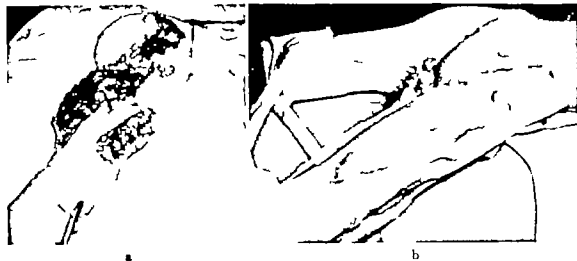
by undercutting and mobilization of skin margins, all grafts have been exposed. c, A large split thickness graft was applied immediately as dressing for the remaining defect. d, Appearance of wound 8 days after operation. There is a complete take of the graft.

Foreign bodies 1 centimeter or over in diameter almost invariably have to be removed because of the cloth which has been carried in arbitrary categories. Group I included those that healed primarily without drainage. They usually required little or no dressing after 7 days and simulated the healing of clean operative wounds. Group II included those which exhibited wet healing. In this group there was usually some reaction about the sutures and frequently serosanguineous drainage. However the Group II wounds were well healed in 14 to 16 days and did not require any further definitive treatment and were considered to give just as satisfactory an end result as those in Group I. Groups I and II comprise the satisfactory group. Group III included those closures considered unsatisfactory because at

the end of 2 weeks they were not healed and frequently required additional surgical procedures, such as grafting, suture or strapping, to obtain final epithelization of the wound.

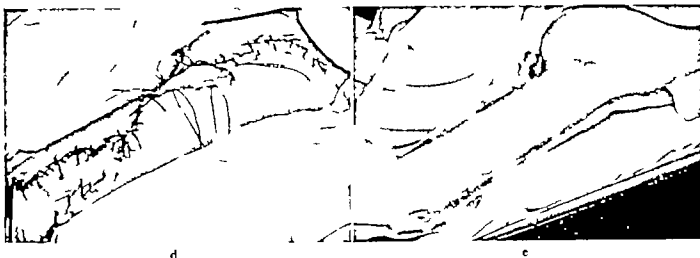
In 600 patients who did not receive topical chemotherapy, primary healing (Group I) was obtained in 67 per cent of all wounds closed. Wet healing (Group II) was obtained in 29.3 per cent. Unsatisfactory results (Group III) were obtained in 3.7 per cent of the cases. With this technique of wound closure 96 per cent of the cases (Group I and II) can be placed in the satisfactory group.

In 125 patients with dusted penicillin and sulfanilamide there was no significant difference in the total of satisfactory results (95.6 per cent). However there was an increased incidence in the "wet healing" group (35.6 per cent) and a somewhat lower per



a

b



d

c



e

Fig. 4. Compound fracture of the femur with extensive soft tissue injury. a, Illustrates appearance of the wound 6 days after injury. There are large masses of necrotic muscle and fascia. Débridement has been incomplete. b, Illustrates the wound 3 weeks after the débridement. c, X-ray film. d, After closure and graft. e, Wound completely healed.

centage in Group I (60 per cent). Unsatisfactory results occurred in 4.4 per cent of the cases.

When first confronted with several hundred large contaminated wounds of the buttocks, arms, legs and trunk, it is not without some apprehension that one undertakes closure. It can be candidly stated, however, that in only a few instances throughout the entire series were signs of systemic infection observed following secondary suture. The most amazing defects could frequently be drawn together

with considerable tension and primary healing would still occur.

#### CASE REPORTS

**CASE I. Extensive wound of the buttock.** This soldier was wounded June 14, 1944, by a high explosive shell. Thorough débridement was carried out in Normandy, France. The wound was initially dressed with vaseline gauze and local sulfanilamide. Penicillin was not given in any form. He was given an indeterminate amount of sulfadiazine orally. He was admitted to the hospital June 20, 1944. Vaseline packs were removed and wet saline dressings applied on the 20th and 21st of June. The soldier was then

## SURGERY GYNECOLOGY AND OBSTETRICS

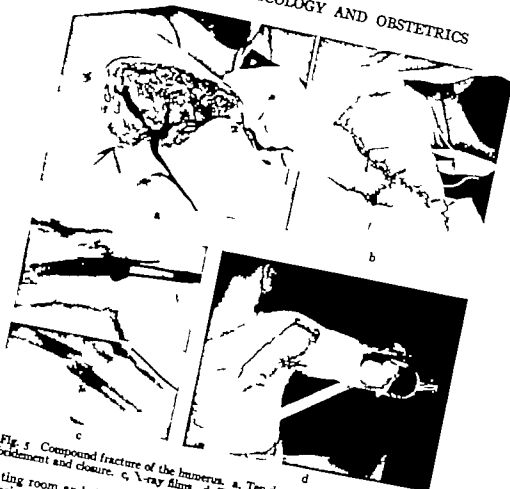


Fig. 5 Compound fracture of the humerus. a, Ten days after injury. b, After re-debridement and closure. c, X-ray film. d, Two weeks after suture.

taken to the operating room and the wound closed under local anesthesia (1 week after injury). The wound was 5 or 6 inches in depth and the gluteal muscles were completely divided. Closure was accomplished with deep through-and-through silk sutures which included the margins of the divided muscle. No local chemotherapeutic agent was placed in the wound. The wound was closed under considerable tension as can be seen from the illustration (Fig. 1a) and the suture line was reinforced with strips of adhesive. A large pressure dressing was applied. Figure 1b shows the result at 1 week. No medication was given during the postoperative period except oral sulfadiazine for 5 days. At the end of 2 weeks the patient was up and about and the wound was completely dry and perfectly healed.

**CASE 2 Extensive wound of the elbow.** This soldier sustained a penetrating wound of the forearm near the elbow from a machine gun bullet on June 23, 1944. Debridement was not done until the following day at which time the wound was packed with vasoline gauze and sulfanilamide powder. He did not receive penicillin in any form. He was admitted on June 25, 1944. The vaseline pack was removed, wet dressings were applied for 24 hours and closure was done on June 26, 1944 (3 days after original dé-

bridement). No local chemotherapy was given. Sulfadiazine was given orally on the day preceding operation and for 4 days after operation. Complete primary healing was obtained. Physical therapy began 14 days after operation.<sup>1</sup>

**CASE 3 Massive wound of posterior aspect of thigh.** This soldier was wounded on July 25, 1944 by an aerial bomb. There was extensive hemorrhage and shock, and debridement was not done until 48 hours following injury. He was evacuated to the United Kingdom and arrived in Oxford August 5, 1944 (5 days after primary debridement). He was in a plaster of paris hip spica and his field medical record contained the following note: "Recommend Cast not to be removed for a minimum period of 8 weeks because of massive tissue loss. Femoral artery femur and sciatic nerve exposed at time of operation for a distance of 6 inches." There was a nauseating odor as much drainage through the cast, and it was therefore promptly removed. The wound involved the

Primary healing is almost invariably observed in wounds which are closed with few days of the primary debridement. Most of the complications in wound healing after secondary closure were observed in those wounds in which there was much edema. The reasons that sutures might fail to hold in the wound at the original operation and after 4 or 5 days of simple dressing up the wound to be closed, the wound can be closed by simply drawing up the sutures (detached primary sutures).

entire thigh and was swathed in vaseline gauze. There was much purulent exudate in spite of the fact that he had received large doses of penicillin both at the field hospital in France (initial intravenous dose of 100,000 units) and during his transport to the United Kingdom.

A large simple saline dressing was applied and changed frequently during a period of 4 days, and on August 7 1944 he was taken to the operating room and a partial closure accomplished by mobilization of the skin margins (Fig. 3b). Granulations were just beginning to appear and they were removed from the muscle surfaces. The femoral vessels were exposed for a distance of 5 or 6 inches in the depth of the wound and the femur was covered only with a thin fascial layer. A single sheet of split thickness skin was taken from the opposite thigh with a free hand knife and sutured into place in the remaining defect (Fig. 3c). A large pressure dressing was applied. Figure 3d illustrated the appearance of the wound at the first dressing with a complete take of the graft. Physical therapy was begun in about 10 days and the patient was out of bed on the 14 day with the wound healed. Penicillin was not used. Nothing was put into the wound topically and the only medication was sulfadiazine orally.<sup>1</sup>

**CASE 4. Severe compound fracture of the femur.** This soldier sustained multiple shrapnel wounds of the right thigh and abdomen and a compound comminuted fracture of the femoral shaft, also an intracapsular fracture of the neck of the femur on June 16 1944 in Normandy. A partial débridement was done about 4 hours later. Eviscerated loops of bowel were replaced within the abdomen, a portion of omentum resected and the abdominal wound closed. In the following 48 hours he received 5 units of plasma, 20,000 units of penicillin every 4 hours, two transfusions of whole blood and sulfa drugs topically and systemically. He was admitted to our general hospital 4 days after injury in very poor condition: temperature 101, pulse 120, hemoglobin 45, red blood count 1.9 million and white blood count 28,000. He was in a hip spica which was soaked with blood. He was given several blood transfusions in the following 48 hours and then taken to the operating room where the cast was bivalved. Figure 4 illustrates the condition of the wound June 22 1944, (6 days after the original injury) and it can be noted that there had been incomplete débridement. There was much necrotic tissue which was removed from the wound. A Kirschner wire was in-

serted into the tibial tuberosity for traction. A new double hip spica was applied. On July 6 the cast was bivalved and the wound treated extensively with saline dressings which were changed frequently in preparation for closure of the wound. On July 16 (1 month after wounding) the patient was taken to the operating room and the wounds were completely closed by secondary suture and split thickness graft (Figure 4b illustrates the appearance of the wound after wet saline dressings and secondary débridement and Figure 4d shows the wound immediately after secondary closure. Figure 4c shows the wound completely healed just before he was sent to the United States with a simple fracture of the femur in good position.

This case is an excellent example of how a severely wounded man with multiple injuries has gone through the various steps in the chain of evacuation to make a good recovery. It is our feeling that these compound fractures, no matter how severe, can be converted into simple fractures in many instances when good surgical principles are observed. On the other hand these extremely large wounds would take months to heal by secondary intention and when packed with gauze and kept open there is opportunity for infection of bone, secondary hemorrhage and disability from scar contracture. (This patient was treated in collaboration with Lieutenant Colonel Yancey, Chief of the Orthopedic Section and Major C. N. Mell, Assistant Chief of the Orthopedic Section.)<sup>1</sup>

**CASE 5. Compound fracture of the humerus.** This soldier was wounded in the right shoulder by a high explosive shell on September 1 1944. There was severe hemorrhage and shock. He was treated in a field hospital 3½ hours later and débridement was done followed by the application of a shoulder spica. Penicillin was not used. He was given oral sulfadiazine in adequate amounts. He was admitted to this hospital 8 days after injury (September 9) and on September 11 he was taken to the operating room and the wound was closed without topical chemotherapy. Secondary débridement with complete revision of the wound was performed and he was given several transfusions for his anemia. (Figure 5 illustrates the appearance of the wound before and after closure and again 2 weeks later.) This is another example of how a very extensive compound fracture can be converted into a simple fracture by simple closure. This procedure is only possible because of the skillful débridement. He had a completely healed wound only 3 weeks after injury whereas the plaster treatment of such an open wound would result in purulent drainage and prolonged convalescence. There is also evidence to support the view that healing of bone is greatly enhanced when the wound is covered with skin. (This case was under the care of

<sup>1</sup>This is a gratifying result and is much better than many weeks or months in a plaster cast. There likewise is complete restoration of function without limitation of motion by scar which is an inevitable sequel of prolonged healing by secondary intention. The presence or absence of fracture in the involved bone should not make the slightest difference in the basic principles involved in the healing of the wound. We consider easily treated fractures of the femur with extensive soft tissue loss in the same manner. There is no question but that compound fractures left open with large vaseline packs over a period of many weeks, invariably develop a certain degree of bone infection whereas if the overlying wounds are promptly closed, compound fractures, in the great majority of cases, are converted into simple fractures and infection avoided or minimized. This should prove to be one of the most significant contributions of the war, and differs radically from the original precepts popularized by Orr and Traut.

A survey of 200 consecutive compound fractures of the femur treated by secondary closure revealed that 90 per cent of them healed completely and were returned to the United States 6-9 days after hospitalization; 10 cases showed evidence of bony union. This series of cases will serve as the basis for a subsequent report by Lieutenant Colonel Daniel L. Yancey, Chief of Orthopedic Section.

## SURGERY GYNECOLOGY AND OBSTETRICS

Lieutenant Colonel D. L. Yancey, Chief of Orthopedic Section and Major C. N. McAllister, Assistant Chief of Orthopedic Section.)

**Analysis of results.** It has been surprising to observe that 96 per cent of so called contaminated wounds heal satisfactorily when closed by secondary suture. The policy of leaving traumatic wounds open after careful débridement and the rôle of systemic chemotherapy in the prevention of hemolytic infections no longer needs to be defended. However there is less agreement as to the management of these same wounds after they have once reached a general hospital where definitive treatment may be carried out. Medical curricula have rather universally included strict admonitions against the closure of contaminated wounds after some arbitrary time interval. Once this interval had expired it was thought necessary to keep these wounds open for an indefinite period of time in order to avoid infection which presumably would follow closure. The present experience shows this reasoning to be invalid. This is in contrast to experience reported in the last war. Several factors must be considered as a possible explanation for the excellent results that were obtained. In the beginning the excellence and promptness of emergency treatment rendered cannot be minimized. There are two outstanding features in connection with essential primary treatment—good surgical débridement and the transfusion of whole blood. Experience in this war has demonstrated that there is no substitute for the latter under battle conditions.

**Penicillin.** The antibacterial potency of penicillin is well known. Many of the wounded had received penicillin both topically and systemically beginning at the forward area and continued through the echelons of evacuation. It was given on the LST's at regular intervals when the patients were brought across the channel as well as on air evacuation ambulances enroute to the United Kingdom. It is extremely difficult to accurately evaluate the effect that this prophylactic measure has had upon the subsequent absence of infection when these wounds were closed. We are inclined to minimize the effect that it has had upon the bacterial flora of the wound how-

ever. For example some of our sickest patients had received penicillin in adequate amounts but arrived extremely septic because of retained clothing or necrotic tissue in the depths of a wound. It was invariably true that when débridement had been inadequate, and it was absolutely true that when débridement had been adequately done, it seemed to make little difference whether penicillin had been given or not. We admitted many patients who had had only 1 or 2 doses of 20,000 units over a period of several days. Their field medical records still carried a notation "penicillin treated and in the subsequent analysis of results, such cases give an unreliable index of the efficacy of penicillin. Many patients had received none whatsoever and their subsequent course when definitive treatment was carried out, varied little or none from those in which large amounts of penicillin had been given. There were many patients who received a large initial intravenous dose at the time of débridement in France but did not receive a single dose thereafter. Their records are still classified as "penicillin treated and are misleading in this respect. It was rare to encounter a patient who had received therapeutic doses of penicillin at regular intervals and one must be extremely critical when evaluating the rôle that this drug played. Our cases did not receive penicillin either preoperatively or postoperatively except for definite indications. Wherever possible efforts were then made to identify the organism and its sensitivity.

A nearby general hospital on the other hand has used penicillin extensively as a prophylactic measure. During the month of July 1944, this neighboring hospital used 2,208,000 units, while in our work during the same period we used 9,500,000 units. In other words, in treating approximately the same number of patients with the same type of wounds, the neighboring hospital used 200 to 250 times the amount of penicillin that was used in our hospital. A few cases on the orthopedic service with compound fractures received penicillin irrigations to the open wounds. This practice was discontinued because there was little difference observed when these wounds were

compared with others that were treated with ordinary wet dressings.

Penicillin remains extremely valuable in the armamentarium of the war surgeon where definite indications exist for its use. It does seem however, that there is considerable evidence in the present study to show that its routine prophylactic use is of equivocal value and perhaps wasteful. In the great majority of cases there is no such indication and in this series satisfactory healing was observed in 96 per cent of the cases without the use of penicillin.

*Sulfonamide therapy* Much of the conflicting evidence in both experimental and clinical studies on wound healing is a result of a failure adequately to control conditions. We determined from the beginning to treat all wounds uniformly so that there would subsequently be an opportunity to evaluate the results. There seemed to be considerable evidence to support the view that the local use of the sulfonamide drugs in contaminated wounds possessed many limitations. The inhibitory powers of the para amino benzoic acid derivative are well known and the wounds with which we were dealing invariably contained a certain amount of purulent exudate. In addition the relative insolubility of the various drugs results in an exudation of plasma like fluid into the wound which in many instances is detrimental to wound healing. Ten grams of sulfa drug in a wound will frequently give a blood level of only 2 or 3 milligrams per cent and this is not of therapeutic value. For example erysipeloid infections in the periphery of open wounds do not respond well to local sulfa drug medication when it is used alone but they promptly subside on adequate dosages by mouth. It was decided that if an indication for a sulfa drug existed it would be given in adequate dosages by mouth.

As is well known the majority of wounds when they occur on the battle front are dusted with sulfanilamide powder before the first aid dressing is applied. In addition most of them are subsequently treated locally at the time of secondary dressings and almost invariably at the time of débridement. The soldiers also take 4 grams by mouth at the time they are wounded in most instances and the oral medication is almost invariably continued. Intra-

venous sulfa drugs have also been utilized freely at forward medical stations. There is no question but that this has been of tremendous prophylactic value and there is no doubt but that it is the reason that streptococcus cellulitis rarely occurred in the wounded of this war. Septicemia as a complication is extremely rare.

The inclusion of this potent bacteriostatic agent in the armamentarium of the war surgeon has allowed a freedom of action which has permitted many advances in the surgical treatment of these contaminated wounds. One of the single factors which has allowed surgeons to close compound fractures and large soft tissue defects—oftentimes many days after the original wound—is the security afforded by the knowledge that one possesses an agent which successfully combats hemolytic infection and prevents septicemia.

All of the patients in this series received sulfadiazine before and after wound closure. In several hundred cases there was not a single case of systemic infection. In only a few instances was it necessary to open a wound to liberate pus. An occasional wound showing an area of cellulitis would invariably subside on wet dressings and subsequently heal primarily. As evidence accumulated there was little to condone the topical application of chemotherapeutic agents. They are capable of interfering with healing because they act as foreign bodies, they increase the exudation of fluid into the wound and the therapeutic value has never been unequivocally proved.

It should be re-emphasized that whenever débridement had been inadequate in the emergency treatment of the wound there were frequently dire consequences no matter how adequately the various chemotherapeutic agents had been administered either topically or systemically. If on the other hand the essential débridement had been well carried out, the patients arrived in good condition even in those instances in which chemotherapy had been omitted or given in subtherapeutic doses.

The results in these closures were not appreciably altered by either sulfonamides or penicillin locally or systemically when given at the time of closure. The principle of closure of wounds has progressed to the point that it is

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perhaps justifiable to postulate that superficial wounds not closed or covered by graft within 3 or 4 weeks of receipt of injury are being improperly treated. The deterioration of muscle, fascia, tendon, blood vessels, and bone when exposed in an open wound progresses at an alarming rate and most of the complications of wounds can be prevented by covering them with epithelium. This procedure is only possible when accurate and complete débridement has been carried out. In many cases in which débridement has been improperly done or omitted entirely it is feasible to carry out this essential part of the treatment some days later at a fixed installation. It has been stated that the last war only after considerable experience and error. However surgeons of this war were well versed in this particular phase of the emergency treatment of wounds. This factor is undoubtedly of prime importance in the consideration of the excellent results that were obtained.

Opinions concerning the plaster treatment of compound fractures are likewise rather universally being revised. There is no question but that the plaster method as outlined by Trueta is an excellent method for carrying out emergency treatment of wounds under battle conditions, permitting rapid evacuation of wounded with a minimum of trauma. Unfortunately there has been misinterpretation on the part of many as to the applicability and this method has been employed on a large scale in some centers for the definitive treatment.

There were only 5 or 6 instances of secondary hemorrhage. This infrequent occurrence may be attributed to the lack of infection and deterioration of tissue which is prevented by prompt wound epithelialization. There were only 3 deaths which can reasonably be attributed to any operative procedure in 2915 operations performed upon this group of patients. Death in these cases was due to pulmonary embolism. Of 4,471 patients discharged from the surgical service less than 5

per cent left with a wound requiring any dressing whatsoever. All soft part wounds have been epithelialized either by closure or grafting and practically all compound fractures have been covered with skin either by closure or grafting. The notable exceptions have been wounds of the foot with extensive loss of skin and infection of the small bones of the foot, many of which had persistent and resistant sinuses despite best efforts at closure.

## SUMMARY AND CONCLUSIONS

- 1 The 735 secondary wound closures of so-called contaminated wounds resulted in satisfactory healing.
- 2 The results in secondary closures are not appreciably altered by either sulfonamides or penicillin when applied locally at the time of closure.
- 3 One of the most important factors which has allowed surgeons to close compound fractures and large soft tissue defects, often time many days after the original wound, is the security afforded by the knowledge that one possesses an agent (systemic penicillin and sulfonamides) which successfully combats hemolytic infection and prevents septicemia.
- 4 Secondary closure of granulating wounds can only be successfully performed when secondary débridement is carried out.

The capacity for regeneration and repair as related to wound healing involves certain fundamental principles. To speak of the wounds of warfare categorically and to consider them apart from the traumatic and surgical wounds of civilian life may lead to certain conclusions in the consideration of the general features of wound healing. Present experiences indicate more than ever the importance of surgical knowledge of the basic fundamentals of surgical principles. Careful débridement carried out is still the one most important single treatment for wounds. Without it, no supplementary form of treatment will succeed. Although conditions may be far from ideal the principles of peace time surgery continue to be perfectly valid in times of war.

# MASCULINIZING TUMORS OF THE OVARY

## A Clinicopathologic Survey with Discussion of Histogenesis and Report of Three Cases

LALLA IVERSON M.D. Durham North Carolina

**I**NCREASING numbers of masculinizing tumors of the ovary are reported in the literature.

The histological appearance of the arrhenoblastoma group heretofore has occasioned little difficulty in pathologic diagnosis. More confusing are those few cases associated with virilizing symptoms which, because of their microscopic appearance, have been variously termed hypernephroma of the ovary masculinovoblastoma ovarian adrenal rest, or adrenal cortical inclusion. Sometimes classified with the virilizing lipoid cell tumors of the ovary and often indistinguishable from them are the luteinomas or luteomas.

Two of the following cases illustrate interesting variations of the more typical findings of arrhenoblastoma. Case 3 represents both of the above general histologic types in intimate association and is reported for its contribution to the understanding of the histogenesis of these tumors.

**CASE 1** Mrs. C. L. D. Duke Surgical Pathology No. 5636. The patient was 37 years of age, white, a nullipara with a previous history of regular menstrual periods and an oophorectomy at 17 years of age. Her present illness was of 18 months' duration, the onset marked by amenorrhea and followed by growth of coarse black hair over her face and chin. In addition to the hoarseness of her voice she noted a tendency to perspire easily, and nervousness accompanied by bitemporal headaches. A slight weight loss and mild lower abdominal pain were experienced during the last few months of her illness.

Patient's height was 63 inches, weight 163 pounds, blood pressure 144/100.

The patient's face and chin were covered by a growth of hair about 1 inch in length. There was no temporal recession of the hairline. Some coarse hair was distributed about the breasts which were of normal size. A moderately tender cystic mass occupied the right lower abdomen extending up to the umbilicus. Appearance of clitoris and vocal cords were not recorded.

From the Department of Pathology, Duke University School of Medicine, Durham, North Carolina.

At operation a large cystic mass was found in the region of the right ovary. The left ovary was small and firm. Three small pedunculated fibromyomas were removed from the uterus together with the entire ovarian tumor.

After operation the headaches disappeared immediately and menstruation began shortly after discharge from the hospital. The hirsutism diminished and after 10 years the patient remained free of symptoms of recurrence.

**Accessory clinical findings:** hemoglobin 90 per cent, leucocyte count 8,600, differential, normal. Urea, 28 milligrams per 100 cubic centimeters. Wassermann negative. Glucose tolerance test (50 mgm. of glucose given) fasting 80 milligrams, first hour 125 milligrams, second hour, 118 milligrams, third hour 77 milligrams. Urine clear, Bence Jones protein present. Basal metabolic rate +7.

**Pathologic examination.** The gross specimen consisted of a mass measuring 16 by 8 by 6 centimeters and weighing 1500 grams. The outer surface was smooth except for several cystic areas on the surface. In the center was a well circumscribed semisolid area, grossly hemorrhagic. Numerous multilocular cysts with thin gray walls occupied the rest of the tumor.

The microscopic sections revealed ovarian cortex with primitive follicles at the periphery of the mass. Many large hemorrhagic cysts lined by macrophages containing hemosiderin were noted. There was an imperceptible transition between ovarian mesenchyme and tumor stroma, which for the most part, appeared very edematous and myxomatous. In the myxomatous tissue were clumps and columns of large polyhedral cells with dark staining eccentrically placed nuclei and granular or foamy eosinophilic cytoplasm. These cells were especially abundant about the periphery of masses of sarcoma like tissue consisting of whorls of elongated spindle-shaped cells (Figs. 9, 13, 15 O). The latter in some areas were rounded resembling granulosa cells, and in others ovarian stroma.

The histological picture of the ovarian mass was almost identical with that of 2 cases of arrhenoblastoma with metastases seen in this laboratory (Table I, Cases 38 and 41). One of the latter patients died within 2 years after removal of the primary tumor, the patient just described was free of symptoms of recurrence for at least 10 years after operation.



# SURGERY GYNECOLOGY AND OBSTETRICS

TABLE I—ARRHENOBLASTOMA CLINICAL AND

Author Year	Type*	Age (years) Race	Duration	Weight loss	Pain	Abdominal swelling or pelvic mass	Level of bladder	Uterus	Vaginal discharge	Amniotic fluid	Hypertrophy of ovary	Atrophy of ovary	Fracture test egg	Remarks
Roberts and Oxford, 1936	II	C	yr	0	+	+	0	+	0	+	+	+	+	
McLester 1935	II	W	3 yr	+	0	+	0	+	0	+	+	+	+	
3 Behrman and Larson, 1930	I	W	4 yr	0	0	+	0	+	+	+	+	+	+	
Marshall, 1937	Atypical	W		+	0	+	0	0	0	+	+	+	+	
5 von Sodenstam 1937	II & III	W	1/2 yr	+	0	+	0	+	+	Lifelong	0	+	+	
6 Haffner 1937	Atypical	W	3	0	0	0	+	+	+	Post menopausal	+	+	+	Proper uterine cavity at men- struation
7 Fockert, 1937	III	W	yr	0	+	+	+	+	+	+	+	+	+	Proper uterine cavity at men- struation
8 Miller 1937	I	W	yr	0	0	+	+	+	+	+	+	+	+	Proper uterine cavity at men- struation
Dickman, 19	II	W	yr	0	0	+	+	+	+	+	+	+	+	Proper uterine cavity at men- struation
10 Norris, 1935	III?	W	3 yr	+	0	0	0	0	+	+	0	0	0	
DeCosta, 1935	II?	W	6 yr	0	0	+	0	0	+	+	0	0	0	
Norak, 1935	I	W	mo	0	+	0	+	0	+	+	0	0	0	
3 Norak 1935	II	W	yr	0	0	0	+	0	+	+	0	0	0	
Norak, 1935	II	W	yr	0	0	0	+	0	+	+	0	0	0	
5 Norak, 1935	II	W	yr	0	0	0	+	0	+	+	0	0	0	
6 Norak, 1935	I	W	7 mo	0	0	0	+	0	+	+	0	0	0	
7 Norak, 1935	III	W	7 mo	0	0	0	+	0	+	+	0	0	0	
8 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
10 Spillhoe (Case ) 1935	II	W	yr	0	0	0	+	0	+	+	0	0	0	
11 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
12 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
13 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
14 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
15 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
16 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
17 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
18 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
19 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
20 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
21 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
22 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
23 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
24 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
25 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
26 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
27 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
28 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
29 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
30 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
31 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
32 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
33 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
34 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
35 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
36 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
37 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
38 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
39 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
40 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
41 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
42 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
43 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
44 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
45 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
46 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
47 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
48 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
49 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
50 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
51 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
52 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
53 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
54 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
55 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
56 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
57 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
58 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
59 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
60 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
61 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
62 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
63 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
64 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
65 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
66 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
67 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
68 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
69 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
70 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
71 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
72 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
73 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
74 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
75 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
76 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
77 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
78 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
79 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
80 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
81 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
82 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
83 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
84 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
85 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
86 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
87 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
88 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
89 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
90 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
91 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
92 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
93 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
94 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
95 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
96 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
97 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
98 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
99 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	
100 Spillhoe (Case ) 1935	III	W	yr	0	0	0	+	0	+	+	0	0	0	

## MORPHOLOGICAL FEATURES OF 41 CASES

Blood pressure	Blood sugar (mgm. per cent)	Basal metabolic rate	Weight of tumor (grams)	Size of tumor (centimeters)	Marked cystic changes	Atrophy of undiseased ovary	Recurrence	Improvement	Remarks
120/70		+7	100	8x7x1	+	+	0	4 mo.	Bone in one portion of cyst wall. Laparotomy 4 mo after operation showed normal ovary on opposite side
		+95 to 41	930	7	+	+	0	da.	Mucous cyst and rete testis noted in involved ovary
			1030	30	0	0	0		Vaginal atresia, absence of cervix, rudimentary uterus
120/100	87	+30		4x1.5	0	+	0	~4 mo	Schiller interpreted tumor as adrenal cortical neoplasia. Cells were polygonal and spindle shaped
							1½ yr	3 mo.	Mixed type at first operation, sarcoma. Sarcomatous tissue second operation
				14				+	Large numbers of interstitial cells
				5	+	+	0	24 da.	Cells spindle shaped and some containing small vacuoles are arranged in epithelial strands
				12x7	0	0	0		Adenoma tubulare
				7	+	+	0		Absence of internal genitalia. Testicular tissue in place of ovary
90/80	54-54		4.8	5x1	+/-	0	Died	0	Autopsy: metastases to liver, neuroblastoma, adrenals. Pigmentation of skin
145/100				7	+	0	0		Tumor also contained granulosa cells
				5.5	0	+	0	wks	Grossly hemorrhagic appearance of tumor. Some areas have definite tubules, resembling rete tubules of ovary. In others spindle cells, and in others polyhedral cells
				9x1x6	+		0	mo	Sarcoma-like in some areas; in others cells arranged in columns. Also collections of polyhedral cells. Great deal of necrosis
				9	+		0	+	Some portions tubular where compact cells arranged in cords. After 1½ yrs patient still shaving and voice deep. Menstruation regular
					0		0	mo	Spindle cells, as well as cords, tubules and few areas of polygonal cells, Leydig cells. All symptoms disappeared after 3 mos. Acne
					0		0	+	Looks like seminiferous adenoma
				10x12x6	0		0	mo.	Mostly sarcomatous with spindle cells. Also occasional tubules, but imperfect. Few polygonal cells
			200	20x130	+		+	Died	
			245	5	+		0	4 wks.	
90/60	57			5x3	0	0	0	mo.	Leydig cells mixed with adenoma tubulare
20/80	83	-6			0		Died	0	Pituitary cyst; brief period of improvement following hypophysectomy then ascites and abdominal mass. Metastatic interstitial cells. Primary disease simulated Cushing's
94/66		-9		5	0	0	0	mo.-yr	No abnormal distribution of fat. Pregnancy 7 yr later
165/90				20x15	0	0	0	+	Epithelium similar to that forming tubular structure. Adenoma type
112/80		-7		11x5	0	0	0	3 mo.	Acne-Epoid present in large pale interstitial cells

SURGERY GYNECOLOGY AND OBSTETRICS  
TABLE I—ARRHENOBLASTOMA. CLINICAL AND

Author Year	Type*	Age (years) Race	Duration	Weight lbs	Pain	Abdominal swelling or palpable mass	Loss of Hbld	Menstrua-	Uterine change	Amenorrhea	Hypertrophy of Ovary	Atrophy of Uterus	Remarks
1. Dockerty and MacCarty, 1939	I	31 W	yr.	0	0	0	0	0	0	0	0	0	Normal size
24. Barker and Tribble, 1930	II	28 Hind	mo	0	0	+	+	+	+	+	+	+	
27. Bullock, 1920	II & III	28 W	yr	+	+	+	+	+	+	+	+	+	
28. Karter and Klaume, 1920	III	47 W	4 yr	Gals 24	+	+	+	+	+	+	+	+	
29. Karter and Kaplan, 1924	II	47 W	yr	+	+	+	+	+	+	+	+	+	
30. Stone, Ochs Hospital, 191	I	31 W	yr?	0	+	+	+	+	+	+	+	+	Female breasts increased, male none
3. McIntyre, 1918	II	30 W	yr	0	+	+	+	+	+	+	+	+	Pres. 11 cysts max 1.5 cm; 5 cysts small
21. Lissner Palmer and Markon, 1918	II	30 W	yr	0	0	+	+	+	+	+	+	+	
22. Coffey, Beacham and Schatzberg, 1913	I	30 W	yr	0	+	+	+	+	+	+	+	+	37 Enostoids 3.5 mm & 3.5 mm in 42 sec.
24. Johnson, 1911	II	30 C	8 yr	0	+	+	+	+	+	+	+	+	
25. Pines, 1914	II	30 C	yr	0	+	+	+	+	+	+	+	+	Prognathid O Ovarioepithelium O
26. Harris, 1915	II	30 C	yr	0	+	+	+	+	+	+	+	+	
37. Brewster, 1915	II	30 C	yr	0	+	+	+	+	+	+	+	+	
28. Davis and Fleming (in press), 1918	II	30 W	yr	0	+	+	+	+	+	+	+	+	
30. Iverson (Case 1), 1916	II	30 W	yr	0	+	+	+	+	+	+	+	+	
40. Iverson (Case 2), 1916	II	30 W	yr	0	+	+	+	+	+	+	+	+	
41. Iverson (Case 3), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
42. Iverson (Case 4), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
43. Iverson (Case 5), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
44. Iverson (Case 6), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
45. Iverson (Case 7), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
46. Iverson (Case 8), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
47. Iverson (Case 9), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
48. Iverson (Case 10), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
49. Iverson (Case 11), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
50. Iverson (Case 12), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
51. Iverson (Case 13), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
52. Iverson (Case 14), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
53. Iverson (Case 15), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
54. Iverson (Case 16), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
55. Iverson (Case 17), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
56. Iverson (Case 18), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
57. Iverson (Case 19), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
58. Iverson (Case 20), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
59. Iverson (Case 21), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
60. Iverson (Case 22), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
61. Iverson (Case 23), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
62. Iverson (Case 24), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
63. Iverson (Case 25), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
64. Iverson (Case 26), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
65. Iverson (Case 27), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
66. Iverson (Case 28), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
67. Iverson (Case 29), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
68. Iverson (Case 30), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
69. Iverson (Case 31), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
70. Iverson (Case 32), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
71. Iverson (Case 33), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
72. Iverson (Case 34), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
73. Iverson (Case 35), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
74. Iverson (Case 36), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
75. Iverson (Case 37), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
76. Iverson (Case 38), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
77. Iverson (Case 39), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
78. Iverson (Case 40), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
79. Iverson (Case 41), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
80. Iverson (Case 42), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
81. Iverson (Case 43), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
82. Iverson (Case 44), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
83. Iverson (Case 45), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
84. Iverson (Case 46), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
85. Iverson (Case 47), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
86. Iverson (Case 48), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
87. Iverson (Case 49), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
88. Iverson (Case 50), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
89. Iverson (Case 51), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
90. Iverson (Case 52), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
91. Iverson (Case 53), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
92. Iverson (Case 54), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
93. Iverson (Case 55), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
94. Iverson (Case 56), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
95. Iverson (Case 57), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
96. Iverson (Case 58), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
97. Iverson (Case 59), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
98. Iverson (Case 60), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
99. Iverson (Case 61), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
100. Iverson (Case 62), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
101. Iverson (Case 63), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
102. Iverson (Case 64), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
103. Iverson (Case 65), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
104. Iverson (Case 66), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
105. Iverson (Case 67), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
106. Iverson (Case 68), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
107. Iverson (Case 69), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
108. Iverson (Case 70), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
109. Iverson (Case 71), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
110. Iverson (Case 72), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
111. Iverson (Case 73), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
112. Iverson (Case 74), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
113. Iverson (Case 75), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
114. Iverson (Case 76), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
115. Iverson (Case 77), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
116. Iverson (Case 78), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
117. Iverson (Case 79), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
118. Iverson (Case 80), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
119. Iverson (Case 81), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
120. Iverson (Case 82), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
121. Iverson (Case 83), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
122. Iverson (Case 84), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
123. Iverson (Case 85), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
124. Iverson (Case 86), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
125. Iverson (Case 87), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
126. Iverson (Case 88), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
127. Iverson (Case 89), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
128. Iverson (Case 90), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
129. Iverson (Case 91), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
130. Iverson (Case 92), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
131. Iverson (Case 93), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
132. Iverson (Case 94), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
133. Iverson (Case 95), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
134. Iverson (Case 96), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
135. Iverson (Case 97), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
136. Iverson (Case 98), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
137. Iverson (Case 99), 1916	II & III	30 W	yr	0	+	+	+	+	+	+	+	+	
138. Iverson (Case 100), 1916	II & III												

## MORPHOLOGICAL FEATURES OF 41 CASES—Continued

Blood pressure	Blood sugar (mgm. per cent)	Based metabolic rate	Weight of tumor (grams)	Size of tumor (centimeters)	Marked cystic changes	Atrophy of uninvolved ovary	Recurrence	Improvement	Remarks
					0	0	0	7 y	All 3 cellular elements present. Few interstitial cells
5/85				20			0	no	Tubular structures as well as sarcoma-like areas
9/85		—		0.9	+	0	0	+	Few interstitial cells at periphery; otherwise sarcomatous
9/80			46.20	2.8	+	+	0	+	Embryonic rete and cartilage noted
10/80				5x17	+/-	0	0	6 wk.	Ascites, lipid granules in cells
20/00	90			35	0	0	0		Brownish vaginal discharge. Tumor grossly yellow
130/80				20x3	0	+	0	no	Tumor grossly yellow; loss of libido postoperatively
	83	-6	87	7x5	+		0	no	Myxomatous. Pregnancy 1 mo. postoperatively
16/88	95			5	0	+			Fibromyxomatous uterus
12/100		+26		3	0	0	0	+	Dermoid cyst on left. Infantile uterus and cervix
					0			28 da.	Acne. Zones of definite epithelial proliferation, as well as sarcomatous areas and clear vacuolated large cells like Leydig cells postop. 3 pregnancies; miscarriage, normal
			00		+	0	0	no	Cyst lined by columnar epithelium of endodermal origin. Some portions of tumor resemble granulosa cell (teratoid) carcinoma also present in tumor
	Normal			9x7	0				Acne. Interstitial cells in soft matrix. Pregnancy together with glycosuria and arthralgias symptoms. Child a "pseudobulimaphroditic," had 3 "periods." Mother acted 4 days postpartum. Hirsutism gone after 3 months
140/90	73		500	2x3	+		+	Initially	Metastases to peritoneal surfaces, ascites, pleural effusion; improvement after first operation. Died 4 years after onset
44/100	80	+7	300	6x8	+	+	0	mo. yr	Bence-Jones proteins present in urine
20/00				7.5x7	0		+	Initially	Metastatic to liver and peritoneal surfaces
140/80	27	-3	400	1x7	+	+	0	mo.	Arrhenoblastomas associated with adrenal pheochromocytoma

1030: Lacey, Abereel, Marz, and Dobrovski; Ekens and Harstad  
Sordillo Hardjosehatino  
940: Kae, Menon, and Narayanaswami, Wjzenbeck and Plate; Xavier  
and Jesuquina; Althabe, dePaola, and Collares

943: Usodilings and Oliva.

944: Miron and Velazco.

944: Medina and Asorin; Bello and Rivero Velasco and Zapatero

TOTAL—20 cases.

months after the onset of symptoms an ovarian tumor was found and removed.

The specimen consisted of a single encapsulated tumor mass which measured 7.5 by 7 by 5 centimeters. The outer surface was firm somewhat nodular and contained a thin walled 2 centimeter cyst filled with straw colored fluid. The remainder

of the specimen was a solid tumor like growth. The cut surface appeared homogeneous somewhat fibrous in character and had a slight yellowish discoloration. Scattered through the deeper part of the specimen were small areas of cystic degeneration.

Microscopic sections revealed the tumor to be composed of interlacing spindle-shaped cells with

## SURGERY GYNECOLOGY AND OBSTETRICS

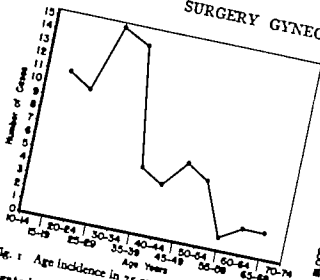


Fig. 1 Age incidence in 75 cases of arrhenoblastoma.

elongated vesicular nuclei surrounding large plump cells in arrhenoblastoma.

Transitions from the former primitive type to the latter differentiated cell were prominent. There was abortive tubule formation (Fig. 3).

The patient improved slightly after the operation but noticed no permanent regression of her symptoms. Her weight loss increased to 50 pounds, and she complained of a loss of libido. Five months after operation a marked ascites and left hydrothorax brought her to the out-patient clinic of this hospital. Because of her progressively weakening condition she was admitted and a diagnosis of Meigs' syndrome was considered. At this time the original slides were requested and a diagnosis of arrhenoblastoma was made.

**Accessory clinical findings:** Pleural and abdominal fluid no tumor cells. Hemoglobin 12 grams erythrocyte count 4.13 million leucocyte count, 9,500 with normal differential. Sedimentation rate 44 millimeters per hour Urine clear Tuberculin negative Total protein 6.3 grams albumin 3.7 grams per 100 cubic centimeters globulin 3.6 grams per 100 cubic centimeters 17 ketosteroids averaged 3.1 milligrams per 24 hours for 3 days.

The patient was operated upon 3 weeks after admission to the hospital. Exploration revealed grossly enlarged metastases studding the peritoneum and serosal surfaces of the intestines. The thickened omentum was drawn up to the transverse colon. There were metastases to the liver the surface of which was roughly nodular. Biopsy specimens were taken from the omentum parietal peritoneum,

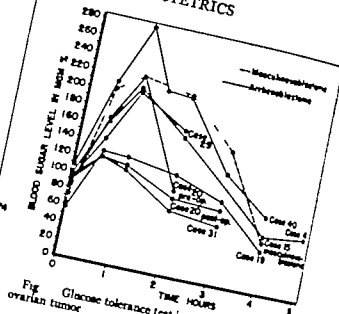


Fig. 2 Glucose tolerance test in 7 cases of arrhenoblastoma.



Fig. 3

Fig. 3 Case 175. Section from primary tumor. Note spindle shaped cells, vascularity and abortive tubule formation. There are numerous gradations between primitive mesenchymal cells and eosinophilic polyhedral interstitial cells.  $\times 175$



Fig. 4

Fig. 4 Case 175. Metastasis to fallopian tube. Many large eosinophilic polyhedral cells are intermingled with spindle cells. Note similarity to Figure 3.  $\times 75$

Fig. 5

Fig. 5 Case 175. Metastasis to appendix. Note eosinophilic interstitial cells. Submucosa of appendix, more closely resembling those of primary tumor than of fallopian tube.  $\times 75$

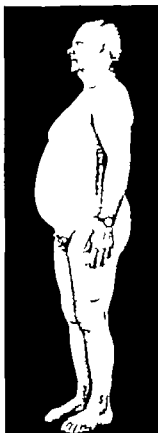


Fig 6. Case 3. Lateral view demonstrating distribution of fat. Note hairy arms and legs.



Fig 7. Case 3. Patient before operation (after shaving) showing temporal recession of hair line, loss of hair on scalp, masculine features.

appendix, and tube. The patient died 2 weeks after operation 18 months after the initial symptoms. No autopsy was obtained.

All of the sections showed metastatic tumor the microscopic appearance of which varied greatly. The surface implants were characterized by a friable mass of fibrin, necrotic debris, and large cells resembling "interstitial cells." Infiltrating or metastatic lesions were accompanied by more connective tissue and primitive stroma in the meshes of which were numerous fat laden foam cells (Fig 4). The latter, where found in the appendix, contained less fat (Fig. 5) and more closely resembled the original eosinophilic interstitial cells.

Because of the early metastasis of this tumor and the rapid growth of primitive cells functional signs were slight. Masculinizing symptoms were elicited only in retrospect. The ascites and hydrothorax resulting from the widespread metastases led to a clinical diagnosis of Meigs's syndrome before the second hospital admission. The original tumor presented a relatively benign appearance at a time when there was already evidence (ascites) of early metastasis. The varied and baffling histological picture of the metastatic implants and their dissimilarity to the primary mass re-



Fig 8. Case 3. View of enlarged clitoris, which measured approximately 2.5 centimeters.

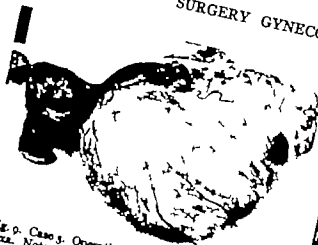


Fig. 9. Case 5. Operative specimen including uterus and adnexa. Note small uterus and atrophic right ovary. The left tube roughly marks the boundary of the large thin-walled cyst below and the nodular multicystic tumor mass above.

moved 10 months previously emphasize the need for careful clinical and pathologic investigation of every case of primary ovarian neoplasm.

**CASE 5.** Miss J. S. Duke Hospital No. B54444. The patient, aged 61 years, a single white female, multipara, was admitted to the hospital complaining of a pelvic tumor of 3 years' duration. Her mother and maternal grandmother had facial hirsutism, but there was no family history of masculinizing tumors. Her father and one brother had diabetes mellitus. The patient stated that her flat hips, large abdomen, "herited" from her father. The essential features of her development and illness are summarized as follows: Age 10 Reached maximum height maturing at same rate as sister. Axillary and pubic hair appeared. Age 13 Menarche periods regular every 38 days lasting 4 to 5 days. normal flow. Age 15 Weight 136 pounds, maintained for 10 years. Age 17 Increase in hair on chest, upper lip, side of face, controlled by plucking the more unlighty areas. Age 26 Began to gain weight, slowly attaining maximum weight of 155 pounds. Age 35 Heavy hair appeared on arms and legs. This persisted, but there was no change in axillary or pubic hair. Age 44 Forced to begin shaving of hair on cheeks, upper and lower lips, and neck. Age 55 Spontaneous hot flashes. Age 58 (3 1/4 years before admission) Pain in knees and back upon exercise. Abdominal swelling. Diagnosis of local physician: fibroid tumor "size of grapefruit." Age 59 (1 1/4 years before admission) Voice became harsh and continued to assume a lower pitch and coarser quality. Age 61 (Six months before admission) Slight vaginal bleeding every day for 5 months. The breasts were reported as having always been small. The patient admitted no change in emotional



Fig. 10. Case 5. Cross section of left ovarian tumor viewed from behind. Note thickening of medial portion of large cyst wall. Small nodular masses in cyst wall above A. Other small nodules scattered throughout the peritoneum. Tumor mass above the large cyst contained varying proportions of spindle cells and interstitial cells. Tumor nodules A and B represent the gross picture of arrhenoblastoma and adrenal-like tissue, respectively.

make-up or sexual desire with her illness. She received no hormonal therapy. Physical examination revealed temperature, 37 degrees; pulse 79 respirations, 20 blood pressure, 140/80.

The patient was a co-operative, intelligent woman whose manner was conventional and feminine, and whose voice was slightly hoarse but well within a feminine range. The hair was gray or white and quite sparse especially at the temporal region. There was evidence of recently shaved beard over the face and neck (Figs. 6, 7). Heavy black hair was distributed over the shoulders and became quite long and coarse over both forearms and the entire surface of the muscular legs. The pubic hair had a masculine distribution, pointing upward toward the umbilicus. The skin was coarse in texture, and the chest suggested a buffalo distribution of fat. The breasts were extremely small, flat with pale pink nipples and areolae surrounded by a ring of fine black hair. There was no hair between the breasts. Both vocal cords were slightly reddened posteriorly and moved on phonation. The thyroid was not palpable. The abdomen was slightly protuberant. A firm, mobile, painless mass rose from the level of the umbilicus.

There was moderate hypertrophy of both labia majora and minora. The clitoris was hypertrophied, attaining a length of 2.0 to 3.5 centimeters and a diameter of 1 centimeter (Fig. 8). There was a nulliparous introitus of excellent support. The cervix was small, conical, and firm. The uterus was not palpable and appeared to be separate from the large mass which extended into both adnexal regions.

**Necessary clinical findings:** Roentgenograms of the skull showed no change in the sella turcica. Retrograde pyelograms revealed a slight dilatation of the

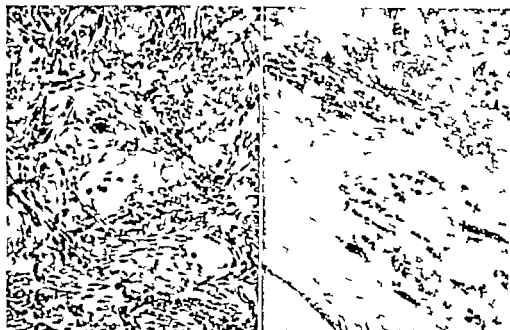


Fig. 11 left. Case 3. Microscopic section of tumor nodule A (Fig. 10). Note large polyhedral "interstitial" cells within the sarcomatous tissue. This section resembles primary tumor seen in Case 1.  $\times 170$ .

Fig. 12 Case 3. Microscopic appearance of edge of a small cyst. Note lining up of interstitial cells in loose connective tissue. Tumor nodule B was composed of a large area such as this. At upper right is seen the periphery of a small mass similar to tumor A (Fig. 11).  $\times 85$ .



Fig. 13 left. Case 3. Microscopic appearance of a small nodule (C in Fig. 10). Compare with interstitial cells in Figure 11. Note foamy appearance of cells, comparatively slight stroma, marked vascularity and great variation in cell size.  $\times 170$ .

Fig. 14. Case 3. Microscopic section of peritoneal implant. This was the only metastasis and contained fat-laden polyhedral cells resembling those in metastatic lesion in Case 9 (Fig. 4). Note similarity of these cells to those in masculinovoblastoma (Fig. 15P). Interesting tubular structures characteristic of intermediate types of arrhenoblastoma were not seen in primary tumor.



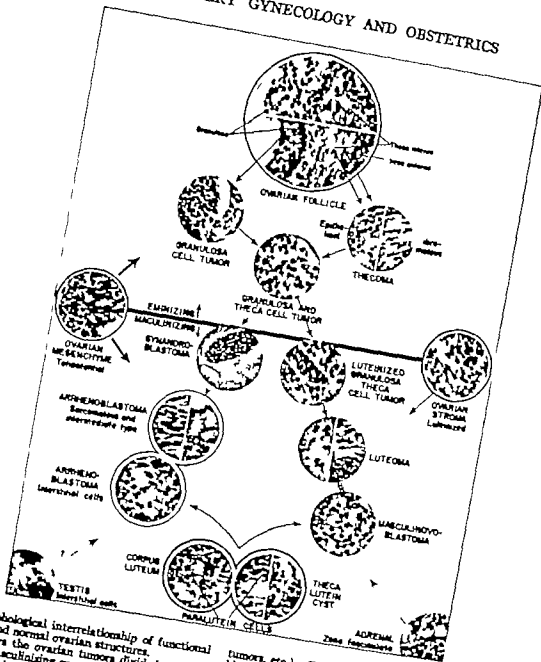


Fig. 5 Morphological interrelationship of functional ovarian tumors and normal ovarian structures.

The chart shows the ovarian tumors divided into the feminizing and masculinizing groups by a line connecting two pictures of ovarian stroma *G* the relatively undifferentiated primitive mesenchyme *G* the relatively undifferentiated the lutealized ovarian stroma.

At the top center are seen two pictures of an ovarian follicle, *A* and *B* showing the three layers of the follicle and the corresponding tumors, so named because of their morphological resemblance to the granulosa and theca cells. Two examples of thecomas are included to show the more cellular type resembling the theca interna, *D* and that which resembles fibroma, *E*, morphologically similar to the cells in the theca externa. Combinations similar to the types of feminizing tumors are frequently seen, *F*. There are two main groups of frankly masculinizing tumors, the arrhenoblastomas, *O* and the masculinovblastoma, *P* (adrenal cortical rest, virilizing lipid cell

tumors, etc.). *K* shows the sarcomatous type of arrhenoblastoma in a large metastatic growth, the more frequent histological appearance of metastatic arrhenoblastomas (Figs. 4, 5, 14). *L* represents the primary tumor in the most case (Table I, Case 38) demonstrating the tubular form cell tumor.

*O* shows a cluster of interstitial cells at the periphery of a sarcomatous arrhenoblastoma nodule (Case 1) resembling the larger masses of such cells seen in the adrenal-like theca (Figs. 4, 5, 14). Note the similarity to luteinized *S* and masculinovblastoma, *P* (Table II, Case 81). These morphological similarities would suggest that arrhenoblastomas may represent neoplastic growths from embryonic ovarian mesenchyma, *G* *H* rather than from cumm.) They further suggest the fact that masculinovblastoma may actually represent a neoplasm of interstitial

(Legend continued on opposite page.)

right pelvis and ureter. Vaginal smear consisted almost entirely of debris and degenerated cells very rarely an atypical epithelial cell was seen. The smear indicated extreme hypogonadism (Mack, Grade 1). There was some spilling of sugar in the urine during the glucose tolerance test and blood level indicated a decreased tolerance to glucose suggesting a diabetic tendency. Fasting specimen, 108 milligrams  $\frac{1}{2}$  hour 210 milligrams 1 hour 280 milligrams  $1\frac{1}{2}$  hours 212 milligrams 3 hours 131 milligrams 4 hours 90 milligrams. Blood sugar 103 milligrams total proteins 7 grams chloides 600 milligrams cholesterol 150 milligrams calcium 8.4 milligrams. Basal metabolic rate -13. Serological tests for syphilis negative. Urinary assays of ketosteroids preoperative 10.9 milligrams per 24 hours postoperative 8.85 milligrams per 24 hours. Preoperative gonadotropins 12 rat uterine units 6 rat ovarian units 4 rat macroscopic corpus luteum units. Postoperative gonadotropins 18 rat uterine units 10 rat ovarian units 4 rat macroscopic corpus luteum units.

The following diagnoses were made arrhenoblastoma adrenal cortical neoplasm or hyperplasia adrenal rest tumor of the ovary.

On the 18th hospital day operation was performed. A large cystic tumor about 25 centimeters in diameter was found replacing the left ovary. Following an uneventful recovery the patient was discharged on the 20th hospital day. Four months later she wrote: "Everyone marvels at my quick recovery. The hair on my face and arms is not so thick, about half as much as before the operation. A few new hairs are growing on top of my head where the baldness was taking place. My voice is remarkably better. I can sing a little which I had been unable to do in almost a year and one half."

The gross specimen consisted of a uterus and bilateral adnexa (Fig 9).

The uterus was 8 by 6 by 5 centimeters and contained four small intramural fibromyomas. A soft grayish polyp projected into the endometrial cavity from the superior fundic wall. The right ovary was fibrous indurated, and obviously atrophic. The right tube showed no gross lesions. The left tube was stretched to a length of 10 centimeters as it coursed up to the superior pole of a large 21 centimeter cyst containing clear yellow fluid.

Cells shown to be morphologically similar to theca lutein or paralutein cells (Table III).

Gynandroblastomas, *T*, and luteinized granulosa or theca cell tumors or both, *J*, are both histologically and clinically borderline. Luteomas, *M*, *N* are completely luteinized granulosa or theca cell tumors or both and may be masculinizing or feminizing. The tumor shown at *J* was masculinizing; others histologically similar may be feminizing.

Some workers include masculinizing luteomas within category of virilizing lipid cell tumors or masculinovblastomas. This relationship is shown by double arrow connecting *M*, *N* and *P*.

Note morphological similarity of luteoma *M*, *N*, to paralutein cells, *R*, rather than to lutein cells at right of *Q* (more

The lateral and inferior cyst walls were paper thin and numerous tortuous veins were prominent over the surface. Bordering the thicker superior cyst wall was a rough boggy mass which was divided by fibrous septa into several polycystic gelatinous masses. The largest of these was located in the superior lateral curvature of the cyst wall and was composed grossly of grayish-green myxomatous tissue in the center of which were two separate and distinct nodules. The first (tumor *A* in Fig 10) was a firm white tumor 2 by 1.5 centimeters the second (tumor *B* in Fig 10) was a soft bright orange, irregular mass 3 by 2 centimeters. Scattered throughout the myxomatous stroma were numerous tiny yellow flecks of varying size and shape. In some areas these assumed a well circumscribed soft white nodular form with no gross encapsulation. The various septa appeared to converge posteriorly as a band of white fibrous tissue 0.5 to 1.5 centimeters thick, gradually thinning out toward the medial surface of the cyst.

Microscopic sections revealed a chronic vaginitis and cervicitis. The endometrial polyps were characterized by an atrophic stroma and cystic, nonfunctioning glands. The small intramural and surface nodules proved to be fibromyomas surrounded by edematous myometrium.

No ovarian tissue could be demonstrated on the left. Many sections of the cyst wall showed dense collagenous fibrous tissue interspersed with myxomatous tissue. No evidence of teratomatous growth was found. The yellowish nodule in the midst of the wall where the Fallopian tube ended showed a sarcomatous pattern with an imperceptible transition to myxomatous or fibrous tissue at its border. Parts of the more compact regions of the cyst wall were hyalinized and at the edge of the larger gelatinous mass there was an abrupt transition between the fibrous capsule and the myxomatous stroma.

Tumor *A* was composed of spindle-shaped cells with elongated vesicular nuclei which were marked by a clear nuclear membrane and two or three nucleoli. The larger nuclei contained a coarser chromatin network than the smaller more compact nuclei. Gradations toward the interstitial cell described below were frequent. Bipolar strands of cytoplasm containing minute fat droplets were so interlaced that cell borders could not be distinguished. The tumor was not encapsulated but ap-

accurately termed "paraluteinoma"? There is a resemblance between androgen and progesterone-producing paralutein cells, *Q*, and theca lutein cells, *S*, and those of masculinovblastoma, *P*.

Former theories relative to the histogenesis of the two types of masculinizing tumors are represented by photographs of a normal testis showing interstitial cells of Leydig, *T*, and of a normal adrenal, zona fasciculata, *U*, showing cells similar to those in the masculinovblastoma. The morphological gradations between tumors known to arise from ovarian structures (totipotent ovarian mesenchyme) and the masculinizing tumors strengthen the histogenetic relationship of the theca lutein or paralutein cell to arrhenoblastoma and masculinovblastoma.

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE II—ADRENAL TUMORS OF OVARY CLINICAL

Author Year	Age (years)	Race	Duration (years)	Weight kgm	Pain	Abdominal swelling or palpable mass	Loss of blood	Hirsutism	Voice changes	Amenorrhea	Hypertrophy of clitoris	Uterus of breasts	Internal secret.
Berlin, 1908	48	W	7	0	+	+							
Mengel, 19	47	W	7(?)	Ovar.		+				+			
1. Silberman, 1913	40	W	6	Gain		+	Inc. tenderness	+	+	+		0	
Combes et al., 1915	34	W	8	0		+	+	+	+	+			
5. Septhar and Parker 1920	3	W		Ovar. acf	0	0	+	+	+	+	4 cm	0	
6. Stachem, 37	30	W	2-3	+	0	+	+	+	+	+	3 cm	+	
7. Novak J and Wells, 1917	30	W		0	0	0	0	0	0	Irregular	0	+	Conductance (urinary) normal on Karyomegaly
8. Marwell, 1917	6	W	20	+	0	+	0	+	+	+	0	0	Friedman test neg
Novak, E. (Case 1), 1928		W			0	+	0	+	+	+	+	+	Fallopian O Fallopian O Anteroposterior
Novak, E. (Case 2), 1928	7	W											Post menopausal
Scheimberg and Miller (Novak Case 2), 1928	27	W											Post menopausal
Reis and Septhar (Case 1), 1928		W											Post menopausal
Reis and Septhar (Case 2), 1928		W											Post menopausal
Van Kirk and Edwards, 1930		W											Post menopausal
Rottino and McGrath (Case 1) 1930		W											Post menopausal
6. Rottino and McGrath (Case 2), 1930	30	W	5										Post menopausal
Reis 1930		W											Post menopausal
12. Blackman, 1931	3	W	2 1/2	Gain									Post menopausal
13. Kamenetzky Brown and Kover, 1933	5	W		Ovar.									Post menopausal
14. Kuper 1934	28	W		Gain									Post menopausal
15. Greene and Lipp, 1934	30	C		0	LLQ	+	0	+	+	+	+	+	Post menopausal

STILLBORN NODULAR TUMOR IN CORTEX COMPOSED

Author Year	Age (years)	Race	Duration (years)	Weight kgm	Pain	Abdominal swelling or palpable mass	Loss of blood	Hirsutism	Voice changes	Amenorrhea	Hypertrophy of clitoris	Uterus of breasts	Internal secret.
Reis and Septhar (Case 2), 1928		W											
Van Kirk and Edwards, 1930		W											
Rottino and McGrath (Case 1) 1930		W											
6. Rottino and McGrath (Case 2), 1930	30	W	5										
Reis 1930		W											
12. Blackman, 1931	3	W	2 1/2	Gain									
13. Kamenetzky Brown and Kover, 1933	5	W		Ovar.									
14. Kuper 1934	28	W		Gain									
15. Greene and Lipp, 1934	30	C		0	LLQ	+	0	+	+	+	+	+	

## AND MORPHOLOGICAL FEATURES OF 24 CASES

Blood pressure	Blood sugar (mgm. per cent.)	Basal metabolic rate	Weight of tumor (grams)	Size of tumor (centimeters)	Marked cystic changes	Atrophy of undivided ovary	Recurrence	Improvement	Remarks
				8x3x3	+	+	0	1/2 mo.	Tumor made up of fat-containing large polyhedral cells. Some other cells did not contain fat but had granular cytoplasm.
				6x2x4		+	0	+	Polydipsia during last 4 years preop; RBC 8.9 million; Hgb 18.0 per cent. Tumor cells granular eosinophilic cytoplasm. N fat, large nuclei, lutein cell.
				?		+	0	3 wk.	Polygonal cells, no fat or glycogen. Large nuclei and nucleoli.
				5	+	0	0	1 mo.	Large uniform cells, fat filled.
130/70	Nor				+	0	0	4 da.	Serous cysts lined by granular cells, nests of polygonal vacuolated cells. Hirsutism unchanged after months.
80/80	100	+40		14x11	0		Death after 6 mo.	0	Metastatic hypernephroma.
				12x3.5	0		0	4 wk.	Polycythemia, hyperglycemia improved postop. Tumor resembled lutein and theca lutein thoma, diagnosed as adrenal inclusion by Schiller.
130/100	97	+30		4x1.5	0	+	0	1-4 mo.	Schiller interpreted tumor as adrenal cortical neoplasm. Cells were polygonal and spindle shaped.
				3x1.5					Same case as Rathbone and McGrath, Case 2.
90/90	Nor	-7	5	6	0	0	0	+	Polygonal cells in alveolar arrangement; fat-containing.
								mo.	

## ADRENAL CORTICAL CELLS\*

				5.6x7	+	0	0	Prog nancy	Hyperthyroidism followed by hypothyroidism and amenorrhea, preop; "adrenal cortical cells" at periphery of corpus luteum in wall of cyst.
		40		5.5x3.5	0	0	0	6 mo.	Tumor resembles corpus luteum.
140/90		8700		23.5x12.0	+	0	0		78 per cent glycogen; fat stains showed little fat. Glycogen stains revealed cells packed with large and small droplets.
90/60	7			3x1.5	0	+	0	mo.	Cells 0-16 microns, polyhedral, nuclei small, eccentric.
30/70				Ellipt. —5 cm.	0			3 yr.	Lutein-like; ascites at first operation. Cells 8-16 microns, vacuolar.
				14x11x3.5					Operative death. Trabeculation. Cells contain lipid and have eosinophilic granules.
	91			6.5	+	+	0	4 mo.	Poncau fastchain stains positive. Cells filled with fat.
					+	+	Died		Autopsy Hypernephroma of right kidney removed, yrs. previously. Diagnosis metastatic ovarian hypernephroma.
60/110	63		650	5x14x0			0	mo.	17 Cm. High postop. Ketosteroids 6 mgm. in 24. Bright yellow tumor. Cells contain lipid, are polygonal with central nucleus and nucleoli, good number mitoses.
130/70	88			7.5x5	0	0	0	6 mo.	Grossly yellow. Sheets of polygonal fat-containing cells in delicate fibrous stroma.

# SURGERY GYNECOLOGY AND OBSTETRICS

TABLE II.—ADRENAL TUMORS OF OVARY: CLINICAL

Author Year	Age (years)	Race	Duration (years)	Weight loss	Pain	Abdominal swelling or palpable mass	Loss of blood	Effusion	Venous changes	Arteriosclerosis	Hypertrophy of adrenals	Atrophy of adrenals	Hormonal assays
Borker and Abell, 1944	36	W?	10?	+	+	+		+	+				
J. Abraham, et al 1945	36	C								6 yr.			
14 Wollerman and Davis (in press), 1935	18	W	3	0	0	0	0	+	+		0	+	
*Cases of malignancy, excluded from statistical summary Additional cases classified as: hyperplasia, not included in Table II													
								+	+	+	+	+	Pre-op and post 147 Int. units

peared to end abruptly at its periphery where it was replaced by loose myxomatous tissue. Here the vascularity was greatly increased and clumps of large polyhedral, eosinophilic cells with small round dark eccentric nuclei were seen. Occasional clumps of these cells were included within the sarcomatous mass (Fig. 11).

Tumor B was merely a large concentration of the "interstitial cells." Their nuclei were sometimes slightly oval and irregular but were more often round. The nuclear membrane was clear and the chromatin material coarsely granular. The nucleoli was prominent and usually eccentric. In some areas, the nucleus was more compact and finely granular with a hairy nucleolus. Large giant cells with irregular hyperchromatic nuclei were frequent and mitoses were noted in all sections.

The yellow appearance in the mass was due to the accumulation of the "interstitial cells" in concentrications great enough for their lipid content to influence the gross picture. Figure 12 indicates the approximate concentration of these cells in tumor B and shows their arrangement in the myxomatous tissue at the periphery of a sarcomatous nodule. They were seen singly or in groups throughout the entire large tumor mass wherever the loose connective tissue was found. Some of the smaller nodules noted grossly contained polyhedral cells so closely packed in cords and columns that the tumor resembled a leiomyoma (Fig. 11). Others of the small nodules showed an arrangement of cells more typical of arrhenoblastoma and very similar to tumor A. One peritoneal implant was noted in a mass of tissue removed separately at operation. This showed three main types of tissue: actual tubule formation approaching the more differentiated type of arrhenoblastoma, a small area of spindle-shaped cells and clumps of foamy cells whose cytoplasm was swollen with fat (Fig. 14).

The clinical diagnosis of adrenal cortical neoplasm was justified in this case of an illness with a relatively insidious onset and long du-

ration in a postmenopausal diabetic. However most of the specimen was typical of arrhenoblastoma, except for the yellowish nodule which resembled adrenal tissue grossly. The identity of the latter with the interstitial cells of the arrhenoblastoma was shown by cytological studies. The influence of this variation on the clinical picture is not known. Its significance will be discussed later.

## REVIEW OF LITERATURE

**A Arrhenoblastoma** The first 25 cases of arrhenoblastoma were summarized in 1933 by Buettner. In 1933 Taylor Wollerman and Krock claimed the first United States case, which was reviewed 8 years later by the latter two authors (108, 68).

By 1936 the total number of cases was 33. These were comprehensively surveyed by Baldwin and Gafford, who grouped them according to Meyer's classification (81).

I. The adenoma tubulare (testicular) of Pick. The most differentiated type, usually unassociated with masculinizing symptoms.

II A middle group with typical and atypical tubular elements and with solid elements.

III Atypical tumors, solid or predominantly solid, with atypical tubular elements. Their major findings are calculated below.

1 Average age 20.3 years range 16 to 33 years.

2 Number of cases Type I Nine (Three showed virilizing symptoms. These contained mixtures of cells represented in the other two types and were not pure examples of "adenoma testicularis") Type II Ten (All showed

## AND MORPHOLOGICAL FEATURES OF 24 CASES—Continued

Blood pressure	Blood sugar (mgm. per cent)	Basal metabolic rate	Weight of tumor (grams)	Size of tumor (centimeters)	Marked cystic changes	Atrophy of undrained ovary	Recurrence	Improvement	Remarks
14/75				6x3	0	0	Died wk post oper	Initially	Bluish discoloration of face and neck; hemoglobin normal, cords / smaller compact cells mixed with polygonal lipoid cells.
				7.5x4.5	0		0	4 mo.	Lipoid-containing polyhedral cells
14/70		+9	200	7x6	0	0	0	+	N N-pregnandiol glucoside. N progesterone activity of tumor

93: Klefke (primary hypernephroid blastoma, 9 cases)  
Kretschmann (atypical malignant hypernephroma)

943 Neumann (hypernephroma with virilism)

virilizing symptoms) Type III Fourteen (All showed virilizing symptoms)

3 Frequency of important symptoms  
Change in voice or vocal cords, 21 hirsutism, 17, clitoral hypertrophy, 14 amenorrhea, 12 atrophy of breasts 9

4. Recurrence of tumor 5

5 Return of feminism 25 (mentioned in 29 cases) A total of 8 pregnancies 5 in 1 patient, were recorded Earliest improvement noted was resumption of period within 3 weeks

Fifty-eight cases have been reported since 1936, to which we have added 3 cases making a total of 94 cases of arrhenoblastoma. Those reported since Baldwin and Gafford's review are recorded in Table I

*B Adrenal rest tumor Luteinoma etc*

The second group of masculinizing tumors is called merely virilizing lipoid cell tumors by Barzilai. This name was chosen to avoid confusion of terminology in a group in which rigid diagnostic classifications are made by some workers and in which the same diagnostic terms are used interchangeably by others. In this group Barzilai includes luteinomas as well as adrenal rests and "interstitionomas"

In 1908 Bovin recorded the first case of hypernephroma or adrenal rest tumor of the ovary A critical survey of the status of the lipoid cell tumors luteomas and hypernephromas was made by Glynn in 1921 who favored a lutein origin of the primary lipoid cell ovarian neoplasm

More confusion was created by the indiscriminate use of the term hypernephroma

which may include metastatic nonvirilizing tumors in the ovary For example, Stadiem's review in 1937 of Nineteen cases of hypernephroma of the ovary included no cases which can now be classified as primary virilizing lipoid cell tumors of the ovary

In 1939 Rottino and McGrath limited the entire number of virilizing lipoid cell tumors to 7 cases. These and the subsequent reports totaling 14 cases were incorporated into a review by Kepler et al in 1944 Seven additional cases of lipoid cell tumor associated with masculinizing symptoms can be included at the present time bringing the total to 21 cases. These are summarized with the exception of Neumann's report, in Table II Four other cases classified as adrenal rest or hypernephroma in recent years but not associated with virilism, are included in the chart for the purpose of comparison

Attention must be called to the fact that the above 20 cases include Sellheim's case containing no fat (Case 30 in Baldwin and Gafford's chart of arrhenoblastoma?) Cosaccesco's case which is also included in the series of luteomas by Traut, Kuder and Cadden (112) Saphir and Parker's case of adrenal cortical inclusion in which a definite neoplasm was not found Maxwell's case diagnosed as adrenal rest by Schiller but described as arrhenoblastoma by the author Reis and Saphir's 2 cases of partial masculinization with lipoid cell tumor Exclusion of these cases would limit the entire series to 15 cases of complete masculinization with a lipoid cell tumor of ovary and classified as adrenal in origin

## SURGERY GYNECOLOGY AND OBSTETRICS

Additional cases of masculinization have been associated with tumors which the authors have separated from the above group and have designated strictly as luteinomas or luteomas. Some of this confusion has persisted because some workers justifiably object to the term adrenal rest, believing that there is no final basis for such a histogenetic classification. The proponents of the adrenal rest theory in turn, object to the word luteinoma. Therefore Rottino and McGrath propose the noncommittal term masculinizing lipoid cell tumor.

The following list of luteomas is modified from the series of Traut, Kuder and Cadden who separate the 2 groups histologically

- |      |                      |  |
|------|----------------------|--|
| 1908 | Gardner and McCleary | (Amorrrhoes for 8 years)   |
| 1913 | Marmabau             | (No virilizing symptoms)   |
| 98   | Gordon               | (These cases were originally diagnosed as hyperandrogenism, later reviewed by Turnbull and reclassified as luteomas. No virilizing symptoms) |
| 1930 | Gordon               | (No virilizing symptoms)   |
| 1927 | Wolfe                | (No virilizing symptoms)   |
| 193  | Cosmesco, et al.     | (See Table. Classified as adrenal rest tumor by Rottino and McGrath.)  |
| 1937 | Torres               | (No virilizing symptoms)   |
| 938  | Viana                | (No virilizing symptoms)   |
| 1938 | Giampalmo            | (No virilizing symptoms)   |
| 943  | Mayer                | (Virilizing)   |
| 944  | Giordano and Haymond | (Virilizing)   |

The histological similarity of the adrenal rest tumors luteomas and luteinized granulosa or theca cell tumors (14 28 109 121) necessitate careful evaluation of the clinical signs for accurate classification. Geist and Spielman (41) suggest that when the tumor is accompanied by signs of masculinization it be considered an adrenal rest tumor and when it is accompanied by evidence of feminizing influence it be termed a luteinized granulosa or theca cell tumor. Such an evaluation of the more recent cases of luteoma may lead to their reclassification as adrenal rest tumor as in the case of Cosmesco and coworkers.

## CLINICAL DATA

Consideration of the clinical features of these tumors is of the utmost importance in understanding their anatomic relationship. In comparing virilizing lipoid cell tumors with arrhenoblastomas it must be remembered that

the significance of the data will change as more cases are added to both groups and as diagnostic criteria become standardized.

**Age** Figure 1 shows the age distribution of 75 cases of arrhenoblastoma, which corresponds roughly to that of virilizing lipoid cell tumors. Arrhenoblastoma average age, 31.86 years range 15 to 66 years. Masculinoblastoma average age, 31.7 years range 15 to 61 years. These findings do not correspond with the statements of some observers that masculinoblastomas occur in later life reported in Hindu Spanish, and Latin American women. Five cases of arrhenoblastoma and 2 cases of masculinoblastoma have appeared in the colored race. There is no record of cases occurring in the Orient.

**Duration** The preoperative course of arrhenoblastoma averages 4 years. The majority of cases are of 1 5 to 2 5 years duration, and the entire series range from 1 to 17 years of symptoms previous to operation. Cases diagnosed as masculinoblastoma average 4.3 years in duration ranging 1 to 17 years and the majority have a duration of 3 years or less.

**Weight** Fluctuation of weight occurred in 18 of 33 cases of arrhenoblastoma. Of these, 11 showed weight loss and 5 became more obese gaining 20 to 58 pounds. Masculinoblastoma 8 no change 6 gain up to 35 pounds 5 loss of weight. A tendency toward obesity at the onset of the disease is noted in some instances. Loss of weight occurred in 6 of the 7 fatal cases.

**Pain abdominal swelling palpable mass** One third of the total number of patients with masculinizing tumors complained of pain. Twice that number exhibited objective evidence of the presence of tumor such as palpable mass or abdominal swelling. The symptoms of pain and abdominal swelling or mass are correlated with the size of the tumor except for metastatic cases in which ascites may be present.

There is little significant difference between the number of virilizing tumors located on right or left side.

<sup>17</sup>The term masculinoblastoma (Rottino and McGrath) will be used for the purpose of this paper. Virilizing lipoid cell tumor adrenal rest tumor, hyperandrogenism, and hyperandrogenism.

**Loss of libido** A loss of libido occurred in approximately 20 per cent of the patients with arrhenoblastoma where this symptom was mentioned. In one patient libido was increased with the presence of tumor. In others the patient experienced a loss of libido only after the tumor was removed.

Available data showed no correlation between libido and basal metabolic rate.

**Sterility** Some women complaining of previous sterility become pregnant subsequent to removal of the tumor. Pregnancy has occurred in 10 to 15 per cent of the cases of child bearing age following operation. In 2 cases (17, 125) pregnancy and growth of the tumor occurred simultaneously. One infant was a pseudohermaphrodite had an enlarged clitoris and had 4 periods beginning immediately after birth at 28 day intervals.

**Hormonal studies** Accurate evaluation of hormonal assays is impossible because of the great variation in standards and methods, and because of the absence of control assays. In general there is an increase in androgens and decrease in estrogens and gonadotropins. In absence of recurrence the normal levels are gradually resumed postoperatively.

**Virilizing and defeminizing symptoms** The patient may give a past history of long standing amenorrhea, of moderate excess hirsutism of masculine habitus or of unusual strength. Some complain of lack of libido during married life or of sterility for many years.

Usually however the onset is more definite progressing steadily for 1 to 4 years until the tumor is suspected. The degree of masculinization is not correlated with size or histological appearance of the tumor except in patients with those tumors classified as adenoma tubulare.

1. **Amenorrhea** Scant menstruation was present in one patient with arrhenoblastoma (Type I). In all other cases complete amenorrhea occurred including 5 which were postmenopausal. Amenorrhea is usually the first symptom to appear and after the tumor is removed the periods may return within 1 month.

**Menorrhagia** sometimes precedes the amenorrhea. In some cases it is associated with polyps and fibromyomata uteri in others the significance is not known.

Examination of the opposite ovary at the time of operation reveals atrophy of this organ in less than 50 per cent of the cases. Function was completely restored in all but one case.

2. **Hirsutism** Hirsutism was present in 85 per cent of patients with arrhenoblastoma. The hair was usually coarse and distributed over the lower forearms, legs, thighs, chest, chin and face. At the pubic region it pointed up toward the umbilicus in typical masculine distribution. It is not unusual for the patient to shave every day. Many of the patients demonstrated a temporal recession at the hairline approaching baldness. The patients who exhibited no hirsutism had no other associated masculinizing symptoms, except for amenorrhea (defeminization). The hirsutism decreases gradually after removal of the tumor.

3. **Voice change** This sign was present in 62 per cent of the patients with arrhenoblastoma, some of whom noticed it only in retrospect. The vocal cords when examined showed reddening, true hypertrophy or no change. A prominent Adam's apple appeared in some instances.

After removal of the tumor the voice becomes higher and the vocal cords diminish in size. In some cases no improvement is noted.

4. **Atrophy of breast** Seventy per cent of the cases of arrhenoblastoma showed atrophy of the breast. Actual loss of glandular tissue can be determined by careful palpation even in a breast which is not appreciably diminished in size. This symptom regresses rapidly postoperatively.

5. **Hypertrophy of clitoris** Seventy per cent of patients with arrhenoblastoma show clitoral hypertrophy, the clitoris ranging from 2 to 7.2 centimeters in length and averaging about 3 to 4 centimeters. The postoperative regression has not been observed closely. In some cases an appreciable decrease in size has been recorded.

6. **Other symptoms** Masculine habitus and muscular development, loss of female fat distribution, acne and thickening of the skin are frequently noted and mentioned in both groups of tumors. Rare cases of pseudohermaphroditism, vaginal atresia, infantile uterus and adnexa occur.



The prominent masculinizing symptoms of the lipoid cell tumors correspond to the above distribution: amenorrhea was present in all cases except one which was complicated by other hormonal imbalance: hirsutism 100 per cent, voice change 90 per cent, hypertrophy of clitoris, 72 per cent, atrophy of breasts 50 per cent.

*Other clinical data* Some writers have stressed the clinical similarity between adrenal rest tumors of the ovary and of adrenal cortical adenomas, hyperplasia, or carcinoma. They would distinguish masculinovblastoma from arrhenoblastoma on the basis of certain metabolic changes. The presence of moderate polycythemia in 5 cases of masculinovblastoma has been recorded some of these associated with bluish complexions. One case of arrhenoblastoma was diagnosed Cushing's disease. It is not remarkable that these findings are present, in view of the interdependence of the pituitary, adrenal ovaries, and other endocrine glands.

Dorfman Wilson and Peters maintain that cortical tumors appear to resemble in all respects arrhenoblastoma and to secrete male sex hormone or an allied substance with the same action. They state however that patients with cortical tumors may in addition have hypertension and diabetes.

In the present series it is found that hypertension is correlated more obviously with age than with the type of tumor present. Comparison of the blood pressure in the two groups shows that only 2 of 9 cases of masculinizing lipoid cell tumors had a blood pressure over 140/90 while 8 of 20 cases of arrhenoblastoma had a blood pressure of 140/90 or above. Of the latter group the average age was 47 years.

Furthermore diabetic tendencies are not found exclusively in the lipoid cell group. One case of arrhenoblastoma had glycosuria, another case had elevated blood sugar and 5 of 6 showed diabetic tendency with the glucose tolerance test. An elevated blood sugar was recorded in none of the cases of masculinovblastoma, but the glucose tolerance test in 1 case showed a diabetic curve (Fig. 2). A transient glycosuria may be found in both groups of tumors.

Generalization as to metabolic effects cannot be made with the data available and should be deferred until more evidence is at hand.

Other glands may be involved. Hyperplasia of the adrenal glands, a pituitary cyst, and enlarged thyroid glands have been associated with the presence of arrhenoblastoma. The basal metabolic rate varied in the arrhenoblastoma group from -16 to +24, 6 were below normal, averaging -13, and 5 above normal averaging +24. The basal metabolic rate was recorded in 3 cases of masculinovblastoma -7, +19, +39.

*Improvement and recurrence* All of the cases show regression of symptoms except those which ultimately prove fatal. Ten to 14 per cent of cases of arrhenoblastoma have shown metastases and 2 in 17 cases of masculinovblastoma.

Malignancy may be suspected clinically in the presence of a rapidly growing tumor, ascites or hydrothorax or both, loss of weight, or return of symptoms postoperatively after the first period of initial improvement. The prognosis cannot be determined from the histological appearance of the primary tumor. Indeed the metastatic lesions may vary widely and may not resemble the original mass. Usually the metastatic lesions are sarcomatous in pattern and may be nonincretory thus creating some confusion in clinical evaluation of the symptoms unless a careful past history is obtained (Figs. 4, 5, 14, 15A).

#### MORPHOLOGY

1. *The masculinovblastoma* is a well encapsulated round or oval tumor 2 to 16 centimeters in length, averaging 7.1 centimeters. Only 3 cases in the entire series were above average size. The cystic changes found in less than 25 per cent of the cases are correlated with size of tumor. The ovary is compressed to one side of the tumor or may be absent altogether. The yellowish-orange color is due to the presence of lipoids within the cytoplasm of large polyhedral cells. These cells tend to be arranged in columns within a very vascular delicate fibrous stroma. In some areas near the periphery of the tumor the cells may be clumped together. A fine reticulum is usually

present. Ponceau fuchsin stains may show fuchsinophile granules within the cytoplasm of some of the cells, supposedly indicating androgenic function. Some of the tumors show inclusions resembling granulosa cells, spindle shaped sarcomatous cells, or theca cells.

The variation in appearance of the tumors heretofore reported may be due to the quantity, distribution and type of fat present.

2. *The arrhenoblastoma* averages 12 to 14 centimeters in its greatest dimension, the cases ranging from 2.5 centimeters to an indeterminate size ('fills pelvis,' 'large as a man's head,' etc.) Thirty per cent of the cases are above average size and most of these show cystic changes. The tumor may be white or yellow or show hemorrhagic necrotic areas.

a. The adenoma tubulare (testiculare) is said to be the most differentiated form. This tumor is composed of round tubular or gland like structures of varying size often filled with pink staining homogeneous material. The epithelium may be cuboidal or columnar and there is no marked resemblance to testicular tubules. Some cases reported as struma ovarii bear a striking histologic similarity to this type of arrhenoblastoma. When spindle-shaped cells and interstitial cells are found interspersed with the tubular structures some masculinization may occur.

b. The intermediate form contains varying proportions of the sarcomatous cells and interstitial cells. Gradations between the two are seen and abortive attempts at tubule formation are frequent. This type is invariably associated with masculinization.

c. The least differentiated type exhibits a sarcomatous pattern resembling ovarian stroma in which are found clumps or columns of polyhedral cells similar to those comprising the masculinovoblastoma. There is very little tubule formation. Masculinization is found in 100 per cent of these cases.

In a small percentage of cases of arrhenoblastoma various teratomatous inclusions have been found: mucous membrane, cartilage, bone, thyroid (adenoma tubulare?) etc. These inclusions have formed the basis for theories as to the teratomatous derivation of arrhenoblastoma.

#### HISTOGENESIS

Present theories (86, 88) attribute the origin of arrhenoblastoma to certain undifferentiated male directed cells in the rete ovarii, the female homologue of the testis. Masculinovoblastomas are thought by most workers to represent adrenal rests (97) by some, tumors of lutein cells (45).

A histogenetic relationship between the two tumors is suggested by Case 3 in which ad renal like tissue (tumor nodule B) was found associated with typical arrhenoblastoma (tumor nodule A). That these 2 masses are variations of one tumor is evidenced by the following facts:

1. The striking superficial resemblance of the interstitial cells of the arrhenoblastoma to those comprising the adrenal like tissue.

2. The presence of sarcomatous cells and polyhedral cells in other tumor nodules in various proportions. Transitions between the two types of cells are seen.

3. At operation one metastasis was seen which proved to contain masses of lipoid cells, tubular elements and spindle cells so that both primary tumors were represented in the one metastasis.

4. Finally cytological studies showed the cells comprising tumor nodule B and those termed interstitial cells in the arrhenoblastoma to be identical (Table III).

It is of interest that Haffner mentions large masses of interstitial cells in his case of arrhenoblastoma (Table I, Case 6).

If a relationship between these two nodules actually exists it may be asked how one tumor can be derived from two cell rests. The pre-existing confusion concerning the masculinizing ovarian tumors may justify a reconsideration of the available morphological, clinical, experimental and embryological evidence for the present theories of histogenesis and a search for a common ancestor for the two types of tumor.

a. *Evidence for adrenal rest theory.* The term adrenal rest is not without reasonable basis (83). It is conceivable that these cells may be accidentally misplaced in the neighboring gonads during the course of their embryonic descent into the pelvis from their position near the mesonephros (4, 45, 86, 88).

TABLE III—CYTOLOGICAL STUDIES: A COMPARISON OF CELLS OF ADRENAL, TESTIS, AND OVARY WITH THOSE COMPRISING VARIOUS MASCULINIZING OVARIAN TUMORS

Tissue	Size cell (microns)	Size nucleus (microns)	Glycogen	Fat (Schmorlach red)	Mitoferrugineous	Pancreas nucleoli stain	Reticulum	Hematoxylin and eosin stain
Case 3: Cells comprising yellow nodule	Largest: 35 x 23 Average: 9 x 17.7	30 x 23.5 6 x 6	?	Large and small droplets; fine droplets in stroma	Fine crystals periphery of cell; some extracellular	Androgen cells" none?	Fine fibrils cytoplasmic staining cells	Cell membrane distinct in less contracted areas; cytoplasm faint or granular; clear nucleus and frame; or eccentric basophilic, granular or coarse eccentric nucleoli
Case 3: Interstitial cells in white mass	9 x 6.7	7 x 6	?	Large and small droplets	None	None	None	None; less variation
Case 3: Spindle cells in white mass	—	2 x 5	?	Fine droplets; occasional larger clumps	Rare, granular	None	Good reticulum	Cell borders not distinct; nuclei small, elongated, 1-3 nuclei varying with size of cell, nuclear membranes distinct
Cells comprising masculinized adrenoblastoma	37 x 18 range 14 Average 7 on 14.3	8 x 7.7	?	Large granules of uterine-type and extra cellular	Frequent, fine and acicular; few large clumps	No androgen cells seen	Very fine and light reticulum	Uniform; cytoplasmic nucleus distinct when large masses of fat present; prominent nuclear membrane; eccentric nucleoli; coarse rounded nucleus
Cells from adrenoma	6 x 2	9 x 9	?					Cytoplasm granular; cell nucleus, some distinct nucleoli; prominent, eccentric nucleoli in round or oval nucleus
Testis interstitial cells of Leydig	5 x 5	6 x 5.4	None	Scarcely large and small droplets in Leydig cells	None	No reaction		Cytoplasm scanty or granular, containing brownish pigment; nucleus fairly compact, deeply oval, chromatin fairly dispersed, fragment eccentric; nucleoli
Adrenal cortical cells	9 x 18 x 18 3 x 17 Average 5 x 23.5	5 x 23.5	?	Packed some fasciculated	Many large clumps; crystals in some fasciculated	No androgen cells seen	Few strands in outer cortex	Morphology varies with position; nuclei vary; stretched but distinct nuclear membranes; distinct nucleoli; nucleoli; granular clumps of chromatin, or watery nucleus
Corpus luteum luteal cells	—	10 x 13.9	None	Early, fine droplets; late marked accumulation	None	None	Scarcely reticulum	Cell outlines indistinct; distinct nuclear membranes; watery nucleus, sparse chromatin; nucleoli
Corpus luteum corpus luteum cells	7 x 16.3	6 x 5.4	Many droplets in vascular regions	All phases marked accumulation, large and small droplets	Rare; fine and acicular	No androgen cells seen	Fine prominent fibrils	Cytoplasm amphiphilic, heavy or granular; periphery indistinct; well defined cell membrane; eccentric or central nucleoli in granular nucleus
Ovary: para luteal stromal cells	—	5 x 6	Occasional accumulation above blood vessels in trabeculae	Fine droplets	None	None	Good reticulum	Spindle shaped, cytoplasm indistinct; large elongated nucleus; nucleoli; coarse clumps chromatin

Certainly if they occur in the eye (58) and epididymis (36) they may occur in the ovary. Moreover morphological evidence supports the adrenal rest theory in that these tumors bear more than a superficial resemblance to the zona fasciculata of the adrenal cortex, both in their tendency to line up in columns and their fat content.

Further evidence is given by Greenblatt and associates, who compare the lipoids in adrenal rest, arrhenoblastoma, and other tumors to

the adrenal and corpus luteum. Differential studies of fat content of the masculinoblastoma group revealed the cells comprising these tumors to be more similar to those of the adrenal cortex and of adrenal cortical adenomas than to those of the corpus luteum.

In our studies (Table III) the luteal cells were found to be more or less uniform and static. They resembled neither the adrenal cortex, masculinoblastoma, nor interstitial cells of the arrhenoblastoma. Furthermore,

we found little similarity between the latter cells and the Leydig cells of the testis.

In these and other respects our findings agree essentially with those of Greenblatt with the exception that all of the arrhenoblastomas studied by us had minute fat droplets in the cytoplasm of the sarcomatous cells.

If the choice for the histogenetic relative of the masculinovoblastoma lay between the adrenal rest and the corpus luteum only the adrenal should be chosen not only on the basis of fat content, but also on the basis of cytoplasmic and nuclear similarities.

*b Evidence for ovarian origin of masculinizing tumors*

1 Morphological Our cytological studies pointed very definitely to the striking similarity between the paralutein (or theca lutein) cells of the corpus luteum the interstitial cells of the arrhenoblastoma and the cells comprising the tumor nodule B of Case 3. The presence of doubly refractile crystals in theca lutein or paralutein cells the abundance of neutral fats the reticulum and the glycogen distribution justify the assumption of its potentialities as a factor in the histogenesis of 'lipoid cell tumors' of the ovary.

The presence of glycogen and fuchsinophile granules in the adrenal gland (45-8) and their occasional presence in tumors designated as masculinovoblastomas have contributed to the theory that the two tissues are related. However, both of these substances are also found at the periphery of the corpus luteum in the paralutein cells.

Reticulum studies may be of help in the future in differentiating between tumors of thecal origin and those of adrenal origin (112) since the theca cells about the follicle and their luteinized cousins around the corpus luteum both contain a more striking reticulum than the adrenal cortex.

2 Functional Culiner observed The similarity of these [theca lutein] cells to the adrenal cortex is remarkable and is probably not without significance. Therefore it is pertinent to determine the functional basis for the incrimination of theca lutein cells in the histogenesis of masculinovoblastoma.

This relationship was suggested by Novak in 1940 (86). The endocrine significance of

these theca lutein or paralutein cells is not known but their appearance would seem to leave little doubt that they play an endocrine rôle of some sort.

It is well known that preovulatory secretory changes can be recognized in the endometrium indicating a source of progesterone other than mature lutein cells of the corpus luteum. This finding is associated with the appearance of luteinized theca interna in the ovary.

Furthermore the androgenic effect of progesterone has been demonstrated (51-99) by the fact that progesterone when given to castrated male rats will maintain the prostate and when given to the immature female in large doses will cause clitoral hypertrophy.

In recent years evidence has accumulated for the presence of other androgenic substances in the ovary and the involvement of the paralutein or theca lutein cells in their production (6). Greene Burrill and Ivy (51) have shown that APL will stimulate clitoral hypertrophy in the guinea pig as well as the rat an effect not obtained when the ovaries are removed. Greene (99) has shown that APL at the same time produces increased numbers of interstitial cells (luteinized theca cells) in the mouse ovary and causes a marked growth of the clitoris. Ovaries transplanted to the ears of male rats will maintain the prostate and seminal vesicles for a variable period of time.

Therefore morphological similarities of the paralutein cell to the adrenal cortex and to the interstitial cells of Leydig (more superficial in the latter case) are supported by experimental evidence that androgens are produced in the ovary and more specifically by the paralutein or theca lutein cells.

3 Chemical The correlation is further strengthened by chemical tests which show a rise in phospholipids and cholesterol esters in ovaries during the middle part of the cycle when luteinization of theca interna and formation of theca lutein cells is taking place (112). Not only is a higher concentration of these substances found in the secretory group of ovarian tumors than in the nonsecretory group but a further increase was found associated with luteinization of granulosa or theca cell tumor (57). This corresponds to our

polariscopic studies which demonstrate birefractile substances not only in the adrenal cortex but also in luteinized theca cell tumors interstitial cells of the arrhenoblastoma masculinovoblastoma and the theca lutein cells around the corpus luteum.

4. Clinical. There is abundant clinical evidence that the recently discovered androgenic action of the ovary is directly related to the presence of theca lutein or paralutein cells. Stein and associates in 1935 and 1939 described the presence of luteinized theca interna of multifollicular cysts in 28 cases of amenorrhea (106-107).

Other instances are recorded including Turner's case in which multiple cystic ovaries were found in a case of hirsutism and amenorrhea (114). The symptoms regressed when the ovaries were partially resected. The ovaries showed luteinization of the theca interna and some luteinization of the ovarian stroma.

In the case of Saphir and Parker previously classified as masculinovoblastoma (Table II) the virilizing symptoms were associated not with tumor but with luteinized follicles and an accumulation of cells resembling theca lutein cells. That these changes are due to luteinization and not to fatty degeneration can be adequately determined by Traut-Kuder and Cadden's criteria of (a) well defined nucleus (b) size of cell (c) enlargement and fragmentation of Golgi bodies, (d) shortening and disappearance of rods (112).

Reis and Saphir's case, also classified as adrenal rest, (Table II) contained a tumor like nodule 2.9 centimeters in diameter which was thought to be corpus luteum. In one corner however there was an accumulation of very lightly stained cells. These were definitely smaller than the cells making up the corpus luteum and had an eccentrically situated vesicular nucleus. Some of the cells showed an empty cytoplasm while in others the cytoplasm was light pink. They differ morphologically from lutein cells although it is possible that these cells are lutein cells (or theca lutein?).

Case 1 of Rottino and McGrath (Table II) had a recurrence of hirsutism and amenorrhea 4 years after the removal of the tumor. The opposite ovary was shown to contain 8 thin

walled theca lutein cysts. It is curious that the original masculinizing symptoms should be caused by "adrenal cortical cells" and the recurrence of symptoms by cells of ovarian origin.

The evidence for the identity of virilizing lipid cells with theca lutein cells may be strengthened by the examination of plates and reading the descriptions of other cases of masculinovoblastoma.

It has been shown that the tumors of the arrhenoblastoma and masculinovoblastoma types contain cells which morphologically resemble the paralutein cells or the theca lutein cells of the normal ovary as much as they resemble adrenal cortical cells. Experimental evidence has been cited to show that these cells are capable of producing androgens. It has been shown that masculinization without tumor formation is associated with accumulations of these cells, and masculinization with tumor formation is associated with cells that in all respects are similar to theca lutein cells.

5. Embryological and developmental. A. Granulosa and theca interna cells are derived from the primitive ovarian mesenchyme in the embryo. Tubular structures are seen in both female and male gonads below 15 millimeters (4, 41, 85).

The ovary is derived from the proliferation of coelomic epithelium just anterior to the mesonephros. At about 5 millimeters the embryonic gonad consists of a surface layer of superficial cells and of mesenchyme in which begin to appear radially arranged cell cords. The connective tissue surrounding the cell cords is derived from the mesenchyme. Recent evidence points also to the derivation of the cell cords from the mesenchyme, rather than from invagination of the surface epithelium as was formerly supposed (41). Up to about 15 millimeters the male and female gonads are quite similar although their eventual sex differentiation has long been predetermined (85). After this indifferent stage, the cell cords in the males form the tubular system of the testis and those of the female give way to the follicle (granulosa and theca interna cells). Novak (88) agrees that the theca cells come from the ovarian mesenchyme.

b In the adult ovary, theca lutein or para lutein cells are normally derived from (1) luteinization of theca interna of the maturing follicle and subsequent continuation of this process as the corpus luteum is formed and (2) from ovarian stroma

It has been shown that the 'interstitial cell' (theca lutein) is differentiated from the stroma in lower animals and luteinization of ovarian stroma can occur in adult female ovaries producing similar appearing cells. Greenblatt also identifies the interstitial cells of the stroma with theca lutein cells (49). In Rottino and McGrath's case (98) this finding was associated with hirsutism and amenorrhea, which further demonstrates the androgenic action of these lipid cells, whether differentiated from stroma or from theca interna already present.

Culiner's excellent descriptions (26) also show the concomitant differentiation of stroma cells and luteinization of the theca interna. In fact, sometimes the latter merges with the stroma producing isolated islands of theca lutein cells which are seen grossly as yellow specks on the cut surface.

c. Ovarian tumors containing tubular structures and lipid cells may be produced by the radiation of mouse ovaries

Traut and Butterworth (111) show the development of granulosa cell tumors and luteomas by this means. Geist, Gaines and Pollack's descriptions up to the point of tumor formation correspond with Culiner's observation in the human (39). First the follicle is destroyed; this is followed by proliferation of the theca which merges with surrounding parenchyma; the stroma cells increase in size, become round, and separate in groups or cords (compare arrangement of adrenal rest tumor); luteinization of the theca cells and differentiation of parenchymal cells follows. It is interesting that the corpora lutea are well preserved throughout a finding which justifies its rejection as a potential factor in tumor production.

After 6 months 2 types of tumors are formed: the luteinized functional tumor and the nonfunctioning adenoma caused by invagination of the surface epithelium. Mixtures of both types occur.

c. Previous problems leading to confusion in literature. The histopathology of the various functional tumors is better understood if the above findings showing the relation between them and the ovary are accepted. The following observations which have previously complicated the histogenetic classification of masculinizing ovarian tumors may be explained.

1. The sarcomatous appearance and the spindle cells which comprise the more undifferentiated type not only of arrhenoblastoma but also of granulosa and theca cell tumors.

2. The gradation of spindle cells to interstitial cells in the arrhenoblastoma.

3. The oft quoted enigma that the most differentiated type of arrhenoblastoma, the adenoma tubulare, has no masculinizing effect while the least differentiated has the most masculinizing effect. We agree with Norris that the adenoma tubulare does not resemble testis. If present embryological and experimental evidence be applied to this group, the tubules may represent simply a nonfunctioning adenoma such as produced by Geist and associates with no histogenetic connection to the testis or to the cells forming the functional part of the tumor or the tubules in arrhenoblastoma may actually be a reflection of their primitive condition as sex cords, elements as characteristic of the female gonad as the male.

It is impossible to grade the three types of arrhenoblastoma accurately when this is attempted; there is seen to be no correlation between primitivity and degree of masculinity. In our opinion the androgens are produced by the polyhedral cells in all forms of arrhenoblastoma, as well as masculinovoblastoma or by gradations between the primitive stroma and these cells.

4. Difficulty in strict classification of the functional group of ovarian tumors. Gradations between all types are seen. Banner and Dockerty show that some granulosa cells are included in their series of theca cell tumors. Novak says that the two groups no longer can be easily separated. He further states that partial or complete luteinization of granulosa cell tumors (and more important theca cell tumors) may occur to produce masculinizing lipid cell tumors.

Such a patient was recently seen in this laboratory. In this case complete masculinization occurred in a 19 year old girl. The tumor was 7 centimeters in length well circumscribed and bright orange. Microscopically cylindroid strands of granulosa cells were noted masses of theca cells and the expected large percentage of lipid cells (Fig 15 J).

I late (94) and Meckler and Black review cases of gynandroblastoma which are merely arrhenoblastomas containing granulosa cells. Case 3 illustrates the completion of the cycle, the transition between arrhenoblastomas and masculinoblastoma.

The observations described are summarized in Figure 15 and the interrelationship of the functional group of ovarian tumors is shown.

#### SUMMARY

1 Three case reports of arrhenoblastoma are presented 1 with a 10 year follow up showing no recurrence 1 with metastases to liver appendix tubes, and peritoneum and a clinical picture of Meigs syndrome 1 which also contained adrenal like tissue.

2 Evidence is presented to show a possible relationship between arrhenoblastoma and virilizing lipid cell tumors (masculinoblastoma hypernephroma adrenal rest) of the ovary. The case quoted demonstrates both types of tissue in intimate association one metastasis with cells common to both tumors, and cytological studies identifying the cells of the adrenal like tissue as the so called interstitial cells which are found in arrhenoblastomas.

3 The total number of cases of arrhenoblastoma are reviewed with a discussion of the outstanding clinical and pathologic features. These are compared to a similar outline of the cases of masculinoblastoma to show clinical similarities and dissimilarities. Data are presented to show the frequency of metabolic changes in arrhenoblastoma and masculinoblastoma previously considered to be a differential clinical feature.

4. The histogenesis of the masculinoblastoma and arrhenoblastoma groups of ovarian tumors is discussed in detail. The embryology is reviewed to show that the ovary is capable of producing both types of tumor.

Morphological studies demonstrate the similarity between the polyhedral lipid containing cells in both types of tumor and the paraluteal or theca luteal cells of the normal ovary. Clinical functional and experimental evidence is cited to support this relationship. It is concluded that theca luteal or paraluteal cells are directly related histogenetically to both groups of masculinizing tumors. This obviates the necessity of the adrenal rest theory as an explanation of the histogenesis of masculinoblastoma or virilizing lipid cell tumor.

5 It is suggested that the cells comprising arrhenoblastoma are related as follows to ovarian structures: the spindle cells, forming tumors of sarcomatous pattern represent totipotential ovarian stroma the tubular structures are related to invaginated surface epithelium or to primitive sex cords of the female gonad the interstitial cell of Leydig in arrhenoblastoma simulates the paraluteal or theca luteal cell. The virilizing lipid cell tumor in its pure form may represent a neoplasm of luteinized theca interna cells or of paraluteal cells and morphologically is more properly termed paraluteinoma. All types of functional tumors probably originate from undifferentiated mesenchyme.

6 A diagram illustrating the interrelationship of functioning ovarian tumors is presented.

#### REFERENCES

1. ARRELL, E. M. and D. and DORRICK, A. Anat. path. Pat. 1939, 8:6 7-615.
2. ALLEN, W. A. and PAUL, G. and COLLINS, Rev. med. obs. pat. fem. 919, 15: 33-34.
3. ANDERSON, J. T. R. Med. Ch. Soc., Glasgow 1935, 129: 93.
4. ARRY, L. B. Developmental Anatomy and Laboratory Manual of Embryology Philadelphia, W. B. Saunders Co. 936.
5. B. LOWRY, L. G. and GIFFORD, J. A. J. Endocrinology 1936, 20: 373-382.
6. BANNER, L. A., and LOCKERTY, M. B. Surg. Gyn. Obst., 1935, 8: 34-41.
7. BIRZEL, G. Atlas of Ovarian Tumors. New York: Grune and Stratton, 1941.
8. BRYCE, J. T. Bull. Vyer Clin. Lab. 1939, 3: 359-366.
9. BROWN, M. and LEVINE, S. Arch. Surg. 1934, 11: 350.
10. BROWN, E. Med. Welt, 1937, 11: 345-347.
11. BUCKE, A. Deut. med. Woch. 1934, 330-337.
12. BLACKWELL, R. L. Am. J. Obst., 1912, 43: 56-104.
13. BOLTON, S. M. Am. J. Obst., 919, 30: 857-866.
14. BOWEN, R., and ROBERTS, M. Brit. med. 937, 1: 183-835.

15. BOVIN, E. Nord med. Ark., Stockholm 1908 41 1-35
16. BRABSON J A., et al. Bull. Charlotte Mem Hosp 1944 1:19-23
17. BRENTNALL, C P J Obst. Gyn. Brit. Empire, 1945 52:235-246
18. BRITO, V., and RIVERO A. Rev obst. ginec. Caracas, 1944 4 5 19.
19. BUETTNER, A. Virchows Arch 1932, 287:452-482
20. BURKET J A. and ABELL, I Surg Gyn Obst. 1944, 79:651-654
21. CAMILO, C K., and LISSER, H Endocrinology 1939, 24:838-847
22. CARRERAS, J P Rev med. Cubana 1944, 55 297
23. COHEN S., and KUSHNER, J I Am. J Obst St Louis, 1944, 47:421-422
24. COLLINS, C. G., BEACHAM, W and SCHATTENBERG N G N Orleans M S J 1942 94 589 592
25. COSACESCO, A., GRAGANESCO, S GEORGESCO, M., and DIMICHIMOTO G T Presse méd 1931 39 1264-1267
26. CULDER, A. J Obst. Gyn. Brit Empire 1945 52 545-558.
27. D'AMONTE, C. C. Rev gyn. obst., 1938, 2 3
28. DELARUE, J and ISIDOR, P Bull. Ass. fr cancer 1938, 27:429-439
29. DOCKERTY M B Proc. Staff Meet Mayo Clin 1939 14 369-374.
30. DOCKERTY M B and MACCARTY W C Surg Gyn Obst., 1939 68:767-773
31. DORFMAN, R. L., WILSON H. M. and PETERS J P Endocrinology, 1940, 27 1-15
32. DUDMAN, V E. West J Surg 1939, 47 128-136
33. EKKERS R., and HANSTAD K Norsk mag lægevid 1939 1:675-677
34. FOEDERL V Misch Geburtsh. Gyn 1937 106 54-65
35. FORTY J L Gyokuzasshi, 1939, 79 115 Feb 26 1939, p. 138 March 5, 1938, p. 148
36. FRIEDMAN A. Arch. Path., 1945 39 336-337
37. GARDNER, W S., and McCLEARY S Surg. Gyn. Obst., 1908, 7:669-684
38. GEIST S. H. Ovarian Tumors. New York, London Paul B Hoeber Inc. (Harper & Bros.) 1942
39. GEIST, S. H., GAINER, J A., and POLLACK, A. D Am. J Obst., 1939, 38:786-797
40. GEIST, S. H., GAINES, J A. and SALMON U J Am. J Obst., 1941 42:619-637
41. GEIST S. H., and SPIELMAN, F J Clin Endocr 1943, 3:281-295
42. GIAMPALMO, A Pathologica Padova, 1938 30 375-379.
43. GIORDANO A. S. and HAYMOND, J L. Am. J Clin. Path., 1944, 14 28-33.
44. GLASER, E., and HAEMPEL, O Berl. klin. Wochr 1937 16:858-861
45. GLYNN E. J Obst. Gyn. Brit. Empire, 1921 28 23-68.
46. GORDON, A. K Brit. M. J 1929 2:495
47. Ibid. 1930, 1:133
48. GOURG, A. J Obst. Gyn. Brit. Empire, 1938, 45 799-801
49. GREENGLATT, R. B. Am. J Obst., 1941 42:983-996
50. GREENGLATT, R. B. GREENHILL, J P and BROWN W R. Am. J Obst. 1939, 37:929-939
51. GREENE, R. R., BURRILL, M. W., and IVY A. C. Endocrinology 1939, 24:351-357
52. GREENE, H. J. and LAPP W A. Am. J Obst., 1944, 47:63-69.
53. HANKE, K. Zbl. Gyn 1931 55 1088-1108.
54. HARTNER, J Norsk mag lægevid., 1937, 98 1027
55. HARTZ, P H Am J Path., 1945 21 1167-1191
56. HITZANIDES, M. Bull. Soc. obst. gyn Paris, 1938, 27 33
57. HODGSON J E., DOCKERTY M B and MUSSEY R. D Surg Gyn. Obst., 1945 81:631-642
58. HUGHES, L. W. and AMERSON, A. J Am. M. Ass. 1944, 126 231-232
59. JOHNSON C. G. Am J Obst., 1944 48:724-728
60. KAMNERTSTEIN M. BROWN C. R., and ROSEN J A. Am. J Obst. 1943, 46 200-204.
61. KANTER, E E and KILAWAN, A. H Am J Cancer 1940, 40:474-484
62. KANTER, A. E., and RADINS, A. B Am. J Obst., 1941 43 1061-1065
63. KEPLER, E. J., DOCKERTY M. B. and PRIESTLEY J F Am. J Obst., 1944, 47:45-62
64. KLEINE, H. O Zbl. Gyn., 1939, 63 1940-1956
65. Ibid. 1939, 63 2249-2256
66. KLEINSTEIN J. méd Bordeaux, 1938, 115 300-301
67. KREUTEMANN H Zbl Gyn., 1939, 63 2256-2260.
68. KROCK, F., and WOLFFERMAN S. J Ann Surg 1941 114:78-89.
69. LISTER, H., PALMER, A. and MORTON D G Clinica, 1942 1:768-781
70. LUXUY Mém. Acad. chir., Par., 1939, 65 26-37
71. Idem. Bull. Soc. gyn obst 1939, 38 302-306
72. Massachusetts General Hospital Case Records (Case 23351) N England J M., 1939, 22 349-352
73. Idem (Case 27161) N England J M. 1941 224 604-608.
74. MAXWELL, A. F West J Surg. 1937 45 134-147
75. MAYER I. Virchows Arch., 1942, 300:625-645.
76. MCINTYRE, W K. J Obst. Gyn. Brit. Empire, 1942 49:41 50.
77. MCLESTER, J B Arch. Int. M., 1936 57:773-786
78. MECHLIN, E. A. and BLACK W C Am. J Path 1943 19 633-653
79. VIEDMA, J. and AMORIM DE F Ann. brasíl. gyn. 1944 18 313 336
80. MEMOT T B. and VELLIATH, G D J Indian M. Ass. 1943 12 337-342
81. MEYER R. Am. J Obst. 1931 22:697-713
82. MILLER, J R. Am J Obst., 1937 34:686-685
83. MITCHELL, N. and ANONIST A. Arch. Path 1943, 35:46-52
84. NEUMANN, O Zbl. Gyn 1943, 67 576-578
85. NORRIS, E. H. Am J Cancer 1938 32 1 29
86. NOVAK, E. Gynecological and Obstetrical Pathology Philadelphia and London W B Saunders Co 1940.
87. Idem Am J Obst., 1938, 36:840.
88. Idem. Surgery, 1944, 16:82-90.
89. NOVAK, E. and LONO J H. J Am. M. Ass., 1933, 101 1057-1064.
90. NOVAK, J., and WALLIS, O Arch. Gyn. Berl., 1937 164:543.
91. PIRKS, C. E. Rev gyn. obst., 1938, 1:403-423
92. Idem. Rev fr gyn. obst., 1944, 1 227
93. PLATE, W P Ned. Tsch. verlosk. gynaec., 1936, 39:71-86
94. Idem. J Obst. Gyn., Brit. Empire, 1938, 45 254-257
95. RAO, P R., MEMON C. P V., and NARAYANAMURTHI, K. Indian J Surg., 1940, 2:4-12
96. REIS, R. A., and SAPHIR, O Am. J Obst., 1938, 35:954-960.
97. ROTTIMO A., and McGRATH, J F Arch. Int. M 1939, 63:886-710.
98. Idem. Am. J Obst., 1943 45:863-886
99. SAPHIR, O Am. J Obst., 1939 37 1008-1014.
100. SAPHIR, W., and PARKER, M L. J Am M. Ass., 1936, 107:1286-1288.



- 101 SARKAR M. N. and TRIPATHI H. P. Indian M. Gaz., 1939, 74, 284-285.
- 102 SELLHUTT H. Zchr. Zellforsch., 1935, 3, 387-408.
- 103 SOETIDJO HARDJOMOKATMO, R. M. Geneesk. tchr. Ned. Indië, 1937, 70, 3205-3214.
- 04 SPILLING, G. Frankl. Zchr. Path. 1938, 52, 229-242.
- 05 STADEN M. L. Am. J. Surg. 1937, 57, 312-318.
- 06 STEIN I. F. and COHEN M. R. Am. J. Obst., 1937, 38, 465-480.
- 07 STEIN, I. F. and LEVINTHAL, M. L. Am. J. Obst. 1935, 29, 181-191.
- 08 TAYLOR J. M. WOLPERMAN S. J. and KROCK I. Surg. Gyn. Obst. 1935, 55, 1040-1046.
- 09 THOMSON J. C. and ST. BILLY I. J. Obst. Gyn. Brit. Empire 1938, 45, 769-779.
- TERRY P. F. Sem. med. B. A. 1937, 358.
- TRITT H. F. and BUTTERWORTH J. S. Am. J. Obst. 1937, 34, 287-300.
- 1 TRITT H. F. and FETTER A. and CUMMINGS J. I. Am. J. Obst. 1939, 38, 798-811.
- 1 TURCO A. Minerva med. Tur. 1937, 2, 657-688.
- 114 TURNER, S. J. Am. J. Obst., 1941, 45, 777-794.
- 115 URBANTZAGA, M. and OLIVA, E. Rev. de obst., 1942, 5, 18-20.
- 116 VAN KIRK F. W. JR. and EDWARDS E. A. Am. J. Cancer 1939, 37, 209-215.
- 117 VARANGOT J. Bull. Soc. obst. gyn. Paris, 1938, 27, 39-45.
- 118 VELANCO, D. and ZAPATERO G. Q. Rev. Obst., 1941, 3, 124.
- 119 VINCIGUO, F. H. and BROWNE J. S. L. Endocrinology 1938, 21, 711-721.
- 120 VIANA, O. Atti Soc. Ital. ost., 1938, 34, 317-325.
- 121 VON NUPPE C. Acta obst. gyn. scand., 1940, 49, 146-156.
- 122 VON SATHOMAY Z. Arch. Gyn. 1937, 164, 474.
- 123 WIJZENBERG, I. A., and PLATE, W. P. Ned. tchr. Geneesk., 1940, 84, 1022-1027.
- 124 WOLFF S. A. Am. J. Obst., 1937, 35, 375-385.
- 25 XAVIER J. F. DE P. and JUCKOWITZ, M. de A. Rev. gyn. obst., Paris, 1938, 2, 356-377.
- 126 YUD 1940, 2, 225-238.

# THE TECHNIQUE OF THYROIDECTOMY

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**D**URING many years of experience with thyroidectomy, we have constantly made changes in our technique. For this reason a description of our present technique, accompanied by the reasons for its various steps may be of interest. We claim no originality for any of our steps, as most of them are the result of trial and error after observation of other surgeons in various clinics of the world.

Teamwork is especially important in this operation. Our team, consisting of surgeon, assistant surgeon, anesthetist, and instrument nurse, has remained almost intact for many years. Our internes and residents get their experience as second assistants. To have a well trained and experienced assistant surgeon is like having an extra pair of hands because they act and anticipate your wants as though they were being directed by your own brain. A competent anesthetist who takes an interest in thyroid cases and becomes familiar with each patient before operation makes it possible for the surgeon to dismiss from his mind any concern about the patient's condition unless warned by the anesthetist. We depend almost entirely on the judgment of the anesthetist as to whether to do a one stage or two stage operation. An instrument nurse of your own who assists at all operations, looks after the preparations in the operating room, sees that the proper instrument or suture is ready when wanted, relieves the surgeon of much anxiety and allows him to keep his eyes focused on the wound at all times. The instruments, too, should be the private property of the surgeon, should be uniform, should not be used for any other operation, and should be kept in good working condition. For hemostasis, we use the Rankin hemostats throughout.

Our anesthetic of choice is cyclopropane. In patients with heart disturbance, especially those that are fibrillating, ether and oxygen

pentothal intravenously or local anesthesia is used. When there are pressure symptoms, especially respiratory difficulties, an intra-tracheal tube is introduced either through the nose or by direct laryngoscopy through the mouth.

Only the immediate preoperative and post-operative treatment will be described in this paper. The night before operation the patient is given an average dose of 3 grains of luminal. This is repeated 3 hours before the operation. A hypodermic of morphine, grain  $\frac{1}{6}$ , and atropine grain  $\frac{1}{100}$ , is given  $\frac{1}{2}$  hour before operation. The patient is visited by the surgeon on the latter's arrival at the hospital on the day of operation to be sure no contraindication to operation has developed. No other visitors are allowed, the room is left dark, and the patient is not disturbed. All preparations are made the day before operation. The patient is preferably given a room on the same floor as the operating room and at the appointed time is placed directly on the operating table in her room and transported to the operating room as gently as possible.

The operating room is prepared and the anesthetist and surgeons are ready before the arrival of the patient. When the patient arrives, she is immediately, though without haste, anesthetized, to prevent her from seeing much of the operating room or hearing any of its noises. There should be no unnecessary noise or talking in the operating room.

As soon as the patient is unconscious, her arms are fastened to the sides of her body by winding the drawsheet around them, a sand-bag is placed under her shoulders to hyper-extend the head and push the thyroid forward, the upper half of the table is raised about 30 degrees and the ether screen placed in position (Fig. 1). The operative area is then wiped with ether to remove all fat and sebaceous material from the skin and this is followed by a not too wet application of half strength tincture of iodine. We have never seen any reason for changing to any other antiseptic.

From the Surgical Service of the Deaconess Hospital, Buffalo, N. Y., and the Surgical Department of the University of Buffalo Medical School.

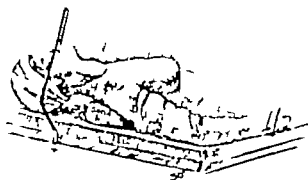


Fig. 1 Position of patient on table

Serious blistering of the skin almost never occurs and infection of the wound is almost unknown about twice in the last thousand cases.

We have tried to make the draping of the patient simple without moving any part of the patient or using special sheets but nevertheless efficient and we believe we have succeeded. A crumpled sterile towel is placed in the hollow on each side of the neck. A towel is placed across the upper part of the chest and still another placed a little higher over this, its upper edge kept taut and fastened on each side of the neck to the crumpled towel and the skin near the upper edge of the operative area with a towel clip and then turned up and fastened to the ether screen with another towel clip on each end. Folded towels are placed diagonally over each side of the neck overlapping below in the midline. A laparotomy sheet is placed over the patient with the operative area appearing in the opening. Finally several crumpled sponges are tucked into any potential openings on each side to cover them and to anchor the draping into position (Fig. 2 a, b, c, and d).

The incision is outlined with the back of the knife about 1 inch above the suprasternal notch and parallel to the folds of the neck. Thus it is made slightly curved with the convexity downward. Whenever there is much protuberance of the skin caused by the underlying goiter the incision is placed correspondingly higher so that after the goiter is removed it is still about 1 inch above the suprasternal notch where it can easily be covered by a string of beads until it fades and becomes almost invisible. A scar that lies on the sternum is very unsightly and difficult to cover.

The incision is made through the skin, subcutaneous tissue, and platysma to the plane of cleavage just above the cervical fascia, avoiding the anterior and external jugular veins that lie on this fascia. If they are injured, they are easily clamped and tied preferably with surrounding suture but usually they are not injured.

The upper flap is then developed partly by sharp dissection and partly by gently wiping it upward with a sponge. This latter maneuver saves time and locates the bleeding points more definitely thus saving the number of hemostats used. The lower flap is similarly prepared. All bleeding points are tied with No. 000 chromicized catgut. A towel is attached to the edge of the lower flap to cover the skin and the flaps held apart by a self-retaining Crotti retractor (Fig. 2 e and f).

We use chromicized catgut throughout. We are well aware of the arguments in favor of nonabsorbable suture material but feel that by using very fine catgut, No. 000 for superficial ties No. 00 for the rest of the operation, we do not cause much more irritation than is caused by nonabsorbable material and without the risk of sinus formation such as we have observed when the latter was used. It is true that these fine ligatures break if too much force is used, but with practice the amount of tension allowed is soon learned and the occasional tear is taken philosophically as the price to be paid for using fine catgut. When such a ligature is once properly tied without tearing it is just as secure as a silk or cotton tie.

A short vertical incision is now made in the midline through the fascia down to the surface of the gland. After a scissors is inserted upward and downward in this plane and the tissues are separated from the gland, the incision is extended upward to the base of the upper flap and downward to the sternum.

The right ribbon muscles are dissected from the gland and retracted with a Parker retractor. The right lobe is grasped with a Lahey forceps and gently pulled upward, at the same time it is gently separated from its surrounding tissues by inserting a finger. This latter must be done very carefully to avoid tearing the veins, especially the middle thy-

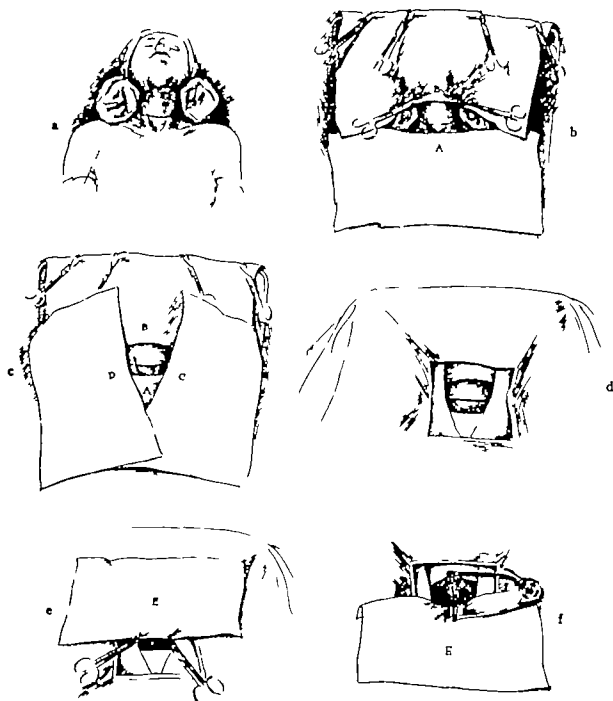
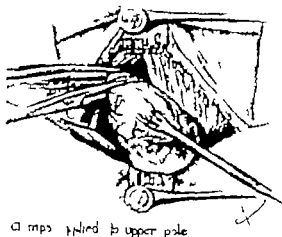


Fig. 2. Draping of patient. a, Crumpled towels placed at sides of neck. b, Towel A laid across chest, B clamped to skin and crumpled towels. c, Towels C and D placed. d, Laparotomy sheet placed incision made. e, Edges of towel clipped to lower edge of incision. f, Free edge of towel E turned downward retractor placed.

roid vein. As soon as this vein appears it is doubly clamped and divided. This vein emerges from the true fascia of the gland and by dividing it, the lobe is further liberated.

If, on inserting the finger the goiter is found to be very large, to extend into the chest or behind the trachea, or to be unusually adherent, it is not delivered until the ribbon

muscles are divided. In such a case, the sternomastoid muscle is liberated by a diagonal incision through its fascia at its anterior border and retracted out of the way after which the ribbon muscles are divided transversely between two Kocher clamps and held out of the way with Lahey forceps. This procedure we have found necessary in only



Clamps applied to upper pole

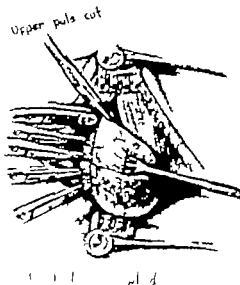


Fig. 3. left. Treatment of superior pole.

Fig. 4. Pole divided, lobe delivered, row of clamps applied.

about 10 per cent of our patients, but when any difficulty is expected the greater exposure obtained is an added safeguard.

After the right lobe is delivered, the superior pole is prepared by traction downward of that part of the gland, retraction of surrounding tissues, and wiping away any extraneous tissue with a 'wiper' (a small folded piece of gauze in a hemostat). Three hemostats are placed on the superior pole just above the gland and the pole divided between the lower two (Fig. 3). Thus the gland is further liberated and it is possible to hold it well over to the left, so that its entire lateral surface is exposed. In cases in which the lobe extends above the line of easy exposure or behind the trachea, the individual vessels at the superior pole are clamped and divided, and the upper part of the lobe allowed to roll out.

At this point it is necessary to decide how much of the lobe to leave behind. This depends upon the age of the patient, the type and toxicity of the goiter and its conformation. We aim to remove all adenomas completely even if they extend far back into the area where the recurrent nerve and parathyroid glands are situated. But in this case the hemostats are placed so close to the tumor that the posterior capsule is left. In general, we leave a thin layer of gland tissue as well

Hemostats are placed along the line of contemplated incision and short cuts made above each hemostat (Fig. 4). The recurrent nerve is not visualized as a routine, but only when we think it is indicated. We believe that there is more danger of injuring the nerve when it is exposed by dissection than there is when its normal location is avoided.

After the outer edge of the lobe is thus mobilized, the isthmus is divided between clamps and the remaining attachments of the right lobe are divided by placing hemostats on the median aspect close to the trachea and working to the right until the lobe is free. All vessels are tied with No. 00 chromogut. At the superior pole, however, a suture is placed around the vessels above the two hemostats, tied the upper hemostat removed, and another tie made around the lower hemostat.

One side is completed before beginning the other side, so that the operation may be terminated at this point, if necessary. After all bleeding is controlled on the right side, a loose tampon is placed in the hollow left by the gland. Enough dissection is made of the left lobe to determine whether operation is necessary on that side. If so the surgeon repeats the same performance on the left side.

If there is difficulty in controlling the oozing from one of the stumps, the lateral border is

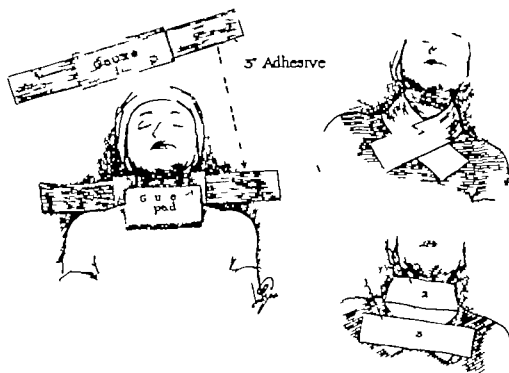


Fig. 5 Application of final dressing

sewed to the pretracheal fascia to fold the raw edge over on itself and thus control the oozing. If the field is dry this procedure is not carried out because the raw area is eventually covered by the ribbon muscles and because there is a slight danger of pulling on the recurrent nerve as indicated in a previous paper (1).

The pillow under the shoulders is now removed and the cavity on each side irrigated with a normal saline solution. Thus blood clots are washed out, any residual bleeding is uncovered and any possible infection is washed out or diluted.

If the ribbon muscles have been divided transversely they are sutured with a running lock stitch. The ribbon muscles are now brought together in the midline in two layers with a running suture, first taking in the muscles only and returning as a fascial suture. This makes a good covering for the thyroid stumps and also for the exposed trachea preventing attachment of the overlying tissues.

The incision in the skin and platysma is closed with Michel clamps, care being taken to evert the edges so that the divided edges of the platysma muscle are closely approximated and good healing takes place. If this does not occur the platysma tends to pull the scar apart and widen it. We have found by ex-

perience that Michel clamps alone cause better healing and a finer scar than sewing the tissues in various layers, besides saving considerable time.

A fairly large dressing is placed over the wound and held in place by a long wide strip of adhesive plaster going around the neck and crossing over the dressing in front. Shorter strips of adhesive are placed over the upper and lower borders of the dressing (Fig 5).

We seldom drain the wounds, even in large intrathoracic goiters. We find that the cavities left are quickly eliminated by pressure from the surrounding tissues. Occasionally we encounter collections of serum under the skin but these can easily be aspirated. The exceptions are cases of uncontrollable oozing or of known or suspected infection. This belief has been a gradual process until we are convinced that the placing of a drain is not only unnecessary but sometimes even invites infection and prevents a perfect scar.

In bad risk cases the operation is done in several stages. In such cases we may merely make the incision or may do one side only. Whenever we are in doubt as to the advisability of continuing the operation, we always play safe and terminate the operation. Thus an opportunity is given to gauge the reaction

of the patient. At the subsequent operation, the incision is quickly and easily opened and the operation completed. However we find it necessary to do stage operations in only about 5 per cent of all thyroidectomies. This we attribute to better preoperative preparation.

A word about intrathoracic goiters. It is very easy to miss even a large downward extension of an adenomatous goiter. We have missed some and have operated upon a considerable number left by other surgeons. This possibility should be thoroughly investigated in every case.

As all the circulation of the intrathoracic portion comes from the regular supply of the thyroid, this should be controlled first. The finger is then gently inserted and swept around the tumor. Care must be taken to be in the correct plane of cleavage. Fortunately there are seldom any dense adhesions to the surrounding tissues and we have never had any trouble from that source. The tumor is now slowly delivered by traction from above and pressure of the finger below. The finger is better than an instrument because it is more easily guided and kept in the right place. If the tumor is too large to be delivered in this way an incision is made in the presenting part of the tumor and its contents usually colloid in character partly expressed. This procedure decreases its size so that it can easily be delivered. Its pedicle is then clamped and divided and the tumor removed.

We no longer aim at high speed in operating but rather to operate gently without any lost

motion or unnecessary delays. In this way we operate more safely and almost as fast as when we try to speed up the operation.

The patient is returned to her room, placed in a semi-sitting position for a few hours, and given enough morphine to control restlessness. Water by mouth is encouraged from the start and usually no intravenous fluids are given. If patients are prepared properly especially if they are given plenty of water and fruit juices preoperatively intravenous therapy is seldom necessary. The patient is kept as quiet as possible with a minimum of fussing. These patients usually get along better on floor service supervised by nurses experienced in thyroid patients than by entrusting them to inexperienced or meddling special nurses.

The initial bulky dressing is changed to a very light one on the day after operation. One-half the clips are removed on the second day and the rest on the third day. Most patients get out of bed on the fourth day and leave the hospital on the fifth day.

Our mortality under this regimen has been 1.2 per cent in our last 1,000 cases. We have had no cases of tetany and no bilateral nerve injuries in these 1,000 cases. With modern methods of preparing iodine-resistant bad risk patients with one of the thiouracil group of drugs or even of curing some of them without operation we hope still further to reduce our mortality.

#### REFERENCE

- NOBBERG, A. H. N. York State J. M., 93: 31 (1942)  
4. 2.

## RESECTION OF THE CLAVICLE

### With Particular Reference to the Use of Bone Chips in the Periosteal Bed

HARRIS B SHUMACKER Jr M D New Haven Connecticut

IN order to provide adequate exposure of the subclavian and innominate vessels particularly in operations upon aneurysms and arteriovenous fistulas resection of a portion of the clavicle is often necessary. I do not know who first employed this procedure. Certainly Cooper in 1859 resected the sternal end of the clavicle and a part of the manubrium in approaching an aneurysm involving the bifurcation of the innominate, as did Burrell in 1895. In 1892 Halsted excised the inner third of the clavicle in extirpating a large subclavioaxillary aneurysm. Before 1886 Bardenhauer had utilized resection of the inner portion of the clavicle and a part of the manubrium and of the first two ribs in operating for a number of conditions, including one case in which a tumor involved the first portion of the left subclavian vessels. Through the years it has become increasingly apparent that added safety could be secured in such cases by removal of some of the bony structures overlying the great vessels.

The manner in which the bony defect has been handled has varied. In many of the early cases the excised portion of clavicle was not replaced. Some surgeons have reinserted the bone and fixed it *in situ* by approximating it to the remaining bone with wire or other sutures. The replacement and fixation with sutures of the resected segment of clavicle is subject to many difficulties. Proper immobilization is often not secured and painful nonunions and malunions occur so commonly as to make the procedure eminently unsatisfactory. Holman recently pointed out that the results of superiosteal resection and discarding of the segment are excellent. My experience is in complete agreement (6).

If the clavicular bed is carefully closed by approximating the periosteum and if the patient is kept flat in bed for 2 weeks with the shoulders held well back and is encouraged to spend a considerable part of the third week lying on his back the results are most satisfactory. Firmness rapidly appears in the region of the missing segment so that long before any evidence of osseous regeneration is evident from roentgenological examination one can hardly tell by palpation that a bony defect exists. Such patients have normal configuration of the chest and shoulders and normal movements of the upper extremities, and are entirely comfortable.

In contrast it has been my experience that replacement of the clavicle often has most unsatisfactory results. In a single instance in which I returned the segment to its bed and fixed it to the remaining ends of the clavicle with wire sutures, a painful nonunion occurred which was relieved only by excision of the segment. A number of other patients who have come under my care after having undergone replacement of a portion of clavicle following excision during the course of operations for aneurysm have had difficulties such as painful nonunion or malunion, conspicuous displacement of fragments, osteomyelitis and poor function.

Satisfactory as are the results from discarding of the resected clavicle and accurate approximation of the periosteal edges it is evident that in many cases regeneration of the bone is slow. Though most of the patients are asymptomatic prior to restoration of bony continuity some have slight discomfort during heavy lifting and other vigorous exercise. Furthermore it seemed desirable if it could be accomplished without significant risk or difficulty to hasten the process of bony regenera-

From the Vascular Center, Mayo General Hospital, Galesburg, Illinois, and The Johns Hopkins Hospital, Baltimore, Maryland.





Fig. Roentgenograms taken 3 weeks after operation in cases in which bone chips were placed in the periosteal bed. The bone chips are seen. Examination of the ray

films themselves reveals definite callus formation in cases which are portrayed in b and c, though this is not evident in the reproductions.

tion With this in mind a small group of patients were treated by filling the periosteal bed with bone chips secured from the excised segment of clavicle. It is the purpose of this communication to draw attention to this procedure.

The operation was carried out upon 4 patients. In 1 patient resection of the middle third of the clavicle was performed, while in 3 resection of the inner third or half of the clavicle with disarticulation at the sternoclavicular joint was done. In 2 of the latter the sternum was split down to the second interspace. One patient had an arteriovenous fistula of the third portion of the subclavian vessels, 1 a mediastinal fistula between the left subclavian artery and vein, 1 a fistula of the second portion of the right subclavian vessels and 1 an arteriovenous and saccular aneurysm in the anterior mediastinum involving the arch of the aorta and the innominate and subclavian vessels which at operation was found to be inoperable. In each case the clavicle was excised subperiosteally care being taken to preserve the periosteum intact. In 1 case the periosteum was also transected in order to facilitate exposure. The bone was divided with a Gigli saw. The excised segment was covered with sterile normal salt solution. After the vascular surgery was completed the removed clavicle was converted into small bone chips 2 to 3 millimeters in diameter with a rongeur. These were packed into the periosteal bed and the periosteum was

closed over them with interrupted sutures of fine silk. Ordinarily sufficient bone chips could be obtained from a half or two thirds of the resected clavicle. The soft tissues were then approximated in the usual manner with interrupted silk sutures. It should be pointed out that in 1 instance the excised clavicle was inadvertently dropped on the floor and was converted into chips after being autoclaved.

The patients were kept in bed for 2 weeks. For the most part they were asked to lie flat on their backs with the shoulders held well back, although they were allowed to assume other positions occasionally after the first few days. No external immobilization was used. During the third week they were allowed to get up but were encouraged to rest a considerable part of the time on their backs. Definite firmness was noted in the region of the resected clavicle even sooner than was the case in patients who had undergone similar resections without replacement of bone chips.

Oseous regeneration was rapid and complete. Three of the patients were examined 3 weeks after operation (Fig. 1). In 2 of them there was already some evidence of callus formation at this early date. One was examined 7 weeks after operation and showed progressing union (Fig. 2a). In another there was evidence of good regeneration 11 weeks after operation (Fig. 2b). Complete regeneration was apparent in the remaining 2 patients who were examined 16 and 18 weeks after operation (Figs. 2c and 2d).

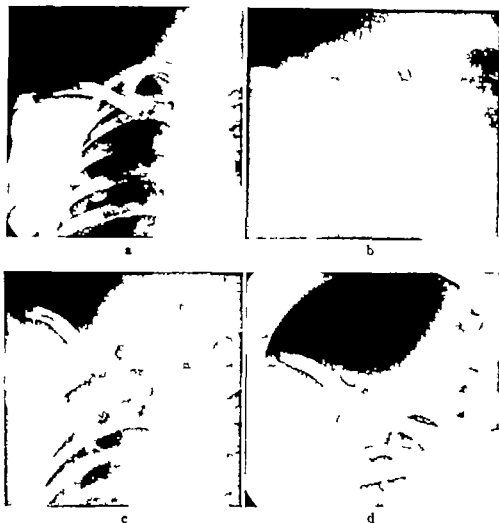


Fig. 2. Roentgenograms taken, a, 7 b, 11, c, 16, and d, 18 weeks after operations in cases in which bone chips were placed in the periosteal bed. It is apparent that excellent bone regeneration is occurring in a and that regeneration is complete in the other 3 cases.

In contrast are the results of roentgenological examination in 10 other patients in whom subperiosteal resection without the use of bone chips had been carried out. In 6 patients there was no evidence of bony regeneration on the last examination made 5, 6, 7, 10, 10, and 13 weeks after operation. One showed only a small amount of callus formation 27 weeks postoperatively. Another had evidence of a little callus at each end of the remaining clavicle 4 weeks after resection but had not achieved union 34 weeks after operation, at which time it appeared that the ends of the bone were becoming eburnated. One patient exhibited excellent regeneration in 8 weeks (Fig. 3a). In 1 there was evidence of progressive union 12 weeks after operation and excellent union 29 weeks after operation (Figs. 3b and c). Thus when these patients were

examined at intervals of from 5 to 34 weeks after excision the majority showed no callus formation. Furthermore when regeneration occurred it sometimes proceeded from the ends of the remaining bone rather than through out the periosteal bed as was the case with those in whom bone chips were used. In one such case it appeared that union would not be achieved because of eburnation of the bone ends (34 weeks after operation) while another proceeded to excellent bony union (Fig. 3c).

#### DISCUSSION

In many operations in the clavicular area and in the anterior mediastinum essential exposure is facilitated by clavicular resection. This is particularly true in cases of aneurysm and arteriovenous fistula of the subclavian, innominate, and internal mammary vessels

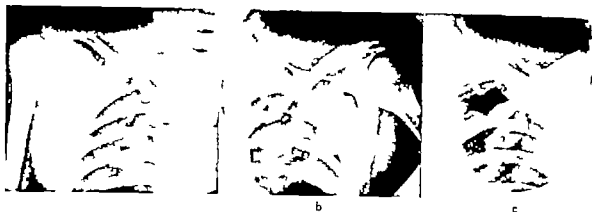


Fig. 3. Roentgenograms of patients in whom there was good bony regeneration following excision of portion of clavicle with simple closure of the periosteum. a, taken 8 weeks after operation shows excellent regeneration. b,

taken weeks after operation upon another patient shows good regeneration of bone but incomplete union in the medial portion of the area from which bone was removed. In c, union is seen to be complete 29 weeks after operation.

Frequently section or resection of the clavicle is necessary in explorations of the brachial plexus. In the latter cases simple osteotomy often suffices and excision of a segment of clavicle is unnecessary in order to secure adequate exposure. Although I have had little experience with clavicular section for exploration of the brachial plexus, I have seen many patients who have undergone such procedures. It is my impression that difficulties with maintenance of position of the fragments with various methods of wire and screw fixation are sufficiently common to justify inquiry at least, into the advisability of resection of a segment of clavicle instead.

When a portion of clavicle is excised the incidence of difficulties in maintaining position in securing union, and in avoiding pain following reinsertion of the intact segment and fixing it in place with wire sutures is so high as to make its use unwise. Although resection and discarding of the excised segment of clavicle with periosteal closure give excellent cosmetic results, stability and good function at least for all but strenuous work and exercise in many instances bony union is long delayed. My own patients have not been followed long enough to permit me to say what percentage will eventually obtain good osseous union, nor are such data available in the literature. In spite of the excellent functional results from such operations it is believed that the simple procedure of replacement of bone chips in the

periosteal bed is worth while. From the small group of cases so treated it appears that such operations are followed by good cosmetic and functional results and by rapid and complete bony restoration.

The successful use of bone chips in the periosteal bed in these cases brings up the question of application of this principle in other situations where bone must be excised in order to facilitate exposure. It also raises the question whether this method may not prove a simple and successful one in cases of old ununited fractures of the clavicle.

#### CONCLUSIONS

1. Experiences are reported in 4 cases of clavicular resection in which rapid and complete restoration of bony continuity followed replacement in the periosteal bed of bone chips which were obtained from the excised portion of the clavicle.

2. The usefulness of this procedure in explorations requiring resection of a segment of clavicle is discussed as well as certain other possible applications of the method.

#### REFERENCES

1. BARDENHEUER, B. *Deuts. Chir. Stuttgart*, 886, 632, part 1, pp. 438-446.
2. ROBERTS, H. L. *T. Am. Surg. Ass.*, 805, 13, 39-41.
3. COOPER, E. S. *Am. J. M. Sc.*, 850, 38, 395-396.
4. HALSTED W. S. *Bull. Johns Hopkins Hosp.*, 802, 3, 93-94.
5. HOLMAN, E. *Surg. Gyn. Obst.*, 1944, 78, 215-217.
6. SKUMACHER, H. B. *Jr. Ann. Surg.*, 946, 124, 586-592.

# EDITORIALS

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### CANCER OF THE CERVIX

THE two papers appearing in this issue of SURGERY GYNECOLOGY AND OBSTETRICS describing the radiation reaction of cells seen in the vaginal secretion in cases of cervical carcinoma, represent a potential advance in the treatment of patients with this disease. The first paper concerns the distinguishing characteristics of cells exposed to radiation and their differentiation from unirradiated cells both normal and malignant. The second paper indicates a possible method of prognosis in cervical cancers under treatment by radiation. While the patient is still receiving radiation treatment, by examination of the vaginal secretion with special attention to the presence or absence of radiation reaction in the normal cells, a prognosis on the ultimate success of the treatment may apparently be obtained. It may be of basic importance that changes in the normal cells rather than disappearance of the malignant cells is the significant factor in prognosis.

Patients in whom malignant cells were found to persist in the smear for some time nevertheless did well if the normal cells showed an adequate response to radiation on the other hand those patients in whom the normal cells showed no response to radiation did poorly, even though the malignant cells disappeared.

Though admittedly the follow up on this series is too short to justify a final conclusion as to the ultimate prognostic value of the vaginal smear in irradiated cases nevertheless the early work of Gluecksmann and Spear on the one hand and of Warren, Meigs and associates on the other hand would substantiate Graham's observations.

If after a longer period of follow up this method still offers the same prognostic accuracy another definite forward step in the treatment of cervical cancer will have been established. Heretofore it has not been uncommon to find after what was believed to be a satisfactory clinical response to radiation that cancer nevertheless recurred. Until now there has been no practical way of determining the response to radiation at the time of treatment. In patients showing minimal response to radiation by vaginal smear it is possible that roentgen therapy should be abandoned and a surgical attack attempted.

In the past few years the attitude toward radical surgery for carcinoma of the cervix has undergone considerable modification. It is recognized that simple total hysterectomy is not the proper operation. Metastases to lymph nodes may occur early in the disease and therefore this operation is not adequate. Taussig and Bonney have shown that the surgical removal of lymph nodes may cure 1

of 5 patients. Taussig's operation for the transperitoneal removal of nodes after radiation treatment of the local cervical growth has proved satisfactory in the hands of both Taussig and Morton. Recently at the Massachusetts General Hospital and the Pondville Hospital, a retroperitoneal operation has been advocated for the removal of these nodes and this approach has been found more satisfactory than the transperitoneal method of Taussig. The radical surgical operation has been proved to be safe for in our hands one hundred patients have been operated upon without a single postoperative death. The bugbear of ureteral fistula has been overcome by greater care in preservation of the ureter's blood supply.

If Graham's work is corroborated the surgeon is offered an opportunity in radiation resistant cases to operate, rather than wait upon the results of radiation as he has had to

do in the past. Radical operation in the group of patients may salvage a certain percentage that would otherwise be lost. Another possibility is that by the use of the vaginal smear during radiation treatment the radiologist may be able to increase the dosage of radiation in certain resistant cases.

Advances in methods of radiation treatment have also been made and Merritt's work, on the use of the vaginal cone, has been corroborated and advanced by Behney. In a disease for which progress in treatment seemed almost at a standstill ten years ago the outlook is more encouraging. Early diagnosis of cancer of the cervix by vaginal smear as described by Papanicolaou, together with the possible selection of proper cases for radiation or surgery—as suggested by Graham's work—constitute two definite advances in the control of cervical cancer.

JOE VINCENT MILES.

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE second edition of *Mason and Zintel's Preoperative and Postoperative Treatment*<sup>1</sup> is a well balanced monograph concerned with the modern care of the surgical patient. Its greatest value will be for the younger men entering on their surgical service.

The new edition is divided into the general conditions which concern all surgical patients and considerations of the regional and special divisions of surgery. The chapters on care of the cardiac, hypertensive, and diabetic patients are excellent. Others, as the sections on anesthesia and treatment of shock, are very brief and limited in their scope and give only a superficial summary of these subjects.

The indications for use of blood, the technique of typing and discussions of blood grouping are practical and concise. Postoperative pulmonary complications are presented in an excellent manner. The section on the care of superficial burns is mainly devoted to the triple dye treatment, and the use of antibiotics is only mentioned in a casual manner. The bibliography of this chapter is brief and contains only one reference as recent as 1944, four of 1943 and the remaining fourteen to papers written before the war.

The chapters devoted to the surgical specialties or specific regions of the body are generally good and the methods advocated are sound. The sections devoted to the care of the thyroid patient and that on thoracic conditions are practical and broad in their scope, other sections as those on stomach and small intestine, are brief and rather superficial. The chapters on physical medicine and trauma are of little value to a student desiring detailed information on these subjects.

The volume is well illustrated and most chapters include a satisfactory bibliography. The appendix is a helpful guide to the laboratory findings in blood and urine in health and disease. HARVEY S. ALLEN.

HIS thorough knowledge of electrocardiography is clearly reflected in the extensively revised and expanded second edition of Doctor Katz's book *Electrocardiography*<sup>2</sup>. The volume deals rather completely with the entire subject and is one of the best single volumes yet presented on this still young subject. The book is divided into three sections the

first dealing with the theory of electrocardiography the second with a description of the normal electrocardiogram and the tracings characteristic of many pathological conditions and toxic states, and the third section dealing with a description of the arrhythmias.

Of the three sections the first is probably the most difficult to read and understand and some beginners will no doubt become a little discouraged in trying to master this material. The text, however in the second and third section is to be recommended even though at times the discussion tends to become verbose. The handling of the subjects ventricular strain, coronary insufficiency and digitalis effect, with the differential diagnosis of each, is excellent.

Doctor Katz makes three noticeable exceptions in terminology from that recommended by the American Heart Association. They are the use of axis shift instead of deviation, intraventricular block instead of bundle branch block, and the use of first and second degree arteriovenous block instead of incomplete block and incomplete block with dropped beats. These deviations will no doubt be criticized by other authorities on the subject.

The evolution of the electrocardiogram in recent myocardial infarction is exceedingly well presented and illustrated and will be of great value to the beginner as well as the advanced student. Doctor Katz is not in favor of the use of exercise tests etc. in the attempt to diagnose transitory coronary insufficiency. The subject of interference and dissociation remains a difficult subject for the average student to master and a difficult subject for Doctor Katz to present. If the reader however, will carefully read and reread this chapter he will have certainly a fairly good understanding of these complex arrhythmias.

Summary tables are used throughout the second and third sections which concisely present the salient features of normal and abnormal deflections of specific patterns and of various arrhythmias. The author points out in his preface that these will be of value to the beginner indeed even many of the so-called advanced students will welcome these tables.

The electrocardiograms are numerous, excellent and described in detail. However it is unfortunate that in many instances the print is so small that reading these descriptions is difficult. There is an extensive bibliography at the end of each section which adds greatly to the value of this work to the advanced student.

<sup>1</sup>PREOPERATIVE AND POSTOPERATIVE TREATMENT. Edited by Lt. Col. Robert L. Mason, M.C., A.U.S., and Harold A. Zintel, M.D. 2d ed. Philadelphia and London: W. B. Saunders Co. 1945.

<sup>2</sup>ELECTROCARDIOGRAPHY—INCLUDING AN ATLAS OF ELECTROCARDIOGRAMS. By Louis N. Katz, A.B., M.A., M.D., F.A.C.P. 2d rev. ed. Philadelphia, Lea & Febiger 1945.

anatomical clarity for schematic vividness. The treatment of the inguinal region, mesenteries, blood vessels, kidneys and suprarenals is highly conventional, resembling models rather than dissections themselves.

The schematic drawings of the abdominal layers are architectural achievements but take considerable liberty with the true constitution of the parietal laminae.

In the volume on the pelvis and perineum color is again lavishly and helpfully used, but the author's order of plates is seemingly quite haphazard for a section of anatomy in which a knowledge of serial succession is of the fundamental importance. While the layers of the pelvic and urogenital diaphragms are shown in schematic clearness, they are not portrayed accurately. Fascial layers of the perineum are shown in disjunction, not as strata continuous with layers in adjacent regions. The relations of the pelvic viscera to their ligamentous, fascial, and diaphragmatic supports would be of little use in training critical students for the practice of gynecology, urology or proctology.

In the series of plates depicting the anatomy of the thorax, the schematic method is utilized to greater advantage, since much of the important anatomy of the thoracic cage and of its visceral, vascular and nervous contents may be taught from transverse and sagittal sections and from surface projections of organs.

In the sections on the upper and lower extremities, the figures which show the areas of muscular attachment on the bones are fundamentally similar to those found in the standard textbooks, atlases and manuals of gross anatomy. Here the order is the logical one of successive layers, from cutaneous nerves, superficial veins, and fascial sleeves, through progressively deeper layers of muscle. In the simpler figures, for example, those dealing with the synovial sheaths of the hand and foot, the schematic plan is utilized to great advantage but when the same device is employed to show the tendons, nerves, vessels, and muscles, the collection of transected structures forms a somewhat bewildering assemblage.

The colors employed in the illustrations seem unnecessarily garrish. However the reader cannot blame either the author or illustrator for indulging in such innocent gaiety when chromatic feasts of this nature are so rare in the staid history of anatomical illustration.

Taken as a whole, *Illustrations of Regional Anatomy* is a useful adjunct to the student's regular anatomical library. It treats of the kind of anatomy which is customarily presented in charts. Its graphic character is analytical of the standard type illustration or take-apart models found in all fully equipped laboratories. The volumes of figures serve as a link between the standard atlas which the student uses at the dissection table and the blackboard drawings which are regularly a feature of the lecture in gross anatomy.

BARRY ARDOR.

IN the 300 hundred page monograph *Early Ambulation and Related Procedures in Surgical Management* by Leithauser the author reviews the history and development of early ambulation, making a claim for priority. Early ambulation as described consists in requiring the patient to be out of bed for standing, coughing and walking at frequent intervals starting from 4 to 8 hours after operation. These brief periods of activity are separated by longer periods of rest flat in bed. Profound shock, uncontrolled hemorrhage, imminent death, rectus muscle incisions and improperly closed incisions are believed to be the only contraindications to this type of treatment.

Pulmonary, circulatory and gastrointestinal complications are discussed in some detail and are believed to be eliminated or reduced by early ambulation. Psychological and economic advantages accrue under this management.

The author's routine care is described, including types of incision, suture material, and wound closure believed essential if early ambulation is to be used. His personal experience in the case of 509 patients in whom early ambulation was used is summarized. These reports are wholly favorable and a strong argument is made for this type of management.

Many surgeons will find objection to early ambulation in such cases as active peritonitis or empyema of the gall bladder. The method, however, deserves the careful study of all surgeons.

THOMAS C. DOOLAN.

THE moderately sized book *Treatment of Bronchial Asthma* is written by many authors. It is made up of 23 chapters, some of which are excellent and some quite inadequate. The outstanding chapters are probably those on the history of bronchial asthma, statistics, anatomy and physiology, house dust, pollen and fungi, food allergy, parasites, psychogenic factors, differential diagnosis, surgical treatment, complications and cardiac asthma.

The "Treatment of Bronchial Asthma," the title of the book, is hardly adequate. The information given is accurate but insufficient. Indications and directions for treatment are not clear enough for the general practitioner or medical student. It is unfortunate that there are no case reports, and that although directions for treatment of patients allergic to pollens or house dust are given, practically nothing is said about those allergic to horse dander, cottonseed, farm dusts and other important causes of asthma. The use of tetanus toxoid is not mentioned. By including these omissions in a second edition, this book would be a must in the library of all interested in asthma and related subjects.

LEON UNGER.

*EARLY AMBULATION AND RELATED PROCEDURES IN SURGICAL MANAGEMENT.* By Daniel J. Leithauser, M.D. FACS, Springfield, Ill. Charles C. Thomas, 1941.

*TREATMENT OF BRONCHIAL ASTHMA.* By Vincent J. Darbo, M.D., and Hugo J. Engelhardt, M.D. FACS. With chapters by 19 contributors. Philadelphia, London, Montreal J. B. Lippincott Co., 1941.

FROM the University of Havana *Clinica y Laboratorio* is a critical interpretation of the methods used in the clinical laboratory and the results thereof. Sections are devoted to all of the subjects usually considered in a work of this type. In addition, much space is given to the field of mycology. There are chapters on biopsies, allergy tests and medical toxicology which are necessarily incomplete. An extensive bibliography refers to both the English and Spanish literature, and the author frequently appraises the value of the references listed.

Pittaluga's aim is to acquaint medical men with the value of the standard laboratory procedures, and he does not intend to describe in detail all of the methods discussed. When several methods are available for performing a given examination he discusses their relative merits and expresses his preference. To aid the clinician in intelligent utilization of the laboratory background material from the fields of physiology, biochemistry and pathology is supplied.

This book is not to be regarded as a manual of laboratory procedure nor as a complete treatise on clinical pathology but serves well its expressed purpose of acquainting the general medical man with the usefulness of the various clinical laboratory methods.

AURA P. DUKE.

THE compendium *The Chest* by Dr. Leo Rigler provides a review of thoracic roentgen diagnosis and is likewise useful as an atlas for ready reference, since its 350 odd pages are replete with illustrations of superb clarity and photographic excellence.

The entire thorax is not included in specific detail, the heart and diaphragm, for example, are discussed only insofar as they are implicated in considerations of other thoracic viscera or regions. From the stand point, however, of the physician or surgeon interested in chest diseases the field is well covered.

Roentgen examination methods and techniques are concisely presented from the practical viewpoint of the needs of the clinician, the indications, advantages and limitations of each means of study being given. A minimum of technical physical data is included.

Twenty-five pages are devoted to the normal chest, the anatomic variants or anomalies which may have no clinical significance are discussed and numerous extraneous causes for the production of artefacts which should not be interpreted as intra-thoracic lesions are pointed out. Thoracic physiology is briefly reviewed and the principles governing mediastinal shift and mediastinal movements as in obstructive emphysema, are pointed out.

The pathologic conditions presented and discussed include principally those of the bronchi, lungs, mediastinum, and pleura. A brief concise, general presentation of the subject matter in didactic style

precedes the main feature in this volume which is illustrative roentgenograms. A detailed description of these illustrations accompanies them on opposite pages.

If criticism is to be made of this work it would be in the arrangement of the didactic introductory material in its relation to the illustrations. They do not always follow the same scheme of presentation. For example, the discussion of the 'normal chest' is interrupted at page 36 by numerous illustrations to be resumed only on page 44. This factor is minimized by suitable annotations directing the reader to the proper page for preservation of continuity. Errors in the body of the subject matter might be pointed out but they are minor and not consistent.

This volume is beautifully printed, the roentgenograms are faultlessly reproduced, and to have secured such admirably clear cases for illustration and in such generous numbers is indeed remarkable. The purpose for which this material was compiled has been wholly satisfied.

HIRAM T. LAWSTON

A VERY important book for general surgeons and gynecologists has been written by Richard Te Linde.\* He has endeavored to describe nearly all methods of operative approach to gynecological conditions simple and complicated. By using his own artist and also selecting the drawings from well illustrated articles by other operators he has covered the field beautifully. There are very few criticisms possible in a volume of this size and magnitude. The book is unquestionably up-to-date, and all new operative methods are well described and illustrated. It does not purport to be an atlas for besides the illustrations both line drawings and half tones there is an extensive text giving descriptions of the lesions, their symptoms, diagnosis, etiology and treatment.

For the practitioner who is dependent upon text books for aid in attacking a given problem this book gives excellent advice, very satisfactory reviews of the current opinions and sound advice as to procedures, with these are excellent illustrations of the surgical technique. In most texts of gynecology satisfactorily illustrated operative technique is omitted but in this book operative technique is stressed.

This is an excellent book and one that can be recommended with great enthusiasm.

JOS. V. MIXON.

THE small monograph, *Diseases of the Basal Ganglia and Subthalamic Nuclei*, reprinted from the *Oxford Loose Leaf Medicine* has recently been published in attractive book form and it is an up-to-date treatise on a very difficult subject by one of the country's best informed neurologists and investigators of neurologic problems. Anyone who would attempt an elucidation of the subject of disease of

\*CLINICA Y LABORATORIO. By Dr. Orestes Pittaluga. With the collaboration of Dr. Enrique Galan and Dr. Antonio Goernica. Havana, Cuba. M. V. FERNANDEZ, 94d.

\*THE CHEST: A HANDBOOK OF ROENTGEN DIAGNOSIS. By Leo G. Rigler, M.D. Chicago, Ill.: The Year Book Publishers Inc., 1944.

\*OPERATIVE GYNECOLOGY. By Richard W. T. Linde, M.D. Philadelphia, London, Montreal. J. B. Lippincott Co. 1946.

\*DISEASES OF THE BASAL GANGLIA AND SUBTHALAMIC NUCLEI. By D. DIXIE-BROWN, M.D. CH.B., Dr. Phil. F.R.C.P. Edited by Henry A. Christian, A.M., M.D., LL.D., Sc.D. (Hon.), F.A.C.P. (Hon.), F.R.C.P. (Can.). New York: Oxford University Press, 1945.



## SURGERY GYNECOLOGY AND OBSTETRICS

the basal ganglia must necessarily be not only a clear thinking person, but, more simply, a brave man. This work after a brief consideration of the anatomy physiology and pathology of the basal ganglia in man, discusses individually as to definition, etiology history symptoms physical findings course and treatment, the following diseases: paralysis agitans, progressive atrophy of the globus pallidus, the various forms of parkinsonism, hepatolenticular degeneration, dystonia musculorum deformans the athetoid states, Huntington's chorea, and other forms of adult chorea. The discussion of hepatolenticular degeneration (Wilson's disease) is a particularly lucid and instructive one. Though the section dealing with this syndrome occupies only 21 pages, the reader is given full understanding of the clinical signs, and particularly of the pathological changes

in the brain and liver. In that section, as throughout the book, the older, "basic" literature has been studied and quoted freely as well as all the pertinent literature of a more recent date.

This reviewer is left not only with a clearer knowledge of the fundamental signs and changes in the disease states of the basal ganglia, but also with the rather depressing knowledge that while more and more information is added yearly to the knowledge of the causes and effects of these diseases there is still little that can be accomplished by either medical or surgical treatment.

This book is not easy reading. It is not for the casual reader but rather one for the student specifically interested in the subject. It can be used as source material not only because of the original content, but also because of the exhaustive bibliography which is appended.

JOHN HARRIS

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**INJURIES OF THE KNEE JOINT.** By I. S. Smith, O.B.E., M.B., F.R.C.S. (Ed.) J.R.F.P.S. Baltimore. The Williams & Wilkins Co., 1946.

**A PRACTICAL HANDBOOK OF MIDWIFERY AND Gynaecology for STUDENTS and PRACTITIONERS.** By W. F. T. Haultain, O.B.E., M.C., B.A., M.B. B. Ch., F.R.C.P. Ed., F.R.C.S. Ed., F.R.C.O.G. and Clifford Kennedy M.B., Ch.B., F.R.C.S. Ed., F.R.C.O.G. 3d ed. Baltimore The Williams & Wilkins Co., 1946.

**ENDOCRINE FUNCTION OF THE HYPOTHYROID.** By Harry B. Friedgood, M.D. Edited by Henry A. Christian, A.M., M.D., LL.D., Sc.D. (Hon.) F.A.C.P. Hon. F.R.C.P. (Can.) New York Oxford University Press, 1946.

**UNION OF THE STOMACH, DUODENUM AND JEJUNUM.** By Ralph C. Brown, M.D. Sc.D. (Hon.) F.A.C.P. Hon. F.R.C.P. (Can.) New York Oxford University Press, 1946.

**MEDICAL RESEARCH, A SYMPOSIUM.** Edited by Austin P. Smith, M.D., Philadelphia, London, Montreal J. B. Lippincott Co., 1946.

**CONGENITAL ANOMALIES. Clinical Studies of George P. Mink, M.D., F.A.C.S., F.I.C.A.** Edited by James L. Southworth, M.D., and Robert A. Hingston, M.D. Philadelphia, London, Montreal J. B. Lippincott Co., 1946.

**LA CHIRURGIE DU CANCER DU RECTUM.** By G. Gungl, Paris, Masson et Co., Editeurs, 1946.

**TREATMENT OF CANCER OF THE RECTUM.** By Dr. Francisco d'Almeida, A. La Roy, and Ch. Dubost. Editions Médicales Flammarion, 1946.

**GRANDES PROBLEMAS DE CLINICA QUIRURGICA.** By Alfredo Velasco S. Santiago, Chile. Central de Publicaciones, 1945.

**INTRODUCTION TO SURGERY.** By Virginia Kneeland Franks, M.D., and Harold Dorrice Harvey, M.D. New York Oxford University Press, 1946.

**DIAGNOSIS AND TREATMENT OF MENSTRUAL DISORDERS AND STERILITY.** By Charles Mayer, M.D. and S. Leon Inard, M.D. 2d ed. New York, London: Paul B. Hoeber Inc., 1946.

**URGENT SURGERY.** Vol. 1. Edited by Julius L. Schind, M.D., LL.D. Springfield, Illinois. Charles C. Thomas, 1946.

**SURGICAL TREATMENT OF THE SOFT TISSUES.** Edited by Frederick W. Bancroft, A.B., M.D., F.A.C.S., and George H. Humphreys, II, A.B., M.D., Sc.D. F.A.C.S. Philadelphia, London, Montreal J. B. Lippincott Co., 1946.

**LEHRBUCH DER GYNAEKOLOGISCHEN DIAGNOSTIK UND THERAPIE.** Von Dr. W. Neuwider. Berlin, 1946.

**ADOLESCENT STERILITY.** By M. F. Ashley Mott, M.D., LL.D. Springfield, Illinois. Charles C. Thomas, 1946.

**HEALTH INSURANCE IN THE UNITED STATES.** By Nathan S. Sidel, Dr. P. H. Olin W. Anderson, and Melvin L. Doherty. New York. The Commonwealth Fund, 1946.

**THE X RAY TREATMENT OF ACCESSIBLE CANCER.** By D. Waldron Smith, M.D. D.M.R. Baltimore. The Williams & Wilkins Co., 1946.

**MYASTHENIA GRAVIS.** By Dr. Adalberto R. Goll, Baltimore. The Williams & Wilkins Co., 1946.

**MUSCLE THERAPY TECHNIQUES OF MANUAL EXAMINATION.** Lucille Daniels, Marian Williams, and Catherine Worthingham. Philadelphia and London. W. B. Saunders Co., 1946.

**NURSING CARE IN CHRONIC DISEASES.** Edith L. Mink, R.N. S.C.M. Philadelphia J. B. Lippincott Co., 1946.

**OUTLINE OF CYTOSCOPE THERAPY AND DIAGNOSIS.** By George Schilling, M.D. Ann Arbor Michigan. Edwards Brothers, Inc., 1946.

**THE ANATOMY OF THE BRONCHIAL TREE.** By R. C. Brock, M.S. (Lond.), F.R.C.S. (Eng.). London, New York, Toronto. Geoffrey Cumberlege, Oxford University Press, 1946.

**A MANUAL OF TOMOGRAPHY.** By M. Wolbarsht, B.Sc. (S.A.), M.R.C.S. (Eng.), F.R.C.P. (Lond.), F.I.R. (Lond.), D.M.R.E. (Camb.) London: H. K. Lewis & Co., Ltd., 1946.

**DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY.** By Hamilton Bailey, F.R.C.S. (Eng.), F.I.C.S. Baltimore. The Williams & Wilkins Co., 1946.

**LEHRBUCH DER UROLOGIE.** By Prof. Dr. Med. J. Minder Bern, Hans Huber 1946.

**SEX AND WORK.** By W. E. Tanner, M.S., F.R.C.S. His Love and Work. By W. E. Tanner, M.S., F.R.C.S. Baltimore. The Williams & Wilkins Co., 1946.

February, 1947

**SURGERY**  
**GYNECOLOGY AND OBSTETRICS**  
*Supplement*

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# INTERNATIONAL ABSTRACT OF SURGERY

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## COLLECTIVE REVIEW

### ANTISEPSIS AND DISINFECTION IN SURGERY

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ALTHOUGH the application of drugs to wounds was practiced by the ancients it was not until the classic work of Lister (43) that the full significance of bacterial infection in wounds was appreciated. Modern surgical procedures are based on Lister's observations that suppuration does not take place provided access of bacteria from without is rigidly prevented. Oliver Wendell Holmes and Semmelweis, at an even earlier date, had concluded that puerperal fever could be prevented by aseptic precautions.

Lister achieved the elimination of infection from cases of compound fracture by the use of a crude carbolic acid, but not all attempts to prevent infection by this means were uniformly successful, and he later deprecated bringing this corrosive substance in contact with tissues (43).

Ever since the discovery by Pasteur of the bacterial etiology of infections, many substances have been recommended for their antiseptic or disinfectant properties. Each year finds many additions to the list (40). In most cases these represent efforts to provide an ideal antiseptic.

Antisepsis and disinfection are far from being simple subjects, and advances in our knowledge of the basic facts governing the action of antiseptics, together with changing concepts in the approach toward achieving sterilization of wounds, have added measurably to the complexity of the subject. The discovery of sulfonamides and antibiotics has been largely responsible for these developments and an enormous literature has accumulated on many aspects of the problem. Medical curricula

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too often are weak in presenting this subject in spite of its important bearing on surgery.

Many antiseptics are used today solely because of tradition, a matter of habit, or because of current popularity. There is a general misconception as to what can be done to bacterial flora in the tissues by these agents. Since many compounds are used to disinfect surgical instruments or excreta and act as protoplasmic poisons, there are workers who consider all such agents in this category and therefore unsuitable for application to wounds.

In view of the many misconceptions relative to antisepsis and the plethora of statements regarding them, the author will try to present a review of the subject in a systematic manner in the following order:

1. Mode of action of antiseptics.
2. Need for antiseptics and disinfectants in surgery.
3. Those agents producing disinfection by physical means.
4. Antiseptics acting primarily by chemical activity e.g. the surface antiseptics.
5. Antiseptics which act by interfering with the specific function of the bacterium (sulfonamides and antibiotics).

#### MODE OF ACTION OF ANTISEPTICS

The terms disinfection and sterilization are often used as synonyms. The accepted definition is that after disinfection or sterilization there contains no living bacteria, protozoa, etc. Disinfection usually implies the use of agents to destroy micro-organisms. Most of them, by reason of their nature are also

harmful to tissues. Antiseptics are substances which in some cases kill bacteria and in others simply prevent their multiplication, according to the character of the product and its method of use. Thus, an ointment may be called antiseptic if it prevents the multiplication of bacteria, but a mouth wash which remains in contact with the tissues for only a short time must actually kill bacteria to be so labeled.

Few substances are germicidal in body tissues, so that the term disinfectant is reserved for agents used to destroy micro-organisms in inanimate objects or on the intact skin, while the term antiseptic is applied to those substances used to control infection in the body. The term chemotherapy was coined by Ehrlich and it is today accepted to mean the antiseptic use of a substance which inflicts maximal injury on the bacteria and minimal injury on the tissues of the body.

The ideal antibacterial agent would be one which was powerfully germicidal against all pathogenic bacteria in that bodily environment where its action was required but at the same time completely inactive against the tissues of the body. A number of other characteristics are highly desirable, as follows:

**Physical properties.** The substance should be in a form permitting rapid delivery and easy access to the area needed. Thus, it must be soluble in tissue fluids well beyond effective levels and it must be capable of penetrating beyond tissue exudates to the site of the offending organisms. The vehicle in which it is applied must be inert and also release the drug in effective concentrations on contact with tissues.

**Stability.** The substance should be stable on exposure to light, air, temperature changes, humidity and transport.

**Low Toxicity.** It should lack any tendency to irritate tissues or to cause any adverse reaction on general administration.

**Elimination.** It should be easily removed from wounds or dressings when used locally.

**Cost.** The substance should be comparatively easy to prepare at low cost.

It is apparent that no single antibacterial substance so far available meets all these requirements.

For the proper selection of those agents suitable for the various needs in surgical practice it is necessary to understand the chemical, physical, and biologic properties of the substances available. Laboratory tests have been developed to screen lethal tissue poisons from those wherein low toxicity warrants further study.

A number of factors are involved in antibacterial action. The potency of an antiseptic is usually expressed as its *phenol coefficient* which is obtained by dividing the maximum inhibitory dilution of the unknown by that of phenol. Information as to the minimum concentration at which an antiseptic will act in vitro is of value in that it serves as a guide for the selection of a concentration to be used in wounds. If a concentration greater than this minimum found effective in vitro is tolerated by the tissues the antiseptic may be successful. Other factors enter the picture e. g., dilution by tissue fluids. Thus, phenolic compounds are greatly affected by dilution in their germicidal activity whereas the mercurials and the dyes are only gradually reduced in their activity by progressive dilution.

Time and concentration are interdependent and it is well known that if the concentration is increased less time is required for germicidal action. There is, however, a considerable variation in the speed of action between various antiseptics. The hypochlorites and peroxide are quite rapid as compared with the heavy metals and the sulfonamides, the latter being quite slow.

The temperature at which an antiseptic or disinfectant is employed is important, in that a high temperature increases the germicidal potency. This is true particularly in the case of the phenols. From the practical standpoint the use of an antiseptic at high temperatures is not feasible since the solution would either burn tissue or rapidly assume body temperature.

The susceptibility to the action of antiseptics in general varies with bacterial species. Spore formers and tubercle bacilli are quite resistant because of their impenetrability. *Streptococcus fecalis*, *Pseudomonas aeruginosa* and other gram-negative organisms possess considerable resistance to many kinds of antiseptics while gonococci and meningococci are easily killed. Many antibacterial agents show striking degrees of selective action on bacteria. For example, penicillin and gentian violet are strongly inhibitory to staphylococci but only poorly active against most gram-negative organisms. Acetic acid, in a concentration hardly affecting most organisms, readily destroys the *Pseudomonas aeruginosa* which is quite resistant to most substances. A knowledge of selective action is imperative in the proper choice of an antibacterial agent for use against a specific organism.

It is well established that exposure of bacteria to sublethal doses of an antibacterial agent often results in the propagation of resistant and mutant forms that become increasingly difficult to kill.

This factor has very important therapeutic implications such as the advisability of adequate dosage in the early stages of treatment and the change to another agent should habituation of the organism be suspected.

Antiseptics almost invariably are of greater value *in vitro* than *in vivo* i. e. in the presence of body fluids or tissues. The organic matter with which the antiseptic comes in contact consists of plasma proteins, blood cells and foreign bodies such as sequestra and necrotic tissue. These in varying degrees, interfere with the antibacterial action. It is highly important to know how a given antiseptic behaves in the presence of such material and whether any appreciable antibacterial effect remains. All known antibacterial agents are toxic in some degree to tissues as well as bacteria but the toxicity for tissue varies greatly. A number of methods have been devised for testing tissue toxicity. Thus we have a determination of minimal lethal doses by intravenous, subcutaneous, and intraperitoneal injection and the effects after application to the conjunctiva of rabbits. These methods establish the general toxicity of an agent according to the route of administration and the effects of absorption on contact with vital tissues. Such information is most essential for drugs to be administered systemically. When the antiseptic is to be used locally the effects on the skin, muscles, connective tissue and blood cells are of primary significance. The cells of these tissues can be studied histologically in experimental wounds or by tissue culture and the action on leucocytes determined by direct study in the presence of the antiseptic. The relative vulnerability of fibroblasts in tissues is unknown and it is not established that the behavior of one type of cell can be assumed to be similar to that of another type. Howes (34) has devised a very appropriate test for the determination of wound healing following the application of an antiseptic to simular wounds. By serial photographs he establishes the effect on the rate of epithelization in terms of change in the perimeter of an island of epithelium and the effect on the growth of the surrounding granulation tissue. Only by such data is it possible to evaluate accurately the relative toxicity of antiseptics unless they produce gross and immediate toxic effects.

The choice of the mode of application of an antiseptic introduces two problems first how can it be applied to an area so as to exert maximum results and second how can the substance be maintained in the area long enough to achieve the desired results. Aqueous solutions as a rule provide maximum antibacterial action but in such

form solutions intended for the preoperative preparation of the skin require a long time to dry. The use of alcohol as a vehicle produces more rapid evaporation and drying but otherwise it has little advantage. The case of phenol is interesting and it demonstrates the importance of the base or vehicle employed. Aqueous solutions containing 5 per cent phenol are highly toxic to tissues but the same concentration in petrolatum is bland and nonirritating to wounds. Yet because of the greater affinity of the phenol for petrolatum than for water it is released so poorly from the base that the ointment is inert (52). Generally speaking any vehicle other than water causes some loss in antiseptic power although it may be used to secure greater solubility reduce toxicity or in some way to facilitate application. For immediate rapid effects, an isotonic aqueous solution is preferable but for a more prolonged action a number of bases is recommended for example a carbowax water-soluble base<sup>1</sup> a vanishing cream type base<sup>2</sup> or a lanolin type base<sup>3</sup>. To compensate for the slow release of antiseptics from these bases somewhat higher concentrations of the antiseptic must be included than is necessary in aqueous solution. Comparative data are needed to quantitatively express the rate of release of antiseptic from different vehicles in comparison with water (33 36 52).

From these considerations it will be seen that the "ideal" antibacterial agent has not been perfected. Although many compounds are antiseptic *in vitro* each lacks some specific function or property that removes it from the ideal category. Thus, one compound may be outstanding in speed of action while another may have outstanding penetrating power. For the complete evaluation of an antiseptic a multitude of tests is necessary and the results must be carefully considered. It must be determined what concentration can be used, how this is to be maintained and over what period of time the antiseptic must remain in the wound. Other considerations are the changes produced in the bacterial flora of the wound the antiseptic's action on tissue repair (whether it is severely inhibited by organic matter) and the possibility of the production of drug resistance. Esthetic considerations such as staining color and odor may be important (26). It is the stain produced by dyes which makes the use of these compounds unpopular.

<sup>1</sup>Carbowax is trade name for mixture of polyglycols. An excellent base may be prepared as follows: carbowax (4000) 5 parts, propylene glycol 85 parts.

<sup>2</sup>A base of this type recommended by Jenkins may be made: (follows all phase petrolatum, 45. Ailac 10, aqueous phase (100 cc. water q. s. to 100 cc. Ailac) 10 and Tween 80 may be purchased. An excellent lanolin type base can be obtained in the market.

These many variables are difficult to control and often data on each are not available. It is consequently not always possible to establish or state definitely that one agent is superior to another. Manufacturers, by stressing some one point of superiority such as phenol coefficient or low toxicity have introduced an enormous number of antiseptics on the market. It is apparent that some are superior to others and a clinical therapeutic test is undoubtedly the best criterion for selection, provided that one's observations are complete and on a significant number of cases. One should also keep in mind the many variables which make up any group of like surgical cases as pointed out by Meleney (46)

#### NEED FOR ANTISEPTICS AND DISINFECTANTS IN SURGERY

Every surgical procedure requires some measure of disinfection and antiseptics to convert the nonideal conditions to as near ideal as possible. Specifically one tries to prevent the irreversible damage that is associated with the implantation of bacteria with resulting infection and to minimize the damage that ensues once infection has occurred. The surgeon should keep the following points in mind

1. The oral cavity should receive preoperative preparation when oral sepsis is present to minimize the risk of respiratory disease after inhalation anesthesia.

2. The micro-organisms in the gastrointestinal tract should be destroyed or inhibited so that abdominal procedures will entail less risk of infection

3. Infections of the lungs and urinary tract should be prevented or controlled when incident to or following surgery

4. Wounds accidentally produced require prophylaxis. These are all contaminated and therefore potentially infected (3, 54). Such wounds often occur when ideal surgery is impossible because of such factors as time, geographical situation, or anatomical nature of the wound. The need for antiseptics is increased under conditions of war as adjuvants to fundamental surgical steps such as debridement, control of hemorrhage, and drainage.

5. Wounds in which bacteria have already gained a foothold and are producing an inflammatory process require appropriate treatment.

6. Methods for the destruction or inhibition of organisms which have traveled from a portal of entry by the blood or lymphatic systems to other parts of the body (generalized infection) should be instituted immediately

7. All sutures, tubes, drains, powders, and solutions should be sterilized and all organisms contaminating knife blades, scissors, needles, and the like should be destroyed.

8. Air in operating rooms should be sterilized and cross infection eliminated in wards.

9. The micro-organisms on the hands and arms of the surgeon as well as on the skin of the patient at the site of operation should be destroyed.

10. Contamination of gloves or hands after contact with infected material such as dressings should not be overlooked and when it occurs disinfection instituted.

#### THOSE AGENTS PRODUCING DISINFECTION BY PHYSICAL MEANS

**Dry heat or hot air.** Th. Paul has shown that bacteria dried at various temperatures, according to the organism, die partly as the result of an oxidation reaction. Desiccation is also partially responsible. Glassware and instruments which are not affected by loss of temper may be conveniently sterilized by dry heat. This is of value particularly when they should be dry in order to be stored for future use. Powders such as talcum, zinc peroxide, the sulfonamides, and others which possess a tendency to cake on contact with water, oils, and ointment bases may be sterilized by hot air at a temperature of 140° C. or over in order to destroy spores. The temperature is dependent upon the compound since too high temperatures will decompose some substances. A temperature too much above 160° C. will char cotton plugs and covers. A temperature of 140° C. for 4 hours for zinc peroxide and the carbowaxes has been found satisfactory (38). For the sulfonamides from 145° to 150° C. for 4 hours is sufficient. Six hours at 140° C. are frequently necessary for petrolatum or mineral oil which act as protectives to the bacteria.

**Moist heat.** Moist heat sterilizes or kills bacteria by a completely different mechanism than does dry heat. The protein of the bacteria is coagulated by moist heat which leads to quicker destruction. In the case of moist heat the thermal death points of the bacteria also vary. Spores of certain bacilli and clostridia are exceedingly resistant and may live through 110° C. and 120° C. for 10 minutes. In such cases it is necessary to heat for a longer period of time. This applies to the boiling of instruments in water or the sterilizing of linens in a steam autoclave. In an autoclave the objects being processed become water soaked but they can be dried by producing a partial vacuum as soon as the autoclaving process is finished. Ointment bases such as the carbo-

waxes act as protectives to the bacteria against moisture. In such cases the spores are not destroyed by steam sterilization.

**Ultraviolet light** Ultraviolet radiation does not effect complete sterilization but rather a reduction in the total number of bacteria present. The radiations which destroy the bacteria are found in the spectrum from 2 000 to 2 950 Angstrom units and Finsen first treated skin tuberculosis with such ultraviolet radiation. These radiations destroy both pathogenic organisms and those causing decomposition and putrefaction (27) and they are particularly valuable in operating rooms where the effect is rapid. The incidence of operative and postoperative infection can be reduced by 50 per cent with the use of ultraviolet lamps. Cubicles for the handling of septic cases, nurseries, children's wards, and similar departments may also employ ultraviolet radiation. Unfortunately protection against the erythema producing effect on the eyes and skin is necessary.

#### ANTISEPTICS ACTING PRIMARILY BY CHEMICAL ACTIVITY (THE SURFACE ANTISEPTICS)

**Acids and Alkalies** It has been determined experimentally that the maintenance of pH below 5 or above 9 for a specified period of time will allow for the establishment of a state of antiseptics (1). Except in the urinary tract the maintenance of such pH states is difficult, partly because of the powerful buffering and neutralizing action of the tissues and fluids. In the urinary tract it is possible to maintain certain conditions of pH without harm to the epithelial lining. This is accomplished by the administration of mandelates, phosphates, ammonium chloride and similar substances. Mandelic acid is an effective urinary antiseptic.

The antiseptic activity of many acids is directly proportional to the hydrogen ion concentration which they produce in aqueous solution. This is true also of alkalies in that their activity is directly dependent upon the number of hydroxyl ions which are produced. The theory has been advanced that acids and alkalies neutralize the free basic or acidic portions of protein and consequently destroy the bacterial organisms. Some acids exert their bactericidal effects because of the undissociated molecules. Among these are included acetic, lactic, benzoic, salicylic, and mandelic acids.

The strong mineral acids which dissociate readily are not practical because of the fact that they irritate the skin and mucous membranes and are too caustic. Boric acid has been employed for years as a relatively nonirritating although weak germicide for the eyes and for burns. It is a cumulative poison when applied to extensive raw

surfaces and since its antiseptic action is doubtful, other agents would be more efficient (50). Superficial dog bites are sometimes cauterized with nitric acid although some believe it valueless since the rabies virus spreads so rapidly.

The organic acids are much less dissociated and therefore less powerful than the inorganic or mineral acids. Superficial *Pseudomonas aeruginosa* infections are destroyed with weak solutions of acetic, lactic, or propionic acids, preferably in buffered solutions. These acids are also fungicidal. Buffered solutions of these acids are preferable in order to prolong the time of activity as well as their effectiveness. Experiments in vitro have shown that a weak solution of acetic acid requires from 10 to 15 minutes to destroy cultures of the *Pseudomonas aeruginosa*. Thus it is clear that a vehicle is necessary to maintain the agent in longer contact and to inhibit neutralization by tissue fluids. A carbowax base containing 3 per cent acetic acid and 4 per cent sodium acetate is less irritating and possesses a more prolonged action than a 3 per cent solution of the acid alone (53).

It has been stated previously that maintenance of a high degree of alkalinity (above a pH of 9) is not conducive to the life of bacteria. Alkalies possess a solvent action in dissolving proteins and saponifying fats which property is of value in wounds if the agent is continuously applied. The Carrel Dakin hypochlorite treatment is typical of this technique (9). Caution must be observed in such technique since too great an alkalinity is irritating and corrosive to the skin and other tissues (48). Repeated application of mild acids has been found less harmful in animal wounds than that of mild alkalies (35).

**Alcohols** Absolute and 95 per cent strengths of ethyl alcohol are relatively ineffective. The greatest bactericidal power is obtained with a concentration of 70 per cent by weight. The activity is diminished considerably if this is varied (48). In 70 per cent strength only the less resistant bacteria are killed. The property of coagulating proteins which ethyl alcohol possesses, in turn makes it locally toxic to tissues. Consequently bacteria may be protected from its effect. Chloroform and ether will do the same. This coagulation of protein probably is the cause for the decrease in efficiency of other antiseptics when alcohol is employed as the solvent (4). Thus alcohol is not to be recommended in cleansing wounds of bacteria dirt and greases. Experimental work has revealed that spores survive indefinitely in the presence of ethyl alcohol (38). Alcohol is commonly used to sterilize rubber caps of vials but when sporebearing dust has accumulated such an

and emulsifying action. In antibacterial activity they are comparable to tincture of iodine. The concentrations necessary for an antibacterial effect are relatively nonirritating. In one respect the surface activity of the cationics is a disadvantage. In repeated applications to wounds they disrupt tissue elements, and cause hemolysis, and their antiseptic strength is diminished by the protein present. The cationic detergents also are not very effective against spores (48). Surgical instruments may be sterilized and these detergents used for storage of sterilized instruments, provided their ineffectiveness against spores is kept in mind. Corrosion is prevented by the addition of 0.5 per cent of sodium nitrite.

**Halogens.** No two chemicals possess as well known a reputation for active germicidal action as do chlorine and iodine. Their reaction to form combinations with the protein amine groups is responsible for their antibacterial activity. Continual application or constant renewal of applications is necessary since proteins rapidly inactivate them. The hypochlorite solution commonly known as Dakin's solution is usually employed in place of chlorine. As previously mentioned the alkalinity of the hypochlorite solutions is an additional advantage. As a result of the alkalinity they possess a destructive and solvent action on bacteria, pus, necrotic tissue, silk and catgut. The well known Carrel-Dakin technique (9) of irrigation meets the necessary prerequisites of constant renewal. The disadvantages of this treatment are several.

1. Irrigations must be constantly renewed, special apparatus is necessary and the daily change of dressings, even if painlessly accomplished predisposes to recontamination of the wound from outside sources.

2. The surrounding skin must be protected (by petrolatum gauze) or bothersome irritations will occur.

3. An alkalinity of pH 10 must be maintained by buffers, because tissue irritation is marked on either side of this range. Thus, the solution must be made daily and kept in dark bottles, because of its photolability. (The U.S.P. preparation is a buffered solution).

The next compounds to be considered, namely chloramine T, dichloramine T and azochloramid, act more slowly and combine with organic matter less rapidly but their activity is more prolonged, particularly when serum proteins are present. Unfortunately they do not possess the effect on slough that Dakin's solution does (24). They are more stable but are photolabile and must be stored in amber bottles. The problem of azo-

chloramid in relation to wound healing was studied carefully by Anderson. Single applications for several days caused a reduction of the bacterial flora in granulating wounds but not in sloughing wounds. Healing time was not influenced in either type. In *in vitro* studies, azochloramid possesses a synergistic action with the sulfonamides but no proof has been advanced of the synergism in the body.

Iodine has had a wide reputation as an efficient germicide. It is commonly used in the form of the tincture and is one of the most reliable agents for preoperative skin preparation. The chief advantage of the tincture is the rapid drying brought about by evaporation of the alcohol. Although the tincture has been so widely used the aqueous solutions of iodine are gaining in prominence and more reports appear on their highly germicidal action. Lugol's solution U.S.P. is a 1:6.4 dilution has been shown by Nye (49) to be active *in vitro*. For preoperative skin preparation the aqueous solutions possess certain advantages. Kraissl and Melency compared certain aqueous preparations (ethiome, tetraiodine) with tincture of iodine, U.S.P. on guinea pigs. The addition of certain surface active agents to these aqueous preparations causes them to spread, penetrate and dry more quickly than Lugol's solution. Where the tissues are abraded there is no stinging sensation as with the alcoholic preparations. The use of aqueous iodine preparations has been slow as a result of a necessity to choose between proprietary preparations.

There are available certain organic iodine compounds (chuniofon, vioform, diiodoquinone) which possess no antiseptic value in their use as dusting powders on wound surfaces. Extremely low solubility is the responsible factor. Their use is limited mainly to that of antiseptics (36, 48). The penetrating odor of iodoform has long been associated with antiseptics. However its solubility in water or serum is so slight that it is practically inert. No confirmation has been presented that iodine is liberated by iodoform in contact with tissues. Thymol iodide (aristol) possesses no value as a local antiseptic for its solubility in water is still less.

#### *Heavy metal salts and compounds*

**Mercury.** Cells contain sulfhydryl (SH) groups which are coagulated by inorganic mercury salts to form mercury proteinates. Functional enzyme systems are inactivated and deprived of nutritional support by the compound formed. The reaction is reversible and under optimum conditions the proteinate is dissolved and the bacteria are free to resume normal activities. The bacterio-

static action of the mercurials therefore is diminished considerably by the presence of skin blood and wound exudates which contain sulfides and sulphydryl groups. In addition the simple mercuric compounds are irritating and toxic and not safe for use in wounds. Mercuric chloride solutions which are acid in reaction are very slow in their antibacterial action. This coupled to the fact that a small quantity of soap inactivates a whole basin of the solution is a drawback to their use as hand rinses. Sterilization of instruments with these compounds is precluded because of their corrosive action. In the disinfection and storage of mechanically clean catheters, bougies, filiforms, and similar instruments when there is no danger of spore contamination a 1:1000 solution of mercury oxycyanide is used. The germicidal activity of soaps has been increased by the incorporation of alkaline potassium mercuric iodide. The flora of the skin is not appreciably reduced by this compound or mercuric chloride but strangely a sterile cutaneous surface may be produced. Price explains this as being due to the transparent film on the skin under which the bacteria are confined. Multiplication occurs under this film. The bacterial flora present doubles every 30 minutes. Sweating breaks the film and the uninjured bacteria are released.

Merthiolate, a complex organic mercurial and metaphen, a phenyl mercuric compound and related agents do not take a very clear position. They do not liberate readily inorganic mercuric ions, but they possess cations of high molecular weight which opens the possibility of their behavior as cationic antiseptics. Compared with the simple mercury compounds their potency is much greater and their toxicity and irritating power are considerably less. In the presence of serum proteins they retain a fair proportion of their activity but blood and pus inhibit their activity to some extent. They are not suitable for wounds and are not as efficient as is commonly believed for the disinfection of instruments (6). As preoperative skin disinfectants they are widely used. Their slow action (slower than iodine) and their lack of sporicidal action are disadvantages. Johnson (37) has found that merthiolate is unreliable as a preservative for stored liquid plasma.

Silver and silver foil. Metallic silver is bactericidal and is economically practical in the sterilization of water. Very little evidence has been accumulated in favor of the insertion of silver foil into wounds as an application of the principle of oligodynamic action of metals. A compound of silver namely the nitrate, is employed in surgery mainly for canterization. It is also of use in trim-

ming of granulation tissue and warts. Corrosion, astringency, pain and irritation accompany its application. Silver nitrate formerly was used with tannic acid in the treatment of burns. This has been discontinued because it increases the depth of the burn, masks cellulitis and infection and delays wound healing and early skin grafting. Colloidal silver compounds provide antiseptics by the release of very low concentrations of silver ions. In addition they are noncorrosive and relatively nonirritant. These compounds are employed mainly on mucous membranes. Argyria, an irremediable discoloration of the skin or mucous membrane may occur as a result of the use of silver for a long period of time. Solutions of silver should be freshly prepared as they are photolabile.

Bismuth. Mechanical protection of inflamed or irritated surfaces is provided by the insoluble bismuth compounds. Antiseptic action is possessed by certain combinations of phenols and bismuth salts in which the hydrogen in the benzene ring has been replaced by bromine or iodine such as bismuth tribromphenate (Xeroform). This compound is recommended by plastic surgeons to cover areas of skin grafts and donor sites (66). No delay in wound healing has been observed under this dressing. Xeroform is applied in ointment form for which the formula is bismuth tribromphenate 3, petrolatum 95, paraffin 1, beeswax 1. Several layers of narrow mesh gauze in a rectangular tin box are impregnated with the ointment and the whole sterilized in the oven at 140° C for 4 hours.

*Oxidizing agents.* The oxidizing agents act against bacteria by oxidation of the protoplasmic constituents. Included in this group are ozone, the permanganates and peroxides. Agents of this type are particularly effective against anaerobic organisms which are inhibited by a high concentration of oxygen. Proteins inactivate these oxidants and no distinction is made between those of bacteria and of tissues. They must be constantly renewed in order to sterilize unless the effect is instantaneous. Zinc peroxide (U.S.P. medicinal grade) recently introduced, is the only peroxide which has prolonged action.

The powder may be employed as a 40 per cent cream made with sterile water or a 20 per cent ointment made with a carbowax base (55). Both must be freshly prepared. In these vehicles the zinc peroxide will slowly liberate oxygen in a wound for 24 hours. In vitro tests have shown this chemical to be bactericidal to sporulating anaerobic gram positive bacilli, hemolytic streptococci and pneumococci, anaerobic cocci



and bacilli, but not to the staphylococcus or most aerobic gram-negative rods. Many uses have been developed for zinc peroxide in surgery among which are included the following: (1) orally as a mouth rinse and gargle, in Vincent's angina and pyorrhea alveolaris; (2) topically on foul smelling indolent wounds such as ulcerated cervical cancers which are covered by sloughs and produced by gram negative anaerobic nonspore-forming bacilli such as the *Bacillus fusiformis* and the *Bacillus necrophorus*; (3) in conjunction with excision and wide exposure for control of the chronic indolent burrowing ulcers caused by a microaerophilic hemolytic streptococcus; (4) in conjunction with excision of devitalized tissues and wide exposure for control of the spread of bacterial synergistic skin gangrene caused by the symbiosis of two or more organisms; (5) in empyema after evacuation and rib resection when anaerobic mouth organisms are located on the remaining fibrin and adherent slough; (6) around colostomies as a dressing in the perineum after prostatectomies and resections, and in the anal canal after hemorrhoidectomies and fistulectomies; (8) Zinc peroxide does not reach the deep and widespread infiltration of the infection therefore it does not have a material influence on gas gangrene unless the exposure is adequate. Zinc peroxide decomposes into zinc oxide and hydroxide which remain in the wound and provide a disadvantage. In rectal cases their astringency is advantageous. The vehicles in which zinc peroxide is suspended are absorbed or washed away by exudates which causes the chemical to dry. Therefore, the wounds should be protected by layers of water-saturated cotton and several thicknesses of petrolatum or zinc oxide ointment gauze. Although hydrogen peroxide is a weak antiseptic it does have some value in surgery as an aid in releasing sticky exudate-soaked dressings, cleansing surface wounds and like conditions. A mixture of hydrogen peroxide with tincture of green soap is useful in removing crusts and dried wound exudates. The concentrations necessary for potassium permanganate to be effective are irritating and therefore it is no longer recommended.

**Phenols and phenolic derivatives.** Phenol is the simplest of this group of antiseptics. It is soluble to the extent of approximately 6 per cent in water. Because of its great destructiveness to tissues, its use in surgery is limited chiefly to opening furuncles by allowing the phenol on a needle or toothpick to puncture the center of the furuncle and simultaneously seal off the capillaries (bloodless technique). Although more bactericidal and

less toxic, the higher phenolic derivatives are less soluble in water. The cresols, of which lysol (a mixture of ortho-, meta- and para-cresol) is best known, must be dissolved by means of soap in order to be effective. Lysol is three times more bactericidal than phenol and slightly less toxic, but its caustic property renders it unfit for wounds or skin applications. Lysol is chiefly used for the disinfection of contaminated utensils and the scrubbing of walls, floors, and bath tubs. Cresols, unfortunately, are not sporicidal and not very soluble in water; they possess a strong and persistent odor and lose germicidal activity when mixed with too much soap. Hexylresorcinol, rejected by the Council of Pharmacy and Chemistry in 1936 as an antiseptic for the N. N. R. but official in the U. S. P. as an anthelmintic, is highly bactericidal under optimal conditions. It is irritating to tissue and its activity is diminished by organic matter. Thymol is fungicidal and has produced varying results in the treatment of actinomycosis, blastomycosis, moniliasis, and occlusional granuloma. Trinitrophenol, commonly known as picric acid, is not so widely used as a burn dressing and for preoperative preparation of the skin as formerly because of the fact that it is a systemic poison and occasionally causes a severe local dermatitis. A valuable disinfectant with low toxicity for use on inanimate objects is a combination of certain synthetic alkyl and halogen phenolic derivatives known as amphyl. Moderate amounts of organic matter do not inactivate it. Pulaski and Meloney (53) found para-chlorophenol to be most effective against *Pseudomonas aeruginosa* and *Proteus vulgaris* in dilutions of from 1:3,000 to 1:5,000 both *in vitro* and also in the control of superficial and adequately exposed wounds infected with these organisms. A concentration of 0.25 per cent in carbowax base applied once daily is recommended.

#### COMMENT

The many antiseptics that have been presented represent the continued efforts throughout the years to improve surgical antisepsis. Their acknowledged failure as "all-purpose antiseptics" has resulted in widespread pessimism concerning their utility in practice. Two quite opposite trends have developed: first, there are new antiseptics constantly being introduced and used; second, a trend has developed which might be termed antiseptic nihilism. It discredits all antiseptics for use in wounds and recommends the use of agents to stimulate the normal mechanisms of the body in combating the infective process. According to this school of thought only heat and

salt solutions (lymphagogues) should be used such as sodium chloride sodium sulfate and magnesium sulfate

Is it not too much to ask that all the requirements of the all purpose antiseptic be met by a single substance? It is certain that up to the present no chemical has been discovered which effectively combines all of the properties demanded of a general antiseptic, although a considerable amount of time has been spent in search of it, at present the all purpose antiseptic appears to be an impossibility

For many years clinicians and investigators have had a fixed idea concerning a general purpose antiseptic and this idea has been perpetuated by pharmaceutical houses in their advertising. The term itself suggests that there are substances effectively antibacterial against all forms but still sparing the body tissues. Such generalities should be succeeded by the choice of specific substances which perform the best for a specific requirement, which is in essence the concept of chemotherapy. By such means one selects agents having a much greater affinity for the bacteria present than for the tissues of the host so that the micro-organisms can be overwhelmed at minimal expense to the surrounding tissues. It has been pointed out how certain agents can be used with maximum advantage against certain organisms, i.e., they are chemotherapeutic, while others are so damaging to tissue that they can only be used on nonliving matter

The 'physiological school' also falls into similar errors as those who believe in an 'all purpose antiseptic' by limiting therapy to heat and saline solutions, whether passive (isotonic) or active (hypertonic). Although the use of hypertonic salt solutions can hardly be called physiological, both methods commit the same error in disregarding the bacterial flora of the wounds. In their place these methods, like a given antiseptic have value but not universally so

#### ANTISEPTICS WHICH ACT BY INTERFERING WITH A SPECIFIC FUNCTION OF THE BACTERIUM (SULFONAMIDES AND ANTIBIOTICS)

In previous sections those agents which act as antiseptics when locally applied have been discussed. In this section will be discussed those agents which control infection by what might be called systemic chemotherapy. There are many more possibilities for the use of agents of this type than for the others. Chemotherapy by means of the circulation began centuries ago with the treatment of syphilis by mercurial inunction. It has progressed through the ages to the sulfona-

mides and antibiotics for treatment of bacterial infections.

Ehrlich and Shiga in 1904 used trypan red a synthetic dyestuff to cure an acutely fatal general infection in mice due to trypanosomes. Quinine was the only substance ever used before in an analogous manner. Behring's successful use of antitoxin in diphtheria was valuable but serotherapy still did not furnish a universal method of treating bacterial diseases. Thus coupled with the fact that a synthetic organic compound had cured a protozoan infection furnished the incentive for research. Examination was made of the aniline dyes. Gentian or crystal violet was shown by Churchman to have powerful antibacterial action. Morganroth and his associates reported that optochin (an alkaloid of the quinine group) had cured mice whose blood was infected with virulent pneumococci. In the untreated controls a rapidly fatal septicemia occurred. No similar effects had been achieved with any other drugs or organisms in other animals. Antisera, antitoxins, and bacteriophages were introduced but the situation was still not very hopeful.

A Sulfonamides (60) Domagk in 1935 announced that hemolytic streptococcal sepsis in human beings as well as in mice could be controlled by treatment with certain azo dyes. No announcement of any chemotherapeutic agent was ever so startling or so immediately effective in saving many lives. Sulfanilamide was discovered to be the active part of the dye molecule. The new age of chemotherapy which this discovery heralded has led to more fundamental progress in antiseptics as well as to the solution of many problems of therapy. The search for new agents has become more rationalized. The sulfonamides act systemically by confining their action to a specific function of the bacterium rather than by exerting a universal chemical effect such as that employed by the antiseptics discussed in previous sections.

As a result of certain inherent characteristics information on the sulfonamides was rapidly accumulated. Inexpensive manufacture and general use resulted from their comparative chemical simplicity and feasibility of synthesis. This latter factor showed the way for the preparation of many derivatives of the original compound. In vitro study is possible since the sulfonamides do not require the natural defenses of the body for their effect. Not only do they dissociate as acids but the presence of an amino group which can be rapidly diazotized allows for accurate and fairly simple colorimetric tests of concentration in the body fluids. Thus, the calculation of therapeutic

levels is expedited. The mode of action of the sulfonamides is much less definite than are their therapeutic properties and their limitations due to toxicity and ineffectiveness against certain types of organisms. The discovery (67) that p-aminobenzoic acid neutralized the effect of sulfonamides on hemolytic streptococci in vitro and in vivo led to the conclusion that these drugs must displace or block the utilization of an essential metabolite, probably p-aminobenzoic acid from a bacterial enzyme. With this enzyme system no longer able to function the organisms could not utilize food material and were unable to survive. Thus, the fact that the sulfonamides attack a specific function of bacteria was established. This was one of the first successful attempts in the establishment of antiseptics by this method and proved of great biological interest (13).

Phagocytosis has always been an important factor in eliminating infectious organisms from the body. The sulfonamides allow the host to act against the organisms, which is a secondary factor in their activity.

Unfortunately there are substances of importance to the surgeon which also inhibit sulfonamides. Procaine and other related local anesthetics are esters of p-aminobenzoic acid. When injected they decompose into the parent compound. Inhibiting substances are also present in peptones, pus, and necrotic tissue.

Bacteriological diagnosis, proved efficacy, pharmacological properties, and toxic reactions (variety, frequency, and severity) are the factors to be considered by the surgeon in choosing a sulfonamide compound for control of surgical infections. Sulfadiazine is the best drug for infections caused by the hemolytic streptococcus, pneumococcus, meningococcus, Friedlander's bacillus, and also for *Bacillus coli* and other sulfonamide sensitive urinary tract infections. In gonococcal infections, sulfathiazole is preferable. Sulfasuxidine takes precedence in bacillary dysentery and in pre-operative reduction of the gram-negative flora of the intestine. Hemolytic *Staphylococcus aureus*, the enterococcus, and the viridans group of streptococci are comparatively unaffected by sulfanilamide and sulfapyridine. Sulfonamide therapy is ineffective against anaerobic and microaerophilic hemolytic streptococcus infections irrespective of location. Gas gangrene is not prevented nor is its course influenced by the sulfonamides. They are of little value in brucella, pasteurella, and hemophilus (influenzae) infections.

The local treatment of some bacterial infections by means of crystalline sulfonamides has attained widespread use following the report of control of

infection in compound fractures by Jensen, Jarud, and Johnson. Colebrook found sulfanilamide valuable when applied topically to superficial open hemolytic streptococcal infections. As a result of lay publicity on the control of infections in war wounds, the sulfonamides are enjoying popularity as general purpose antiseptics. The local use of sulfonamides has been carefully reinvestigated. When used to greater extent than a dusting of soluble sulfanilamide they may cause irritation, produce exudate, delay healing, and promote the formation of adhesions. Inhibitory necrotic tissue and pus is pronounced. Rapid absorption and toxic blood levels result from the application of more than 10 gm. over extensively wounded or burned areas in a 24 hour period. When continuously applied to intact skin for more than 5 days sensitization may occur. This is exceedingly dangerous since it may prevent the use of the sulfonamides later in an infection spot which no other drug is effective. The focus are serving to reduce the local use of sulfonamides for wound antiseptics. It is now felt that local use of sulfonamides in wounds has no advantage over systemic administration of the drugs.

#### DRUG RESISTANT INFECTIONS

There has been observed in a certain proportion of cases of pneumonia, wounds, burns, meningitis, and gonorrhea that the sulfonamides do not control the infection. Worthy of particular mention are those refractory cases which obviously have the same species of causal organism and clinical features as the responsive ones. Such organisms are believed to be drug-resistant. The infection first is affected by the drug but before it can be controlled the organisms develop resistance. The resistant bacteria in turn propagate resistant bacteria. They still retain their virulence. Variance in defense by the host also plays a part but this cannot be measured readily. In vitro testing of the responses of each patient's strain of organisms to sulfonamides has been developed into a simple technique (25). With this test accurate prognosis of the results can be made and the period of time wasted before recognition that other forms of therapy are necessary is decreased. This in vitro testing promises much for the future for in some infections (fulminating) life is dependent upon the early use of the proper drug.

#### B Substances of Biologic Origin

Nature is a treasure of antibacterial agents. Quinine, emetine, chaulmoogra oil, tannic acid, and many others are plant products. Even cabbage onion, barberry plants, and others have

provided extracts which possess bacteriostatic agents. Chlorophyll has been found of promise in the acceleration of wound healing (59). Many of these substances require further investigation. Selective antibacterial properties are found in substances contained in tissues and body fluids.

Toxins, antitoxins, and immune sera come from animals. The prophylaxis of gas gangrene with such products is not as clear-cut as immunization in diphtheria and tetanus. The specific antibody still retains an important position in the prophylaxis and treatment of bacterial infections. In infections of the gas gangrene and *Clostridia tetani* group bacteria are so actively toxigenic that penicillin and the sulfonamides have very little direct neutralizing effect upon the toxin.

1. **Antibiotics.** Bacteria and fungi recently have attained great prominence as sources of chemotherapeutic agents. Seven groups of microbial products produced from an amazingly large variety of unrelated micro-organisms have been listed by Waksman (64). Included in this listing are polypeptides such as tyrothricin, pigments such as pyocyanin (alpha-oxypyrazine), lipids, such as pyocyanase, organic bases such as streptothricin, simple organic molecules such as hydrogen peroxide and others, such as penicillin. In general, the antibiotics are toxic to animal tissues just as are the synthetic chemical compounds. Many antibiotics have been isolated but only the following 4 show therapeutic promise: tyrothricin, penicillin, streptothricin, and streptomycin. The N.R.R. has approved the first 2. The use of pyocyanase in the local treatment of infections has been discontinued or limited due to its instability, variability of organisms from which it was derived, and lack of information on the conditions controlling its formation.

a. **Tyrothricin.** Dubos (17) in 1931 first extracted tyrothricin from cultures of *Bacillus brevis*, a gram-positive, aerobic, sporeforming soil organism. To this worker should go the credit for renewing the interest in antibiotics. Tyrothricin is a protein (polypeptide) and a hemolytic agent which makes it dangerous if given intravenously. It is ineffective intravenously and orally as well. It consists of at least two substances, gramicidin and tyrocidin. Gramicidin is more active and although hemolytic, is relatively nontoxic for other tissue cells. Several species of gram-positive organisms such as pneumococci, streptococci and staphylococci are susceptible to its action. It is of value in mastoiditis, burns, empyema, superficial ulcers, and similar conditions in which direct contact locally can be ac-

complished. Its limited penetrating powers restrict its use in deep seated infections. Tyrothricin inhibits enzymatic action in the bacteria causing a retardation of growth and lysis of the cells. Saliva, urine, and serum do not inhibit it to any degree. It is greatly inhibited by gram negative bacilli which in mixed infections may even protect the sensitive gram positive bacteria.

b. **Penicillin.** Penicillin is a solid substance extracted from broth cultures of the mold *Penicillium notatum*. The sodium and calcium salts are the forms principally used. Fleming discovered the presence of penicillin in 1929 but it was not applied clinically until Chain and others produced it in sufficient quantity.

Penicillin is a yellowish brown powder and is marketed in sealed ampules. It is unstable in air, hygroscopic, and loses potency rapidly when exposed to heat, alkalis, acids, primary alcohols and oxidizing agents such as hydrogen peroxide. Crystalline sodium penicillin just recently released, is much more stable and can be stored at ordinary temperatures without refrigeration. It is believed that some of the impurities which cause reactions in some patients have been eliminated in this product. Penicillin is extremely soluble in water and saline and dextrose solutions. The potency of penicillin preparations is measured by comparing them with a standard using either the serial dilution method or a modified agar cup technique and a standard strain of organisms.

In penicillin therapy it is necessary to know the infecting organism. Gram-positive cocci and bacilli, spirochetes, gonococci and meningococci are very susceptible but gram negative bacilli and acid fast bacilli are resistant. Enzymes (penicillinases) produced by gram negative bacilli and by certain aerobic, gram-positive sporebearing bacilli such as the *Bacillus subtilis* group inactivate penicillin. It is also rapidly inactivated by certain strains of resistant micrococci. Infections due to pure cultures of susceptible organisms are considerably more affected by penicillin than are those due to mixtures of gram-negative and gram-positive organisms. Penicillin is the least toxic of all known antibacterial substances. Reference was made to resistant strains and acquired resistance under the sulfonamide drugs. These factors are also prevalent in penicillin therapy but to a lesser degree.

Penicillin possesses certain advantages over the sulfonamides. It is less toxic and therefore there is no tendency to cause the side effects observed with the sulfonamides. Large numbers of bacteria, blood pus, peptones, or necrotic tissue products do not inhibit it when applied locally.

In local administration it tends to diminish the exudate rather than increase it. Drug fastness or resistance is less frequently observed. Unfortunately, it possesses specificity of action, is inhibited by gram-negative bacilli and is rapidly absorbed and excreted, which makes frequent dosage necessary. Instability was initially a disadvantage but this has been diminished to a considerable extent.

Oral administration of penicillin in conjunction with alkalies and other compounds has been accomplished and provides a simpler method of maintaining bacteriostatic levels (18). By the oral route several times the parenteral dosage is required to maintain adequate blood levels.

Penicillin is also administered locally or systemically. Parenteral administration for common infections requires a dosage of 100,000 or more units daily, divided into 3-hour doses. For topical solutions or ointments containing 500 to 5,000 units per gram are recommended. Daily instillation of from 10,000 to 20,000 units diluted in from 5 to 10 c.c. of spinal fluid or in 10 c.c. of isotonic saline solution is the average dose by intrathecal administration. Two or three times this dosage and volume are necessary for intrathoracic instillation. Peanut oil or oil and wax suspensions of the penicillin are used to slow absorption on intramuscular injection. For topical application, penicillin powder with dry plasma, or incorporated into an ointment base such as carbowax or purified lanolin, provides a preparation from which the medication is slowly released.

Claviformin clavacin, penicillic acid pyocyanin, fumigatin streptothricin and streptomycin are also antibiotic agents which have been developed with a view to finding an agent which is less specific. Streptothricin and streptomycin are the only 2 which have shown clinical possibilities.

c. Streptothricin. This substance is obtained from *Actinomyces lavendulae*. It showed promise in the early days in the local treatment of infected wounds and burns and in those infections produced by dysentery and *Salmonella* organisms (gram-negative bacterial infections). Its activity is not influenced by blood, serum, peptone, or B complex vitamins and is not destroyed by gastric acidity. However it has been more or less overshadowed by streptomycin.

d. Streptomycin (20, 29, 30, 39, 56, 57). This substance was first isolated in 1942 from 2 strains of actinomyces related to *Actinomyces griseus*. It is soluble in water and possesses a selective action against gram-negative bacteria as does streptothricin, but it is considerably less toxic. Strept-

othricin possesses some effect on fungi which streptomycin does not. Experiments with larvae tests and infections in mice have shown that streptomycin is active against a variety of gram-negative and gram-positive bacteria. Streptomycin possesses an effect, therefore, on such gram-negative organisms as the *Eberthella*, *Salmonella*, *Escherichia*, *Shigella*, *Klebsiella*, *Brucella*, *Pasteurella*, and the *Proteus* groups. Considerable resistance is shown by some strains of *Pseudomonas*. Sensitivity to streptomycin is shown by staphylococci, hemolytic streptococci, and pneumococci, whereas resistance is exhibited by all members of the sporebearing anaerobic group. Streptomycin is more effective when administered parenterally. Orally, sufficient dosage will sterilize the gastrointestinal tract of lactose-fermenting organisms. In order to maintain an effective blood level, streptomycin must be injected frequently since it is rapidly excreted by the kidneys. The average daily dose administered intramuscularly is from 1 to 3 million units divided into 3-hour doses. Streptomycin is indicated in tularemia, influenza, and *Klebsiella pneumoniae* infections and as a supplemental aid in peritoneal and urinary tract infections caused by susceptible gram-negative and gram-positive organisms. It has shown some promise in tuberculosis therapy.

Lysosyme (16, 32) a polypeptide, is obtained from tissues and egg white. It destroys a polycharidic structure of susceptible bacteria. It is possible that other enzymes will exhibit valuable properties in surgery not for their antibacterial activity but because they accelerate digestion of necrotic tissue which provides the greatest inhibition to antiseptics. The bacteriophages were introduced long before the sulfonamides and penicillin. They were used in treating *Bacillus coli*, *Bacillus proteus*, *Staphylococcus aureus* infections and bacillary dysentery. Further investigations of these may reveal new possibilities.

It is with these substances which act by interfering with the essential metabolism of certain organisms that the greatest developments of the future must lie.

#### BIBLIOGRAPHY

1. ALBERT, A. *Lancet*, Lond., 942, 652.
2. *Idem*. *Med. J. Australia*, 1944, 245.
3. ALBRECHT, W. *A. Surg. Gyn. Obst.* (Internal Abstr. Surg.), 942, 75 (518).
4. ANDERSON, D. P. *Ann. Surg.*, 938, 108 (93).
5. BORDET, V., and ALLEN, H. S. *Brit. M. J.* 1944, 2, 10.
6. BREWER, J. H. *J. Am. M. Ass.*, 939, 1, 3000.
7. BROWN, W. E., and Others. *Surg. Gyn. Obst.*, 1944, 78, 173.

- BURT, C. A. V., and PULASKI E. J. *Surg. Gyn. Obst.* 1942 75 765.
- CARRICK, A. *The Treatment of Infected Wounds* New York Paul B Hoeber Inc., 1917.
- CHAM E., and Others. *Lancet*, 1940, 2 226.
- CHURCHMAN, J. W. *J. Exp. M.*, 1912, 16 221.
- CUTLER, E. C. and SANDUSKY W. R. *Surgery* 1944, 16 937.
- DAVIS, B. D. *N. England J. M.*, 1944, 230 734.
- DICKSON, J. A. *Ann. Surg.*, 1943, 118 427.
- DOMAG, G. *Deutsche med. Wochr.* 1935 61 829.
- DUBOS, R. *J. Am. M. Ass.*, 1944, 124 633.
- DUBOS, R., and AVERY O. T. *J. Exp. M.*, 1937 54 51.
- Editorial. *J. Am. M. Ass.* 1945, 127 1129.
- EHRICH, F., and SHIGA, K. *Berl. klin. Wochr.* 1904, 41 329.
- FELDMAN, W. H. and HINSHAW H. C. *Proc. Mayo Clin.* 1944, 19 593.
- FILDES, P. *Lancet*, Lond., 1940, 1 955.
- FISHER, M. *Medical Uses of Soap* Philadelphia J. B. Lippincott Company, 1945.
- FLEMING, A. *Brit. J. Exp. Path.* 1929, 10 226.
- GARROD L. P. *Lancet*, Lond., 1940, 1 978.
- Ibid.* 1940, 1 845.
- GOODALE, W. T., GOULD R. G. SCHWAB, L., and WINTER, V. G. *J. Am. M. Ass.*, 1943 123 547.
- GOODMAN, L. and GILMAN, A. *The Pharmacological Basis of Therapeutics*. New York The Macmillan Company 1941.
- HART D. *Arch. Surg.* 1937 34 874.
- HATFIELD, C. A., and LOCKWOOD, J. S. *Surgery* 1943 13 931.
- HEILMAN F. R. *Proc. Mayo Clin.*, 1944, 19 553.
- Ibid.*, 1945, 20 32.
- HELMERWORTH, J. A., and HOXWORTH, P. I. *Surg. Gyn. Obst.* 1945 80 473.
- HERRILL, W. E. *Penicillin and Other Antibiotic Agents*. Philadelphia W. B. Saunders Company 1945.
- HOWARD, R. W. *New England J. M.* 1945 232 698.
- HOWES, E. L. *Surg. Gyn. Obst.*, 1943 76 736.
- Idem. Personal communication.
- JENKINS, H. P. and Others. *Surg. Gyn. Obst.*, 1945, 80 85.
- JORDON, B. A. *Bacteriological Control of the Preparation of Plasma in Blood Substitutes and Blood Transfusion*. Mudd, S., and Thalheimer W. p. 242 Springfield, Illinois Charles C. Thomas, 1943.
- JORDON, B. A. PULASKI, E. J., and MELENEY F. L. Unpublished data.
- JONES, D. MITCHELL H. J. SCHATZ, A., and WAKEMAN S. A. *Science* 1944, 100 103.
- KLARMAN E. G. *Soap & San. Chem.* 1935 11 87.
- Ibid.*, 1936, 12 95.
- Ibid.* 1937 13 104.
- 40 c. *Ibid.*, 1938, 14 107.
- 40 d. *Ibid.* 1939, 15 111.
- 40 e. *Ibid.* 1940, 16 109.
- 40 f. *Ibid.* 1941 17 104.
- 40 g. *Ibid.* 1942 18 99.
- 40 h. *Ibid.* 1943 19 97.
- 40 i. *Ibid.*, 1944, 20 109.
- 41 KLARMAN E. SHTEKOV V. A., and GATES, L. W. *J. Lab. Clin. M.* 1934, 19 835.
- 42 KRAISS, C. J., and MELENEY F. L. Unpublished data.
43. LISTER, J. *Lancet*, Lond. 1867 Reprinted in *Med. Classics*, 1937 2 28.
44. McCULLOCH, E. C. *Disinfection and Sterilization*. 2d ed. Philadelphia Lea and Febiger 1945.
45. MCINTOSH, J. and SELDIE, F. R. *Lancet*, Lond 1943 1 793.
- 45 a. *Ibid.* 1944, 1 591.
- 46 MELENEY F. L. *J. Am. M. Ass.*, 1944, 124 1021.
- 47 MORGENROTH, J. and LEVY R. *Berlin klin. Wochr.* 1911 48 1979.
48. *New and Nonofficial Remedies*. Chicago American Medical Association 1944.
49. NYE R. N. *J. Am. M. Ass.* 1937 108 280.
50. PFEIFFER, C. C., HALLMAN L. F., and GIBBS I. *J. Am. M. Ass.*, 1945, 128 266.
51. PRICE, P. B. *J. Am. M. Ass.* 1938, 111 1993.
52. PRING, M. V. H., and ERBAUX, L. P. *Canad. M. Ass. J.* 1942 47 344.
53. PULASKI, E. J. and MELENEY F. L. Unpublished data.
54. PULASKI, E. J., MELENEY F. L., and SPARTH, W. L. *C. Surg. Gyn. Obst.*, 1941 72 982.
55. REID, M. R., and ALTMAYER, W. A. *Ann. Surg.* 1943 118 741.
56. ROBINSON, H. J. SMITH, D. G. and GRAESSLE, O. E. *Proc. Soc. Exp. Biol. N. Y.*, 1944, 57 266.
57. SCHATZ, A., BUGIE, E., and WAKEMAN S. A. *Proc. Soc. Exp. Biol.* 1944, 55 66.
58. SCHUMAKER H. B. and BETHRA, W. R. *Surgery* 1943 14 931.
59. SMITH, L. W. *Am. J. M. Sc.* 1944, 207 647.
60. SPINK, W. W. *Sulfanilamide and Related Compounds in General Practice*. Chicago Year Book Publishers, Inc. 1943.
61. SUTTON, R. L., JR. *J. Am. M. Ass.*, 1938, 110 1733.
62. TADNTER, M. L. THROVSEN A. H., BEARD R. K. and WHEATLAKE, R. J. *J. Am. Dent. A.* 1944 31 470.
63. TRAUB E. F. NEWHALL, C. A. and FULLER J. R. *Surg. Gyn. Obst.* 1944, 79 205.
64. WAKEMAN, S. A. *Am. J. Pub. Health*, 1944, 34 358.
65. WALTER, C. V. *Surg. Clin. N. America* 1942 22 333.
66. WEBSTER, J. P. *Plastic Surgery*. In *Textbook of Surgery by American Authors* (Christophers) p. 1583 Philadelphia W. B. Saunders Co. 1942.
67. WOODS, D. D. *Brit. J. Exp. Path.* 1940, 21 74.

# ABSTRACTS OF CURRENT LITERATURE

## SURGERY OF THE HEAD AND NECK

### EYE

Hughes, W. L. and Cole J. G.: Technical Uses of Air in Ophthalmology. *Arch. Ophth., Chic.* 1946 35 535.

The author describes the various uses of air in the diagnosis and treatment of various ocular conditions. In surgical procedures air has been found of value in several ways namely (1) in perforating injuries of the cornea (2) anterior synechias after discussion (3) vitreous in contact with the cornea (4) cataract extraction (5) trephination (6) absence of the anterior chamber after cataract extraction trephination, or similar operations and (7) air goniotomy.

A description is given of a new instrument which makes possible the instillation of air and active treatment of synechias at the same time.

A complete discussion of the author's paper which was read at the Eighty First Annual Meeting of the American Ophthalmological Society (November 12 1945) is included. HUNTER H. ROMANE, M.D.

Parker, F. W., Jr.: Studies on Dark Adaptation in Military Personnel Complaining of "Night Blindness." *Arch. Ophth., Chic.* 1946, 35 555.

With the use of the Nagel adaptometer the author has investigated the complaints of night blindness in a series of military personnel. The findings are summarized as follows:

Sixty six patients were examined with a Nagel adaptometer for determination of dark adaptation. Careful ophthalmological examinations were made and neuropsychiatric consultation was secured when indicated.

Thirty-nine patients in the group complained of moderate to extreme night blindness. Fourteen had no ocular complaints and 13 were patients with hepatitis.

Of the 14 patients with no ocular complaints, all showed normal adaptation curves, and final readings after a period of 45 minutes ranged from 50,000 to 150,000 Nagel units. None had a corrected central vision of less than 20/30 and with homatropine cycloplegia none had a refractive error of more than 1.00 D.

Of the 39 patients complaining of night blindness, 5 with moderate complaints showed normal dark adaptation and 3 of these had more than -1.50 D. of astigmatism. For 6 others with normal readings but with severe complaints detailed histories revealed some incident that had caused the patient to believe that his night vision was inadequate. Of this group, 3 patients were found to have moderate myopic astigmatism.

The remaining 28 of the 39 patients who complained of night blindness had initial low readings, dark adaptation. No cause for this could be found in 5 patients and these men were considered to have true simple hemeralopia. 4 had a pathological condition of the fundus. 5 patients proved to be malingering and 14 were psychoneurotic.

Of the 19 patients who were malingers or psychoneurotic, 11 had corrected vision of 20/40 or better and 12 had refractive errors of above 1.50 D.

HUNTER H. ROMANE, M.D.

Halk, G. M.: The Management of Intraocular Foreign Bodies in Military Practice. *Am. J. Ophth.* 1946 29 815.

The author discusses the management of intraocular foreign bodies in military practice. In all cases of suspected intraocular foreign bodies and multiple wounds of the face, a posteroanterior view of the skull was first obtained, and then a lateral view. The Waters position was used to exclude the confusing shadow of the petrous bone. More accurate localization was then accomplished by two methods: (1) a silver ring introduced into the cul-de-sac (22-24 or 26 mm. in diameter), and (2) accurate Sweet's localization.

In some cases localization of a foreign body was obtained by the use of four small lead beads sutured about the limbus in four different positions. Injection of air into Tenon's capsule before roentgenological examination clarified conditions in which the foreign body had perforated the eyeball and lay just outside the sclera. Fluoroscopy was disappointing.

Prejudiced adherence to either an anterior or posterior incision is unwise. When the foreign body is more than a few millimeters beyond the posterior capsule of the lens, a posterior rather than an anterior incision is wiser.

After the administration of sodium pentothal and anesthesia, supplemented by local anesthesia, the foreign body was approached usually through a new incision so placed as to permit the most direct approach to the object and as near the foreign body as possible because the magnetism of many modern instruments of war is so low that, to be effective, the magnet must be placed near the object.

The author's technique is as follows: After clearing the affected area of conjunctiva, Tenon's capsule, and episcleral tissue a black silk No. 4-0 suture is introduced into the sclera as a retractor. Another suture, No. 7-0, is inserted into the sclera just to one side of the foreign body for a depth of 0.1 mm. while a similar suture is introduced on the same level and depth just to the other side. An in-

cision is made between the last two sutures down to but not through the choroid, and the foreign body is removed by magnet or forceps. The sutures are tied the area about the incision is coagulated with the diathermy needle, and the episcleral tissue and Tenon's capsule are enclosed with silk sutures to avoid superimposing the incisions in the conjunctiva and sclera.

For foreign bodies in the anterior chamber or iris, essence is instilled preoperatively. If the foreign body has perforated the lens and is in the vitreous the corneal opening is made large enough to permit removal and the lens is extracted at a second operation.

The difference between the small and the large magnet is not the increased magnetic attraction of the larger magnet but the increased size of its magnetic field. A magnet should never be brought to the eye while alive. It is introduced into the wound, as near the foreign body as possible, and the applications are repeated.

Enucleation is now a last resort in the management of foreign bodies. Chemical endophthalmitis is not regarded as an indication for immediate enucleation if the foreign body can not be removed. The infection can usually be controlled by foreign protein therapy.

Postoperative care consisted of the application of 5 per cent atropine sulfate sulfanilamide powder 5 per cent boric acid ointment and a binocular bandage. At the end of 2 weeks a pinpoint shield was placed on the uninjured eye. Bed rest was required for 7 or 8 weeks. Penicillin was given in the evacuation or field hospital—25 000 Oxford units every 3 hours until 2 500 000 units had been given.

Canned milk and typhoid vaccine were used as foreign protein therapy.

Modern warfare has caused a greatly increased number of eye injuries but modern therapeutic methods yield a lower percentage of disability than that of previous wars. Exact localization by roentgenological methods is the secret of successful removal of foreign bodies. JOSHUA ZUCKERMAN M D

Gordes, F. C., and Barber A.: Changes in the Lens of Embryo after Rubella: Microscopic Examination of an 8 Weeks Old Embryo. *Arch. Ophth.* Chic. 1946 36 135

Microscopic examination was made of the eye of an embryo 7 to 8 weeks old from a therapeutic curettement performed 3 weeks after the diagnosis of rubella in a 32 year old primipara. The posterior portion of the eye was normal but showed retardation of development and differentiation of the lens.

The absence of the protection offered by the lids and Descemet's and Bowman's membranes in the cornea during the first 3 months of pregnancy may permit toxic agents to act directly upon the lens by way of the amniotic fluid. No cases of congenital cataract have been reported in which the mother had rubella after the third month of pregnancy and this may be explained by the presence of these barriers after that period.

It is of interest to note that there have been reported a total of 170 cases of rubella during pregnancy with congenital defects of the lens in 3 per cent.

WILLIAM A. MANN M D

Bellows, J. G.: Influence of Local Antiseptics on Regeneration of Corneal Epithelium of Rabbits. *Arch. Ophth.* Chic. 1946 36 70.

The influence of antiseptics on regeneration of the corneal epithelium in rabbits is described. The author experimentally removed the corneal epithelium from rabbits eyes and simultaneously treated one eye with a given antiseptic drug and the other eye with normal saline and in every event the antiseptic drug appeared to retard the rate of regeneration. Some of the following drugs were tried: zinc sulfate (36 per cent), merbromin (2 per cent), phenol chloride, mercuric oxycyanide, metaphen, merthiolate, acriflavine, sephiran chloride, penicillin and sodium sulfathiazole.

The author concluded that in the presence of an infection penicillin and sulfathiazole should be used.

HUNTER H. ROMAN, M D

Larsson H.: Results of Radiotherapy of Epibulbar Tumors at Radiumhemmet Stockholm, 1920-1940. *Acta radiol.* Stockh., 1946, 27 338

The results obtained in 66 cases of epibulbar tumors treated with radium at the Radium Institute Stockholm during a 20 year period are reported.

The usual method of treatment was the surface application of a weakly filtered radium preparation. Roentgen treatment in large doses was used in some of the advanced malignant tumors. With the use of surface applications of radium there seemed to be very little damage to the eye. Of the 46 cases treated by this method only one seemed to show a change which might be attributed to irradiation.

Benign nevoid tumors showed the best response to treatment. Of 14 patients with malignant melanoma 7 have been free of symptoms for 5 years or more. The majority of patients were treated by a combination of surgery and irradiation.

Numerous cases are reported in which there was no histological basis for malignancy as the author is opposed to biopsy of epibulbar tumors and believes there is danger of spreading the tumor.

WILLIAM A. MANN M D

Ajo A.: A Case of Chondroma Bulbi. *Brit. J. Ophth.*, 1946 30 465

The occurrence of cartilaginous tissue as a real tumor or even as part of a mixed tumor in a sound eye is very rare. Cartilaginous tissue generally occurs in eyes which have not developed normally or in healthy eyes which have been attacked by destructive disease. Cartilage may arise from connective tissue changes of an abscess in the vitreous or it may arise from the elastic choroid membrane. Hyaline cartilage also occurs in mixed tumors of the lacrimal gland. Two cases of chondroma of the eye lid have been reported in the literature.



fold to occupy the position of the posterior naris. Bilateral complete atresia may cause urgent symptoms at birth and may result in death from asphyxia. Some infants have a cyclical asphyxia which is relieved by keeping the mouth open others learn to breathe with the mouth open and have difficulty only while suckling and during sleep. They may suffer from starvation. In the presence of atresia, the affected side of the nose fills with mucoid discharge but complications due to infection were not common in the cases reviewed. Antral infection and orbital cellulitis were reported in some and adenoid facies developed.

Operative treatment almost always gives relief. Simple opening of the choanae may produce a cure but usually more radical measures, such as removal of part of the vomer are also necessary. The time of surgery varies according to the individual patient. The maintenance of nutrition and the risks of asphyxia may demand operation in early infancy. Various procedures have been attempted to prevent reclosure by granulation tissue. The radical method of choice combines perforation of the partition and removal of the posterior part of the nasal septum. Two cases are reported. A bilateral case in a child of three months who showed symptoms of asphyxia after birth later developed orbital cellulitis and proptosis. The child subsequently died from infection. Microscopic studies of the nasal structures are presented. The second case a unilateral atresia in a male of 24 years, was treated successfully by perforation of the bony atresia by hammer and gouge and enlargement of the opening by bony forceps. The sinuses were clear to transillumination on both sides.

JOHN R. LINDSAY, M.D.

### MOUTH

Fogh Andersen P: Harelip and Cleft Palate. *Acta chir scand.* 1946, 94 3

In Denmark the surgical treatment of harelip and cleft palate has been centralized to *Diakonissestiftelsen's* Hospital, Copenhagen, through the State Institute for Defects of Speech. The natal frequency has been found to be 1:50 per mille (193 to 128,306). Nine per cent of the afflicted were stillborn. 12 per cent died within 10 days of birth. The number of patients suffering from harelip and/or cleft palate is judged to be about 4,000 in Denmark and is distributed as follows: 25 per cent present harelip, 30 per cent, harelip associated with cleft palate and 25 per cent, isolated cleft palate.

The chief causal factor is that of inheritance. In this connection there are two genetically different deformities, i.e., harelip with or without associated cleft palate, occurring most often in men, with a manner of inheritance that is generally of a recessive character (conditioned dominance) and isolated cleft palate occurring most often in women, presenting a dominant manner of inheritance. Empirical figures for genetic prognosis show that eugenic measures are generally unnecessary.

A total of 1,000 patients were operated on by Fogh Andersen from 1934 to 1945. Infants are operated on under a light chloroform anesthetic, adults under local anesthesia. The harelips are treated according to Veau's method when the children are 2 months old. In cases of associated cleft palate, the hard palate is closed at the same time. In bilateral cases each side is treated separately at intervals of from 6 to 8 weeks. Regarding cleft palate the technique varies according to the nature of the case.

Thirty-one of the 726 patients operated on for harelip and 3 of the 537 operated on for cleft palate died after operation. Thirteen of the deaths were presumably due to intercurrent diseases occurring 3 weeks or more postoperatively. 11 of the remaining deaths were due to postoperative hyperpyrexia.

The results of the harelip operations were in the main satisfactory both as regards the primary operations and the corrective plastics. As to the cleft palate operations the author cannot as yet estimate the results. The anatomical result was generally good but he cannot judge of the functional result until the children operated on according to the modern technique have attained the age at which they are summoned for speech lessons at the State Institute for Defects of Speech.

NOAH D. FARRINGTON, M.D.

### PHARYNX

Violé, P: Schwannoma of the Pharynx. *Ann. Chir. Rhinol.* 1946 55 334.

Schwannoma of the pharynx, sometimes called neurinoma or neurofibroma, has been reported only rarely. It apparently develops from peripheral nerve trunks in the neck, is benign and may appear at any age. It is encapsulated, smooth of surface, usually globular and is firm and fibrous unless degeneration has occurred. On section the tumor has a yellowish color and diagnosis depends upon the histological findings. The cut undersurface is glistening, and poor vascularity and the nuclei appear in a palisade-like arrangement. The location is usually anterior to the carotid artery or beneath the upper third of the sternocleidomastoid muscle. Growth is slow and extends over a period of many years. Throat irritation on swallowing may be the first symptom later a Horner syndrome may appear. Normally these neoplasms are radioresistant and do not metastasize. The diagnosis requires a full microscopic study and aspiration biopsy is recommended. Differentiation from a carotid body tumor also of rare occurrence, can be made only on microscopic examination.

JOHN R. LINDSAY, M.D.

### NECK

Ficarra, B. J: Struma Lymphomatosa: A Clinicopathological Study. *Arch. Surg.* 1946, 59 779

In 1912, Hashimoto described a pathological condition of the thyroid, characterized by a diffusely ex-

arged hard gland insidious onset chronic course, al pressure symptoms weakness fatigability and metimes nervousness The basal metabolism is not evated there may be symptoms of hypothyroid n. The disease is usually confined to women. icroscopically there is a dense, diffuse, lymphoid filtration between the follicles, with occasional rmation of secondary (lymphoid) nodules. There no formation of lymphoid sinuses nor of true lymphoid nodules Connective tissue is swollen and orily stained monocytes and plasmocytes may be und. Occasionally connective tissue predominates er lymphocytic infiltration The condition is called ashimoto's disease, or struma lymphomatosa The sease is rare only 5 pathologically proved cases ere found among 720 thyroidectomies in 3 Brooklyn pitals In a fourth hospital among 1218 thy oidectomies 27 cases of thyroiditis were rported and of these the author concluded that not ore than 9 cases could have been struma lympho- atosa

In diagnosis the disease must be differentiated om Riedel's struma, chronic nonspecific thyroiditis ronic specific thyroiditis (tuberculosis syphilis tinomycosis) calcified adenomatous goiter lym osarcoma, and carcinoma. In Hashimoto's dis- e, inflammatory symptoms are absent a specific rganism cannot be found and the gland is hard not ft. Calcified areas are not seen roentgenologically differs from a neoplasm in that there are no pal- ible nodules and the gland is not attached to sur- unding tissue. The superior poles are extremely oad and the pyramidal lobe is enlarged It differs

from Riedel's struma in that struma lymphomatosa is practically always confined to women there is myxedema, glandular involvement is diffuse and bi lateral, adhesions are absent the pyramidal lobe is prominent, fibrosis is circumscribed lymphoid hyperplasia is pronounced, and there are no Dorothy Reed cells.

Subtotal thyroidectomy is the method of treat- ment. Myxedema usually occurs postoperatively if not preoperatively the hypothyroidism should be treated by daily thyroid administration. Post operative recurrence which is unusual, is probably due to inadequate removal of diseased tis. ue.

CLINTON H. THURNES, M D

Larson, K.: Exophthalmic Goiter in Males. *Acta med scand.* 1946 125 71

This article is a review of the cases of exophthal- mic goiter in male patients admitted to the Medical Department of the Rigshospital Copenhagen during the war years

There was a significant increase in the number of males admitted with this diagnosis in the period from 1933 to 1936 male patients made up 12.6 per cent of the total number of exophthalmic goiter patients while in the period from 1941 to 1944 the corresponding percentage was 21

The author was particularly interested in the cases of masked exophthalmic goiter He found that the disease was masked in 26 of the 81 men (32.1%) and in 11 of the 93 women (11.8%) He thus concludes that exophthalmic goiter is masked more often in men than in women F J LEBEMANN JR M D

# SURGERY OF THE NERVOUS SYSTEM

## BRAIN AND ITS COVERINGS CRANIAL NERVES

Kozol, H. L.: *Pretraumatic Personality and Psychiatric Sequelae of Head Injury: Correlation of Multiple, Specific Factors in the Pretraumatic Personality and Psychiatric Reactions to Head Injury Based on an Analysis of 181 Cases*. *Arch. Nerv. Psychiat.*, Chic., 1946, 36: 245.

The author made a detailed study of the pretraumatic and the post-traumatic personality status in 181 civilians with acute head injuries. A clinical quantitative estimate was made of the degree of each of these specific personality factors. It was found that in a number of patients neurotic symptoms appeared for the first time after a head injury. In most patients psychological changes following head injury became most manifest shortly after discharge of the patient from the hospital, and were at a maximum in 3 to 6 weeks after discharge. The duration of post-traumatic symptoms varied but in general they were substantially receding at the end of a period of 3 months. However approximately 50 per cent of the patients showed some persistence of symptoms at 6 months. The duration of incapacity for work paralleled the persistence of psychological symptoms but most patients returned to work before they were entirely free of symptoms.

Patients with pretraumatic psychoneurotic personalities showed a greater proportion of post-traumatic psychiatric symptoms than did patients in other groups. However the patients with pretraumatic normal personalities were closer to the psychoneurotic patients than were members of other groups (psychovariant, psychopathic, etc.).

There was no close correlation between the severity of the acute injury of the brain, the duration of unconsciousness, and the severity of the sequelae but there was high correlation between the existence of persistent complicating psychological factors, such as continuing compensation pending litigation, occupational stresses and persistent associated bodily injuries, and the severity and persistence of psychiatric sequelae. The most frequent traits occurring after head injuries were periodic headaches, fatigability, tension dizziness, emotional instability, anxiety concerning the head, irritability, insomnia, timorousness, abulia, fitful sleep, difficulty in concentration and memory, seriousness, decreased gaiety, excitability, increased need of sleep and the occurrence of nightmares. GEORGE PIERCE, M.D.

Pitts, W. R.: *The Treatment of Penetrating Wounds of the Brain Produced by Missiles of Warfare*. *South. Surgeon*, 1946, 12: 88.

This article is based upon the author's experience as a neurosurgeon with 126 patients presenting penetrating wounds of the brain at a busy evacuation

hospital during the Italian campaign in the war just past. It is one of the clearest, most complete, and generally satisfactory reports to come out of the war in the literature dealing with specific types of skull injury.

Considerable stress is rightly placed upon the absolute necessity of careful preoperative study of the patient for his total injury as well as for his specific brain injury, of x-ray study of the skull, of treatment of the state of collapse (not shock) seen in these patients and the necessity of careful selection of the patients for surgery according to their obvious prognosis. The point is made that the signs of decerebrate rigidity are almost invariably an indication of the early death of the patient, regardless of what surgical care he may receive. Pitts used local anesthesia (1 per cent novocain) in most of his patients, supplementing this only occasionally by intravenous administration of pentothal in the particularly unmanageable patient. A good account is given of what he found to be the most satisfactory manner in which to handle head wounds in general, and his special treatment for wounds of the dural venous sinuses, the paranasal sinuses, and the cerebral ventricles is described in some detail, yet with comfortable brevity. The use of chemotherapy (as it was then available) postoperative care, and the usual complications are discussed at some length. All of his observations are based on sound surgical principles which need not be applied to neurosurgery alone.

The author makes a strong plea that neurosurgery be just as carefully performed under the conditions of warfare as in civilian practice, stating that the ill effects of careless surgery and rough handling of the brain brings its toll in the wounded soldier just as it does in the sick civilian. One can read between the lines of this article and picture some of the difficulties he must have experienced at times in insisting upon and carrying out his principles of meticulous surgery which his colleagues knew were matters of genuine necessity with him. Such an article would have paid good dividends could it have been in the hands of (1) many young neurosurgeons and (2) hospital commanding officers during the past 4 years.

JOHN MARTIN, M.D.

Martin, J.: *The Surgical Problem of Intracranial Aneurysms and Related Vascular Lesions*. *Q. Bull. Northwestern Univ. M. School*, 1946, 30: 165.

In a series of 52 vascular anomalies of the brain, 17 were arterial aneurysms, 10 were arteriovenous fistulas, and 25 were congenital malformations. They were considered as a group because of the fact that they presented several common problems of surgical care.

The factor of trauma is one which must always be considered in the etiology of intracranial vascular

ions. In 2 patients with aneurysm severe head pain may have been a contributing factor and 2 other patients were suspected of having had trauma which could have been the cause of the lesion. The other 13 patients had no such history of trauma. In contrast 6 patients with fistulas had had craniocerebral injuries which were believed without doubt to have been the cause of the lesion, 2 others had had trauma which could have been the cause and the other 2 had fistulas on the basis of congenital maldevelopment. The congenital malformations were so diagnosed because no known trauma or other cause could be discovered for their existence. In none of the 52 patients was syphilis (present many years earlier in 1 patient with aneurysm) believed to be of any significance. The distribution of all three types of lesions according to sex was without significance and the age distribution was wide from 7 to 79 years.

In general the operative treatment of all three types of lesions was as direct and complete as seemed feasible in the light of the dangers to the patient from rough attempts at complete eradication yet it was conservative compared to the methods of treatment at some neurosurgical centers. Of the 9 patients with aneurysm who were operated upon all had carotid ligation in the neck, and 2 had clips placed on the intracranial aneurysm as well. Carotid ligation with good effect was done in 8 patients with a fistula and a ninth patient was subjected to ligation of an anomalous vessel in the posterior fossa. Craniotomy with partial dissection, desiccation and postoperative x ray or radium treatment were done in 21 patients with congenital vascular anomalies; 2 other patients were subjected to carotid ligation in the neck. A table summarizing the symptoms and treatment of all 52 patients is appended to the original article.

An attempt is made to clarify some of the confusing terms which have heretofore been used to describe the wide variety of congenital vascular anomalies of the brain. Instead of such terms as angioma, cavernoma, cavernoma, and discolored angioma, the lesions have been classified in their simplest anatomical terms.

JOHN MARTIN, M.D.

### SYMPATHETIC NERVES

Lowbotham, G. F.: Migraine and the Sympathetic Pathways. *Brit. M. J.* 1946, 2, 319.

The author has postulated that the pain of migraine is probably due either to spasm or dilatation of the arteries of the scalp and dura mater and that the sensory arm of the painful pathways lies in the ophthalmic portion of the trigeminal nerve. He presents the theory that a migrainous person is born with an unstable mechanism in the hypothalamus which reacts excessively to the many stimuli that may reach it, either from the cerebrum or through the blood stream and thus causes explosive or dysrhythmic messages to be conveyed to the large blood vessels of the head. It is true that the large vessels

of the head are supplied with motor fibers from the efferent side of the autonomic nervous system, so that if disordered impulses from the hypothalamus are transmitted to the vessels concerned through the motor autonomic pathways, theoretically at least, relief should be obtained by section of those pathways.

Four cases of migraine all with operative treatment are presented. In 3 patients who obtained complete relief the operation consisted of removal of the lower half of the upper cervical ganglion stripping of the common external and internal carotid arteries so as to effect a perarterial sympathectomy (leaving the carotid body isolated but still in place) and then complete ligation and section of the external carotid artery. There was produced, of course a full blown Horner's syndrome on the side operated upon. In the fourth patient in whom the entire upper cervical ganglion was removed relief was only partial and the pain recurred. The author believes that in that particular patient the unstable mechanism may lie in the vessels themselves and not in the hypothalamus, or that an error was made in removing the whole and not just the lower half of the ganglion. The physiological basis for the last possibility is not explained. JOHN MARTIN, M.D.

Berry, R. L., Campbell, K. N., Lyons, R. H., Moe, G. K., and Sutler, M. R.: The Use of Tetraethylammonium in Peripheral Vascular Disease and Causal States. *Surgery* 1946 20, 523.

Recently a new method of producing blockade of the autonomic ganglia by means of parenteral injections of tetraethylammonium bromide has been introduced and the authors report deals with the use of the drug in peripheral vascular disease and causal states.

Observations were made upon the recumbent patient with the extremities exposed to controlled room temperatures. The color and the temperature of the skin and the volume of the pulses were noted in the basal state. Tetraethylammonium bromide was then given either intravenously (100 to 500 mgm.) or intramuscularly (on the basis of 30 mgm. per kgm.) one half of the total volume being injected into each buttock. The latter route was used only on patients under observation in the hospital. Intravenous injection of the drug caused a metallic taste within 20 seconds, a "cool sensation" in the extremities with definite increase in skin temperature and incomplete dilatation of the pupil with loss of accommodation. One minute after injection the systolic and diastolic pressures tended to fall particularly in the hypertensive individual, and there was an increase in the pulse rate. The vasoconstrictor gradient in the extremities was abolished so that toe and thigh temperatures assumed the same level.

In a series of 55 comparative tests of peripheral blood flow both on patients with peripheral vascular disease and on a control group it was stated that in 52 instances tetraethylammonium bromide proved equal or superior to the usually accepted methods of

producing sympathetic block such as paravertebral sympathetic block, spinal anesthesia, and sympathectomy.

In a study of 16 patients with functional angiospastic disorders (Raynaud's disease, 8; acrocyanosis and livedo reticularis, 4; Raynaud's disease with scleroderma, 4), there was a marked rise in skin temperature and an improvement of the clinical picture. In general it did away with the necessity of paravertebral blocks and was of aid in establishing the diagnosis by disclosing the presence of a functional vasoconstrictor component.

A group of patients with organic obstructive vascular disease (thromboangitis obliterans, 18; peripheral arteriosclerosis obliterans, 55) were observed. Eleven of the patients with Buerger's disease were treated with repeated sympathetic blocks by the drug of these, 5 are free from symptoms. The remainder of the patients treated conservatively have exhibited a satisfactory decrease in signs and symptoms but have had too brief a period of treatment for evaluation of the end results. However, in all of the cases the exercise tolerance was definitely increased. Fifty-five patients with peripheral arteriosclerosis obliterans received tetraethylammonium bromide, and from the results obtained it was concluded that one could prognosticate the value which might be derived from lumbar sympathectomy. Many of this group received relief from their nocturnal pain, a relief in some cases even greater than from morphine.

Causalgia, post-traumatic edema, or reflex sympathetic dystrophy was diagnosed in 17 patients. In these there was usually a transient and occasionally a sustained relief of pain on administration of the drug. In addition, it was stated that the drug aided in establishing a diagnosis of reflex dystrophy.

Apparently the drug relieved vasoconstriction by block of the sympathetic ganglia in 9 cases of thrombophlebitis—deep in 6 cases and superficial in 3. However, the effect was extremely variable in duration, ranging from a few hours to several days.

The authors have cited in detail at least one case of each of the types of peripheral vascular dysfunction treated with tetraethylammonium bromide in order to illustrate its effects. They state that they have used the drug 1,000 times in 500 patients without a significant toxic disturbance and add that most

toxic effects, reported elsewhere, have been of a transient type probably being related to some peripheral circulatory collapse which can be readily corrected by an injection of epinephrine.

RICHARD C. SCHREIBER, M.D.

De Takats, G., Graupner, G. W., Fowler, L. J., and Jemik, R. J.: The Surgical Approach to Hypertension. Second Report. *Arch. Surg.* 62, 53-111.

The surgical treatment of hypertension is presented by the transdiaphragmatic method of Smithwick. Including the preoperative and postoperative care is discussed in considerable detail. The method of work up is described, as well as the criteria used by the authors as a basis for the selection of cases suitable for operative treatment.

Preoperative medication and anesthesia are discussed in some detail—points which the authors believe are of considerable importance in the operative procedure. The method of operation is also described in detail with illustrations, as well as the method of renal biopsy used by the authors.

A detailed follow-up system has been employed, and a summary of the results is tabulated. Cases have been divided into three groups: (1) those in which there was a clear cut indication for operation as indicated by preoperative studies; (2) those in which the operative indications were relative and debatable; and (3) those in which there was primary and malignant hypertension, which cases were regarded as not suitable for operation.

In 17 patients in the first group the response was considered very good, and in only 2 was there recurrent hypertension, which was corrected after completion of a technically incomplete operation. Six patients showed recurrence in the second group. These recurrences were analyzed, and reasons were found for the organic irreversible lesions which could be detected preoperatively.

The authors concluded that at this time no single combined method of treatment can be identified as one which would give rigidly selected patients with hypertension as much benefit as the transdiaphragmatic splanchnic nerve section combined with dorsal lumbar sympathetic ganglionectomy.

HOWARD A. BROWN, M.D.

# SURGERY OF THE THORAX

## CHEST WALL AND BREAST

Mont E. S.: A Two-Stage Mastopexy in Plastic Surgery of Markedly Enlarged Breasts. *Ann. Surg.* 1946 124 112

The author states that of necessity excessively enlarged breasts often require surgical help. Frequently because of the marked increase in size a one-stage mastopexy is impractical to obtain the desired results, two-stage procedures frequently do obtain the desired results.

The purpose of surgery is four fold: (1) to obtain small breasts with reasonable size, shape, symmetry, and contour; (2) to construct two nearly identical breasts; (3) to obtain intact nipples and other areolae in the desired position; (4) to avoid loss of tissue following surgery.

When breasts are of exaggerated size the two-stage operation will meet all of these requirements and reduce variations to a minimum. Because such large breasts are usually functionless the prime purpose of the operation is to obtain small breasts of the desired proportions. A two-stage operation with re-implantation of the nipple may be utilized in such cases.

The author describes a two-stage technique with a great number of illustrations, and summarizes it as a method which allows for plastic reconstruction of excessively enlarged breasts with a minimum danger of losing any tissue. At the same time the procedure presents sufficient elasticity so that the surgeon may create small breasts of the desired proportions from an exaggerated deformity. Gentleness in handling tissues, meticulous surgery, careful planning of the surgery, and a knowledge of surgical anatomy are presupposed.

PAUL MERRILL, M.D.

Jorgensen, C. D. and Stout, A. P.: Granular Cell Myoblastoma of the Mammary Gland. *Ann. Surg.* 1946 124 218.

Although granular cell myoblastoma is most commonly seen in the tongue, it may occur almost anywhere in the body and at any age. The authors have observed 5 cases in the mammary gland. Here it must be distinguished from carcinoma which closely resembles it.

These 5 cases are described in detail because the authors believe that they illustrate certain features which may be of aid in the diagnosis of myoblastoma of the breast. The authors believe this condition of the breast to be a benign tumor but agree that it is impossible to ignore the fact that it may on occasion become malignant and metastasize. They believe that this condition occurs in the breast and produces the symptoms of early carcinoma, for which it may be mistaken and the breast needlessly sacrificed. The myoblastoma is easily recognized in a good frozen section.

EMIL C. ROBINETTE, M.D.

Sjövall, H.: The Clinical Picture and Therapy of Rib Tuberculosis (Zur klinik und therapie der rippen tuberkulose). *Acta chir. scand.* 1946 94 33

The author has chosen for his discussion a series of 75 cases of tuberculosis of the ribs, observed at the surgical and orthopedic services of the University of Lund between the years of 1919 and 1938. The series was chosen because it permitted an adequate follow-up. Of the 75 patients, 45 were males and 30 were females—a ratio of 3 to 2. The average age of the patients in this series was 39 years which is far higher than the average age of a similar group of patients with extrapulmonary tuberculous lesions other than of the ribs. In this regard some significance may be attached to the fact that most of the patients were derived from a rural district where bovine tuberculosis was not uncommon.

The cases of rib tuberculosis fell into two main groups: in one group the rib involvement was but a part of a tuberculous process and in the second group the rib involvement was the primary and sole site of the disease. Thirty-one or 41 per cent of the patients had another clinical tuberculous lesion while in 16 there was a site of bone or joint tuberculosis.

Since the prognosis in rib tuberculosis is generally considered to be good it was a surprise to the author at the time of investigation to find that of his series of 75 patients 34 or 47 per cent had died. Moreover of the dead 62 per cent had died of tuberculosis.

Etiologically it was interesting to observe that 13 patients gave a definite history of trauma preceding the onset of the symptoms by a day or a week, and in half of these a palpable tumor was discovered within a week of the trauma. The authors feel that the occurrence of the injury merely called attention to the area of involvement in these patients. The symptoms were pain or the presence of a tumefaction. In 2 of the cases, the differential diagnosis between the lesion and breast cancer was considered. In 1 case there were acute symptoms which simulated a cholecystitis. In most instances, however the process took the form of a typical cold abscess. The roentgen film was most productive, the diagnosis being established roentgenologically in 21 patients.

Sixty-one of the patients were treated surgically. Three methods were used: simple incision, incision plus curettage, and resection of the involved segment of rib. In all 3 groups, reoperation was necessary in some of the cases but the smallest number of reoperations were required in those patients who had been subjected to rib resection. In this instance, the rib was resected and the wound closed primarily. Of 44 patients so treated, healing occurred either by primary intention or soon thereafter in 31. Recurrence developed in but 3 of this group. However 20

of the patients were dead at the time of this review. Among these were the unhealed and recurrent cases. Furthermore the poor results in the last group were largely among those patients who had manifest tuberculosis in other parts.

The authors conclude that rib tuberculosis is best treated by rib resection but even with this treatment the prognosis both for healing and for eventual life should be guarded. WILLIAM C. BECK, M.D.

### TRACHEA, LUNGS, AND PLEURA

Gartillet, E., Grasseet, and Houel, J: Hemothorax Walled Off by a Fibrinous Deposit; Impenetrable Hemothorax (*L'hémithorax cloisonné à dépôt fibrineux, hémithorax impenétrable*). *J. chir., Par.* 1946, 63, 5.

The problem of hemothorax has never received the attention that it deserved in the surgery of pleuro-pulmonary wounds; it has received surgical consideration only when it was thought to be septic. The problem of the evolution and sequelae of hemothorax is examined by the authors, especially as it develops into the so-called "clotted hemothorax" which cannot be evacuated by thoracentesis because it is surrounded by a tough impenetrable fibrinous wall.

The recent war has revived the problem of the clotted hemothorax. It has been estimated that between 10 and 20 per cent of hemothoraces evolve into this pathological entity.

In the clinical X-ray study of traumatic hemothorax one sees an opacity at the base or lower third of the chest which may be resorbed in the space of 2 to 4 weeks if no infection occurs; this density may occur as high as the sixth interspace or higher and may be accompanied by pneumothorax and pulmonary embarrassment. Pulmonary collapse with out effusion is suggestive. Symptoms are those of a pleural effusion—cough, pain, dyspnea—but generally they are not so severe. During the early stages these hemothoraces may be punctured and evacuated, but after 8 or 10 days, if no infection supervenes the situation may be very different. Although even then a complete evacuation of the bloody fluid may be accomplished, one may also encounter an impenetrable hemothorax. Clinically and roentgenologically the signs are identical with those of simple hemothorax, and the dry tap alone reveals its presence. Perhaps only a few cubic centimeters of fluid are evacuated from a cavity that appears massive in the roentgenogram. The opacity may be mistaken for a congested lung, but this may be ruled out by lack of physical signs and by failure to evacuate fluid by thoracentesis.

Surgical exploration regularly reveals astonishing and characteristic lesions. On opening the thorax, one finds thick cords and strands of fibrous tissue forming a mass between the lung and pleura and enmeshed with blood. The lesion has the appearance of a vaginal hematocoele—it indeed is an immense hematocoele—and thus a dry puncture is explained.

When the hematocoele is removed with the finger and a knife, one finds a well delineated cavity. The adjacent lung does not lose its ability to re-expand; the re-expansion can be accomplished by insufflation. After the twentieth day, however, exploration with a knife reveals the existence of a rigid fibrous wall 3 mm. thick which must be excised to free the lung. It is important to emphasize that the pleura and lung parenchyma are normal under this capsule.

With regard to the pathogenesis of this lesion, it must be emphasized that the blood which escapes into the pleural cavity does not clot, and at first acts as fibrinogen. However, the amount of fibrinogen in the hemothorax increases slowly and the blood takes on a fibrous character. Time is an important factor in its development, although not all hemothoraces are destined even in time to undergo fibrous change and become walled off. English authorities have postulated a humoral mechanism set off by the puncture wound which prevents coagulation. However, the authors believe that an almost attenuated infection is the important factor in its development. This low grade infection sets up a reaction in the fibrinogen-rich serous surfaces of the pleura which accounts for the fibrous character of the lesion.

Bacteriological studies in 17 cases revealed the presence of bacteria in these lesions—streptococci, staphylococci, and other gram-positive bacilli. There has been a definite increase in the incidence of walled-off hemothorax since the advent of sulfonamides and penicillin; the generalized use of which has attenuated many strains of bacteria, all of the patients had received either one or the other drug.

In some cases these hemothoraces eventually become absorbed, but in other cases serious sequelae (retraction of the thoracic cage, scoliosis, or reduction in vital capacity) occur after some months. This has been observed in several cases followed up since World War I. The authors conclude that a known case of walled-off hemothorax demands prompt surgical intervention.

The surgical procedures which may be employed are three: thoracentesis, thoracotomy and decortication. To wait longer than a day or two before thoracentesis is done allows the walling off process to occur; the fear that an early puncture will result in a new hemorrhage is unfounded, as the authors experience has shown. Sometimes a seroalbuminous exudate appears following an initial puncture, or a new density is seen in the roentgenogram, this calls for a new puncture and a search for organisms. The most optimum time for thoracentesis is the third day but this is not always practicable in the emergencies of war. Several successive punctures may be done and spaced from 24 to 48 hours apart, or a closed trocar may be left in place and the chest tapped successively with only one initial puncture. Lavage of the pleural cavity with physiological serum aids in clearing up the lesion.

A walled-off hemothorax which cannot be evacuated by thoracentesis is a definite indication for

thoracotomy. Generally if it is done under 10 days it is sufficient to evacuate the fluid, remove all adhe- sive fibrous strands and clots with the hand within the pleural cavity and re-expand the lung by insufflation. A drain is left in place.

If the patient is seen from 15 to 20 days after the injury then one may predict that the pleural cavity is lined by the strong fibrous shell described and the lung incapable of expansion (proved by a trial in insufflation). The fibrous wall must then be removed by careful dissection, i.e. the lung must be decorticated until it re-expands under insufflation. Although penicillin has reduced the risks of postoperative infection decortication is still a formidable procedure and can generally be avoided if thoracotomy and early cleaning out of the thoracic cavity is done.

PHILIP B. CHASE, M.D.

Moore R. L.: War Injuries of the Chest. *Ann. Surg.*, 1946 124 367

Chest wounds comprise from one fourth to one-third of all battle casualties and about one twelfth of the wounds of soldiers that survive admission to medical units. The relatively low mortality rate for chest injuries in the present war as compared with all previous wars attests to the high quality of the therapy applied.

The proper treatment of thoracic wounds demands that the physiological alterations which accompany them be well understood. These may be due to (1) open pneumothorax, usually associated with sucking wounds of the chest wall (2) tension pneumothorax (3) surgical emphysema either superficial or mediastinal and (4) cardiac tamponade. All or any of these may be associated with a chest injury. Therefore it is most essential that they be kept in mind when a patient with a chest wound is first examined. All of them may be serious and if overlooked may lead to deaths which could have been prevented. The initial treatment of thoracic injuries consists mainly in combating shock, the proper care of the wound and correcting these physiological disturbances.

Open pneumothorax. The high mortality which followed early open drainage in the streptococcal empyemas of the last war was later proved to be due to the ill effects of the open pneumothorax that was produced by operation. When this method of treatment was changed and the pleural fluid in the early cases was evacuated by repeated aspirations rather than by open drainage the mortality fell from about 50 per cent to about 5 per cent.

When a hole is torn in the chest wall by a shell fragment or bullet, the effect is exactly the same as that of the establishment of open drainage in the early or acute stages of an empyema. Air is sucked in through the opening with each inspiration. The intrapleural pressure rises and the expansion of the lung is reduced. In order to compensate the patient breathes faster and with greater effort and this in turn rapidly leads to exhaustion. Open wounds of this kind so-called sucking wounds, should be

closed as soon as possible. Experience has shown however that closure by suture is inadvisable unless all of the necessary surgery has been completed. When the existing facilities are inadequate for this, or trained personnel is not available, treatment in general should be limited to first-aid measures namely control of shock control of hemorrhage, ex- cision of devitalized and soiled tissue, and removal of readily accessible foreign bodies. The wound is then covered with a pad of vaselined gauze. This is either sutured to the skin, or strapped in position with ad- hesive plaster. In most instances this method will suffice until the soldier can be delivered to a suitable hospital for definitive operating.

Tension pneumothorax. When a lung is pierced or torn or more rarely when a bronchus is lacerated air may repeatedly be sucked into the pleural cavity during inspiration, and trapped. The opening act- ing as a ball valve allows the air to get in, but does not allow it to get out. Under these conditions, the intrapleural pressure steadily increases and the re- sulting tamponade effect may reach alarming pro- portions and seriously interfere with both pulmonary expansion and the filling of the right side of the heart. This leads to severe dyspnea and in extreme instances to acute circulatory failure evidenced by a falling systemic pressure, a high venous pressure and a weak rapid pulse, pallor and sweating. In civil practice this condition known as a tension pneumo- thorax, is occasionally seen after pneumonectomy or lobectomy when the closure of a bronchial stump or lung is insecure or gives way in the presence of infection. It may also follow rupture of an em- physematous bulla. It is more likely to be due to laceration of the lung or bronchi by fragments of broken ribs. The immediate treatment is very simple. The pressure can be relieved quickly by in- troducing a needle with a flange, which can be readily strapped to the chest wall. If such a needle is not available, a flange can be improvised by using an ordinary cork. The needle is inserted through the cork which in turn is fixed to the chest wall with adhesive strapping. The second intercostal space in the midclavicular line is a convenient location for introducing the needle. If left in position the needle should be connected with a water-seal.

Surgical emphysema. Surgical emphysema is superficial or mediastinal. The superficial variety may result from laceration of the lung by in-driven rib fragments or penetration of the lung by a missile. In either case air escapes into the subcutaneous tis- sues, either directly from the lung at the site of an adhesion or indirectly through the medium of an interposed pneumothorax. From the chest wall the air may spread upward to involve the tissues of the neck and face, or downward to the abdominal wall or even to the extremities. The diagnosis is readily established by the crackling sensation which one gets on palpating the involved areas and the air in the tissues is easily recognized on roentgenograms. The condition rarely demands any special treatment be- cause the opening in the pleura usually becomes



sealed after a short period of time and the air in the tissues is readily absorbed. If the pleural opening does not close however and the condition becomes progressive and causes symptoms, relief should be obtained by introducing a needle into the pleural space for the escape of the air.

Mediastinal emphysema is a much more serious condition because air escaping into the mediastinum does not find a ready outlet and there is serious danger of compression of the great vessels and even the esophagus. Here the air escapes from a lacerated trachea or large bronchus and tends to spread toward the neck.

This condition is readily recognized from a soft swelling in the suprasternal notch and the diagnosis can be confirmed roentgenographically. Radical treatment is indicated only when the symptoms of compression are severe enough to endanger life. Treatment is directed toward relief of pressure. A thoracotomy may be necessary followed by incision of the mediastinal pleura and suture of the lacerated bronchus or trachea.

Cardiac tamponade. Cardiac tamponade refers to acute cardiac compression caused by the rapid accumulation of blood or exudate within the pericardial sac. Since the pericardium is a dense, fibrous, relatively inelastic membrane it is not distended appreciably by an acute increase in pressure. The pressure of the fluid obstructs the filling of the heart and the blood is dammed up in the great venous reservoirs of the body. Should the intrapericardial pressure equal the effective venous pressure, the blood can no longer enter the right auricle and death follows. The clinical picture is that of circulatory failure.

In chest injuries, the syndrome is caused by intrapericardial bleeding which usually results from a stab wound in the front of the chest to the left of the sternum, in the third or fourth interspace. The source of the bleeding is most likely to be the right ventricle or the anterior descending branch of the left coronary artery.

Treatment demands the greatest haste, to relieve the pressure and to stop the bleeding. The time required for roentgenologic and fluoroscopic examinations, and long preparation might mean the difference between life and death.

Hemothorax. Hemothorax occurs in 70 per cent of all chest injuries in modern warfare. Notwithstanding, the treatment has been a subject of much discussion. Some have advocated extreme conservatism, aspirating only to relieve pressure or pain. Others have advocated aspiration with air replacement, and still others, aspiration alone. This latter method, with a view toward emptying the pleura as quickly and completely as possible, is now widely approved as the treatment of choice.

When a hemothorax cannot be controlled by aspiration because of clotting, the proper treatment is an early thoracotomy with evacuation of the blood clot. The treatment of chronic hemothorax by excising the fibrous membrane covering the under

lying lung appears to have reduced the incidence of chronic empyema in the present war.

Wounds of the chest wall. The treatment of wounds of the chest wall does not differ from the treatment of similar wounds in other parts of the body except that chest cases should have a high priority among battle casualties, and should be taken as quickly as possible to an installation with complete anesthesia and operative facilities, preferably one with personnel experienced in thoracic surgery. Endotracheal anesthesia should be used in all intrathoracic procedures, and facilities for suction should be available. The wounds should not be sutured until all of the surgery, necessary at the time has been completed. Suturing then should be directed primarily toward closing the pleura. When it is necessary to approximate muscle and fascial layers of the chest wall these structures should be sutured loosely. The skin and subcutaneous tissue should be left open.

Penetrating wounds. The treatment of through and through bullet wounds of the chest which cause slight pulmonary damage and do not injure any blood vessels or other important structures consist mainly of the treatment of hemothorax.

Penetrating wounds with retained foreign bodies. In treating these injuries the risk of the operative procedure which would be required for removal of the foreign body has to be balanced against the risk of complications which are likely to develop if the foreign body is left in place. Experience has shown that pieces of clothing and fragments of bone are especially likely to lead to serious infection and effort should be made to remove these. On the contrary metallic foreign bodies are well tolerated. Nevertheless, it is thought that these should be removed also when they are large (diameter of 1 cm. or more) and causing symptoms, when free in the pleural space with hemothorax, or because of their position, considered to be a threat to vital structures such as the heart, esophagus, and large blood vessels.

Thoracoabdominal wounds. Whenever a missile penetrates the thoracic cavity the possibility of its having traversed the diaphragm and entered the abdomen must always be borne in mind. This is particularly important if the thoracic wound is low, in the region of the diaphragm. Roentgenograms of the abdomen as well as of the chest should be taken regularly. When operation is being planned, careful consideration should be given to all the facts relative to both the thoracic and abdominal wounds. There is no standard procedure that can be applied in all cases.

Infected war wounds of the chest. The treatment is as follows: (1) pleural and pulmonary separation are forestalled by early operation (within 6 to 10 hours) removal of foreign bodies, local and systemic use of the sulfonamides or penicillin, and leaving the superficial layers of the wound in the chest wall open, (2) infected hemothorax in the early stages is properly treated by aspiration. Thoracotomy with no resection (open drainage) should be postponed until

the pleural exudate is definitely purulent and (3) pulmonary or pleuropulmonary suppuration secondary to retained foreign body should be treated first by drainage. STEPHEN A. ZITMAN M D

Wylie, R. H. Hoffman, H. L. Williams, D. B. and Rose W F: The Thoracoabdominal Casualty. *Ann. Surg.* 1946 124 463

This report reviews the case records of 903 thoracoabdominal casualties in the Forward Hospital of the second Auxiliary Surgical Group during 1943-1944 and 1945.

The term thoracoabdominal wound refers to a wound produced by a missile perforating the diaphragm and entering the pleural and peritoneal cavities. Casualties in which the pleural cavity and peritoneum have been entered by separate missiles without injury to the diaphragm are excluded. Thoracoabdominal wounds comprised 25.5 per cent of the abdominal cases treated surgically at this hospital.

The pattern of entry of the fragments or bullets in thoracoabdominal wounds shows that 837 of the missiles entered through the abdomen. The entrance wounds in the chest were equally distributed on the right and left sides.

The intelligent regimen of resuscitation and treatment depends on the early recognition of the thoracoabdominal feature of the wound. For practical purposes any perforating fragment which crosses the horizontal zone bounded by the plane of the costal margin and twelfth rib below and the line between the nipple and the angle of the scapula above may perforate the diaphragm. When a penetrating wound was present, roentgenological examination was a necessity. Further clinical examination of the casualty was directed at an evaluation of the cardiorespiratory status. However in thoracoabdominal wounds less time could be devoted to stabilization of the cardiorespiratory physiology than in the purely thoracic cases. Of prime importance in combating shock and saving life in thoracoabdominal wounds is early operative treatment. Examination and all necessary preoperative therapy were done in the so-called shock tent.

With the movement of the casualty from the shock tent to the operating tent by stretcher the operative phase of management begins. It deals with the anesthesia, pathology operative approach and procedure. In nearly all cases maintenance anesthesia was achieved by endotracheal ether and oxygen in a closed circuit. Injury to the lung was described as contused, containing hematoma, or as perforated or lacerated. Because of the path of the missile through the lower part of the chest in the diaphragmatic zone, the peripheral portions of the lower lobes and less frequently of the middle lobe and lingula of the left upper lobe were injured.

The injury to the diaphragm was a single or double small perforating wound, the large lacerated wound, or the avulsion of the diaphragm from its chest wall attachment. Similar to the chest wall, the right and

left sides of the diaphragms were wounded quite equally.

In the peritoneal cavity the liver took the impact of the missiles entering through the right diaphragm. In order of frequency the right kidney, the colon, the stomach, the small bowel, the duodenum, and the gall bladder were wounded on the right side.

The anatomic relationships below the diaphragm have a direct bearing upon the operative approach and procedure on the right or left side. Any discussion of methods of approach must be qualified at the onset by the statement that no one approach is ideal for all patients and the judgment of the surgeon who knows the individual patient and his own capabilities decides the approach to be used by himself. In general when a thoracotomy and celiotomy were both contemplated the chest procedure was performed first, because the patient stood a celiotomy better after the chest wall and diaphragm had been closed and the lung re-expanded. How much surgery should or can be done through the chest and diaphragm, and how much through the abdomen again depends upon relative factors.

Thoracotomies as performed, were of four types: (1) a limited thoracotomy achieved by extending the missile wound; (2) a thoracotomy through the area of the wound; (3) a thoracotomy outside the area of the wound; and (4) a so-called combined thoracoabdominal incision, in which the thoracotomy was extended through the costal arch and down through the abdominal musculature.

The closure of the diaphragm is of utmost importance both on the right and left sides. Suture of the left diaphragm is imperative to cut off the path of contamination and infection from the peritoneal cavity and to prevent herniation of the abdominal viscera into the pleural cavity. It is, likewise mandatory to close the right diaphragm to prevent the occurrence of bile pleuritis and empyema, and also to keep contamination and infection from invading the pleural cavity. A firm closure was insured by interrupted silk sutures.

Specific treatment of individual organs of the abdominal cavity revealed that wounds of the stomach and duodenum were sutured, wounds of the colon were exteriorized, wounds of the small bowel were treated by suture or by resection and anastomosis of the spleen by splenectomy and of the liver by subcostal drainage. Wounds of the kidney were treated by nephrectomy only when hemorrhage was persistent, or the pelvis involved otherwise drainage sufficed. Treatment of the pancreas was by suture and drainage, or by drainage alone. The celiotomy incision was either a right or left rectus, and closure invariably entailed some type of retention suture.

The postoperative care of the patient with a thoracoabdominal wound entails attention to details of care common to both the chest and the abdominal patient.

The postoperative care of the chest is directed toward maintaining cardiorespiratory balance, promoting expansion of the lung and removal of blood

and air from the pleural cavity to allow full expansion and to minimize the chances of pleural thrombus formation.

The postoperative care directed at the abdominal part of the wound emphasized the importance of nasal tube stomach siphonage, up to 4 days, in accord with the re-establishment of peristalsis to the surgeon's satisfaction. Use of stomach siphonage indiscriminately beyond the period of 4 days may veil a bowel obstruction, and delay recognition and correction of it.

An accurate knowledge of the daily intake and output of the patients is imperative. During the period in which nasogastric siphonage was in use between 2,000 and 3,000 c.c. of 5 per cent glucose in saline solution were given to these patients daily. Caution should be exercised in giving a total amount of parenteral fluids in excess of 3,000 c.c. daily because of the impaired cardiorespiratory reserve which may exist and the possibility of producing pulmonary edema.

Sulfonamide and penicillin therapy were employed from the time of wounding through the postoperative period. Complications recorded in order of frequency were atelectasis, empyema, subphrenic abscess, and pneumonia. Bronchopleural fistula was reported 4 times, twice with empyema, and twice with bile empyema. Pressure pneumothorax occurred in 3 instances as a postoperative complication.

The gross mortality for the 993 cases with thoracoabdominal wounds was 246 or 27.3 per cent.

STEPHEN A. ZIEGLER, M.D.

Sheets, L. M., and Doud, E. A.: The Management of Thoracic and Thoracoabdominal Wounds in the Forward Areas in the Sicilian and Italian Campaigns. *J Thorac Surg* 1946, 15, 305.

The method of treatment and the immediate results of 64 thoracic and thoracoabdominal war injuries with wounds limited to the chest wall, are reported. The cases were selected from a group of 500 patients who had been treated by a team of the Second Auxiliary Surgical Group during a 20 month period commencing with the invasion of Sicily. The patients were evacuated from this first priority field hospital to the chest center of a base hospital in from 8 to 15 days following emergency surgery; therefore the results are uncorrected for the development of subsequent complications and for lethality of concomitant wounds.

Bullets tended to involve more than one celomic cavity and, because of wobbling or high compression wave, to cause contusion of organs and extensive pulmonary hematomas. High explosive fragments have greater tearing action.

Preoperative intercostal nerve block covering two segments above and two segments below the wound in the chest wall, permits a painless cough to clear the tracheobronchial tree. If cough is inadequate endotracheal catheter suction is used at once. Intravenous fluids are given only after an open air

way is established. Hemopneumothorax, encountered in 159 of 500 cases was treated by immediate thoracostomy with autotransfusion of striated citrated blood, when feasible. True, progressive tension pneumothorax was rare in this series, perhaps because air leaks were sealed by hemostasis at the site of the tear. Sucking wounds were closed with large occlusive petrolatum pads. After resuscitation, fluoroscopy for position of the mediastinum for cardiac tamponade was done. Roentgenograms can usually be made in the upright position.

Intra-abdominal injury can be postulated from the position of the wound of entrance, position of the missile, and failure to respond to shock therapy. Deep shock occurs in intraperitoneal hemorrhage, a gross contamination of the left pleural cavity by contents of the large bowel, in shattered spleen, or in wounds of the right lobe of the liver. Immediate exploration is indicated after insertion of a Levine tube in the stomach.

Surgical treatment of penetrating and perforating wounds is based largely on the presence or absence of continued intrathoracic hemorrhage, and steps from local debridement and closure to extensive surgical procedures. Rarely is thoracotomy done because of the presence of missiles. They are removed if convenient, or if they lie in a position which is dangerous to life—the hilus of a lung, the mediastinum, or near the esophagus. Torn pulmonary parenchyma is rarely sutured.

Traumatic thoracotomy arbitrarily means evacuated wounds, palm sized or larger involving the pleural cavity. Treatment is designed to eliminate paradoxical motion and permit closure, without tension, with nonabsorbable material for fixation against cough until the wound is solid, gross contamination notwithstanding.

Thoracoabdominal wounds in which a single missile involves the pleural cavity, diaphragm, and peritoneal cavity are discussed as left and right sided penetrating and perforating wounds, and the optimum surgical approach for each is outlined.

The technique of approach to mediastinal structures, the control of hemorrhage, and the details of mediastinotomy are presented. The prevention and treatment of infection of the subscapular space in chest wall wounds is considered. The progress in combined thoracic and spinal cord injuries, with the level of anesthesia higher than the umbilicus, was found to be hopeless because of paralysis of the neck and ineffective cough.

The postoperative goal is a completely expanded lung. It may be achieved by the anesthetist in conjunction with pleural lavage at the time of closure, and maintained in the presence of a clear tracheobronchial tree. Energetic cough routine is supplemented by intercostal nerve block when pain is an inhibitory factor. Tracheal toilet with catheter rotation and bronchoscopy are freely used postoperatively. Oxygen may be used for short periods.

With an open airway established, endotracheal anesthesia with pentothal or nitrous can be induction

is used with ether for maintenance. Endotracheal catheter suction during surgery to prevent spill-over of secretions and postoperative bronchoscopy are essential.

LYNN JOHNSON M.D.

D'Antona, G. G., and Fojanini, G.: Pleural Complications in the Course of Suppuration of the Lungs (Sulle complicanze pleuriche in corso di suppurazione polmonari). *Policlinico sez. chir.* 1946 53 45 91

In abscesses of the lung the pleura may become involved by direct extension, or through the lymphatics if the abscess is near the surface. In the lung the lymphatics near the surface run toward the pleura while the deeper ones run inward, but in deeper abscesses the lymphatic current may become reversed by its being blocked and carry infectious material to the pleura. And of course, in operation on the lungs infection may be disseminated.

From November 1938 to October, 1943 198 cases of suppuration of the lung were admitted to the University Hospital of Rome. Among these 61 (30.8%) presented pleural complications of various types and in 7 of these the complication was bilateral which made the total number of complications 68. The mortality of pleural complications in these cases was 8.53 per cent, the total mortality being 26.6 per cent. There was a total of 52 deaths 17 of them, or 32.6 per cent, from pleural complications. Of the deaths from pleural complications 6 or 35.2 per cent, were due to simple empyema and 11 or 64.7 per cent, to putrid empyema. In 4 other cases the pleural complication was not the direct cause of death death being due to hemorrhage in 3 cases and to diffusion of the lung process in 1 case.

The localization of the pleural complications is discussed in detail and illustrated. Histories of a number of the cases are given.

In only 1 of the cases was the empyema bilateral. It has been claimed but not demonstrated that there are direct lymphatic communications between the two sides of the pleura. It is true that the empyema may mask an unrecognized lung abscess and although such abscesses can be located by roentgen examination, this is not always true and it may be necessary to make the diagnosis from the history. Serofibrinous pleuritis are generally benign and have a marked tendency toward spontaneous absorption. A rise of temperature after operation which is prolonged and tends to reach a considerable height indicates the possibility of a developing pleural complication. Puncture of the pleura should be performed very carefully in such cases. If the fever persists for too long it indicates the transformation of a serofibrinous pleuritis into a purulent or putrid one. In serohemorrhagic pleuritis, puncture gives a red fluid.

In seropurulent pleuritis the pleural reaction is more intense and the clinical picture more marked. The fever is higher and remittent and the patient's general health is affected. The exudate may increase to such an extent as to cause dyspnea and symptoms from displacement of the mediastinum. The course

is longer than in the preceding forms. In purulent pleuritis the patient has violent pain in the affected side of the thorax and dyspnea. The general condition grows worse rapidly. The physical signs are very marked in these cases. In putrid pleuritis the symptoms are much the same but more violent there may be severe toxemia as the process progresses.

Roentgen examination is used to differentiate between sacculated pyopneumothorax and suppurative lung cavities. Illustrative roentgenograms are given. Lung cavities are generally situated in the peripheral part of the organ, most frequently in the lower right lobe. When infectious material is aspirated it passes more readily into the right bronchus than the left because the former follows more nearly the direction of the trachea. Large areas of air and fluid are more apt to be of pleural than of pulmonary origin. If fragments of tissue project into the clear area they are apt to be of lung tissue and the condition is a lung cavity. The surface is smoother in hydrops of the thorax than in lung cavity. In empyema beyond the limiting band the lung tissue is normal while in lung cavities the passage from diseased to normal tissue is gradual. The angle of the circular shadow with the wall of the thorax is acute in pneumothorax and obtuse in cavity. There is no absolutely certain differential roentgen sign between these two conditions but a number of signs which taken altogether generally suffice for differentiation. In making the roentgen examination the patient should be placed in the position he will assume on the operating table: anteroposterior and laterolateral views are taken.

In order to decrease the very serious mortality in this condition there should be close collaboration between the physician, surgeon, and roentgenologist. The patients should be sent to the surgeon at once without waiting for pneumothoracentesis or treatment with sulfa drugs or arsenobenzol after roentgen examination operation should be performed at once, preferably by the technique of free thoracotomy.

AUBREY G. MORROW M.D.

Dahl Iversen, E., and Möller P. E. The Differential Diagnosis and Treatment of Tuberculomas in the Lung. *Acta chir scand.* 1946 94 243.

The problem is posed as the differential diagnosis of an isolated tuberculous process in the lung and a tumor, an infected cyst, and a chronic lung abscess. It is shown that the differentiation of these conditions even under the most ideal conditions, is extremely difficult or impossible without exploratory thoracotomy. Three cases are presented in great detail to show the difficulties encountered. A fourth case was diagnosed as unilateral cavernous tuberculosis with roentgenographic changes suggestive of carcinoma. The suggestive findings in this case proved erroneous on exploration.

The pathological picture in these cases was that which is clinically termed tuberculoma and which pathoanatomically is called a conglomerate tubercle. The lesion occurs often in the basal part of the cerebrum in the cerebellum and the pons and in the

spleen. The authors state that they have been unable to find a description of this lesion in the lung in the newer texts of pathological anatomy.

It is stated that tuberculomas of the lung should be removed and that the operation of choice if the pleural cavity is free, is lobectomy because resection of the lung carries the risk of tuberculous infection of the pleura from the resected surface. This statement is not based on experience with regard to the course of nonoperated pulmonary tuberculomas but on the fact that the course of tuberculoma in other sites is one of progression. One of the cases cited tends to show this.

The roentgenologist presents his view of the subject and without the history, physical findings and laboratory data his task is next to impossible. Lung tumors may be polymorphous and they can be confused with many other pulmonary conditions. The differential diagnosis from tuberculosis in its various forms often has to be considered and in many cases cannot be positively resolved by this method of investigation. In view of the authors' experience thoracotomy has been necessary for definitive diagnosis.

EDWIN W. PASSARELLI, M.D.

### HEART AND PERICARDIUM

Gilchrist, A. R.: Ligation of the Ductus Arteriosus. *Edinburgh M J*, 1946 53 346.

Forty patients ranging from 4 to 51 years of age came under observation for a patent ductus arteriosus. The diagnosis was confirmed by operation in 19 of them. Four patients were found to have an infection superimposed upon the anatomical defect. Of these 1 patient succumbed shortly after admission and 3 patients were operated upon. A brilliant result was obtained in 1 case but a fatal outcome attended the other two interventions.

Thirty-six patients had no evidence of superimposed infection. Of these 16 were operated upon a second operation being done on 1 patient because of recanalization of the ligated ductus within 2 months. One patient was not benefited, 2 patients died and the condition of 13 was materially improved.

The clinical and radiological features of the condition are described. The continuous, or "Gibson" murmur is almost certainly present by the age of 5 years even though it may be absent before that age. The accentuated pulsations of the pulmonary artery the forceful contraction of the left ventricle at fluoroscopy and the behavior of the blood pressure after exercise are elaborated upon.

Cases having evidence of an infection of the pulmonary artery or ductus are believed to constitute definite indications for surgical intervention. Evidence of such infection lies in the presence of septicaemia usually with cultures positive for streptococcus viridans and signs of pulmonary involvement such as multiple infarcts superimposed upon the signs of a patent ductus.

In the noninfected cases ligation should probably be recommended if there is no evidence that the

ductus is closing spontaneously in patients up to 15 years of age. After the age of 10, ligation is recommended if impairment of function is noted, and after the age of 20 it is justifiable for threatened heart failure or grave symptoms.

Brief allusion to detail of the surgical procedure made and illustrated case reports are appended.

HAROLD T. LAMSON, M.D.

Mercer, W.: Patent Ductus Arteriosus and Its Surgical Treatment. *Edinburgh M J*, 1946 53 341.

The author describes in brief detail the surgical procedure employed. An anterior incision is not usually entering the pleura in the second interspace. The phrenic, vagus and recurrent laryngeal nerves are visualized and spared. The management of the ductus itself follows the techniques of Gross and Touraoff. Dissection is kept preferably against the aorta. Overlapping of the ductus by the adjacent pulmonary artery or by an extension of the pericardium is occasionally noted.

The explanations for recanalization are referred and the technical steps designed to prevent this are pointed out. The author apparently uses unbraided silk sutures or ligatures, but does not practice division of the ductus.

Attention is called to the changes in blood pressure which occur as a result of ligation, and the sometimes dramatic clearing of the blood stream of organisms in the infected cases is pointed out.

HAROLD T. LAMSON, M.D.

### ESOPHAGUS AND MEDIASTINUM

Wellin, S.: A Contribution to the Roentgen Diagnosis of Limited Esophagitis. *Acta radiol., Stockh.*, 1946 27 461.

The occurrence of nonspecific inflammatory changes in the esophagus has long been recognized but neither the pathological anatomy nor the roentgen details of the entity has received any extensive systematic investigation until recent times.

The postmortem examinations have revealed that the changes discovered occurred *intra vitam*. The possibility that gastric juices enter the esophagus after death and cause changes consistent with esophagomalacia acida had to be ruled out. Microscopic studies however clearly proved that the changes were inflammatory and that a definite esophagitis existed. Some maintain that even various stages—acute, subacute, and chronic—can be distinguished. The changes are confined for the most part to the lower esophagus. They may be confused with an ulcerative esophagitis but others think that they do not seem to fit into any of the usual classifications. The process is essentially an inflammatory one causing deep changes in the walls which eventually lead to a spasmlike stenosis. The symptoms easily and frequently mislead to a diagnosis of cancer of the esophagus.

Wellin reports 9 cases in patients ranging from 16 to 82 years of age. The dominant symptoms were 1



Fig. 1

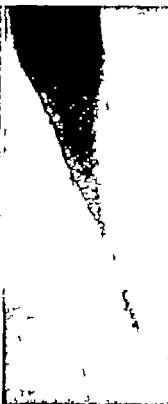


Fig. 2

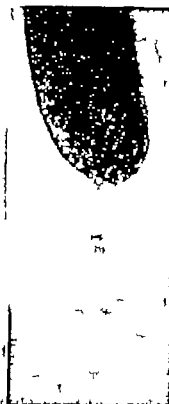


Fig. 3



Fig. 4

Fig. 1 (Welln.) The initial stage of the disease, showing the coarse outline of the mucous membrane.

Fig. 2. The florid stage showing the typical changes, elongated funnel shaped constriction of the distal part, fairly distinct superior boundary, notched contour and dilatation above.

Fig. 3. Two years and 3 months later. The patient has now reached the final stage. The stricture at this stage of the disease is more pronounced, and the "funnel" greatly shortened.

Fig. 4. Pronounced constriction and distinct limitation of florid stage.

progressive dysphagia, frequently at first merely a feeling of some obstruction behind the lower part of the sternum to the passage of solid food but gradually this became worse until only finely divided or liquid food could pass through the esophagus pain, described as a feeling of cramp behind the sternum, and hematemesis occurred later.

Three stages of the disease are recognized. The initial stage shows inflammatory changes limited to an edematous slightly bulging and easily bleeding mucous membrane. The florid exudative stage shows a normal or slightly reddened mucous membrane, and a narrowed lumen strongly inflamed and covered with fibrin. The upper limit of the constriction has a distinct, very sharp and often lineal horizontal demarcation.

The clinical picture of esophagitis is such that clinicians will initially suspect a malignant process but the roentgenological changes are characteristic in the more advanced cases of this disease. An elongated funnel shaped constriction with notched contours in the distal part of the esophagus a relatively distinct superior boundary and a cephalad

dilatation of the process permit a diagnosis differentiating esophagitis from cancer.

Notwithstanding the benign histological nature of the process the prognosis is very serious and in a large number of cases gastrostomy will sooner or later be necessary.

STEPHEN A. ZIEGLER, M.D.

Jacobsson F: A Patient with Cancer of the Esophagus, Alive and Free from Evidence of Tumor 6 Years after Roentgen Treatment. *Acta radiol* Stockh., 1946 27 351

Treatment of cancer of the esophagus still yields poor results and 5 year cures after roentgen treatment are rarely reported in the literature. The author reviews some 9 cases reported but notes that histological proof of the diagnosis was lacking in about half of the cases. He urges that every case of carcinoma of the esophagus surviving more than 5 years be described with details of treatment and sequelae in order to continue the improvement of the treatment.

The author reports the case of a patient treated for cancer of the esophagus who was alive and free

from tumor more than 6 years after the treatment. He was 58 years old when first seen in 1939. A diagnosis of carcinoma of the lower third of the esophagus was made with x-rays. Biopsy showed a squamous cell carcinoma with low differentiation. The chest roentgenogram and electrocardiogram were normal and no evidence of metastases was found.

The patient was treated by the method of Strandqvist with crossfire radiation from three anterior and three posterior fields. The patient received 3,600 r per field, except in the posterior central and the anterior lateral fields, each of which received 3,400 r. The treatment was given with about 175 kv. and an intensity of about 50 r per minute, measured on the surface of the skin. As a filter  $\frac{1}{4}$  mm. of copper plus 1 mm. of aluminum was used. The size of the fields was about 6 by 13 cm. The tumor dosage was estimated at about 5,000 r over 35 days.

The patient developed a blistering epidermatitis from the treatment but was clinically improved. Two months later the barium study of the esophagus was normal. Three months after the treatment the patient developed an induration in the right lung which cleared after 9 months. This was considered a radiation reaction.

The patient's heart began to enlarge 3 months after treatment but after a year the size remained stationary. After 5 years, the electrocardiogram showed signs of intraventricular conduction disturbances, a lesion presumably due to the treatment.

Three years after the treatment the patient developed a right pleural exudate which necessitated aspiration several times for the next 3 years. The exudate never showed tumor cells; therefore it seems likely that pleural metastases did not exist, and the exudate was probably due to the treatment.

More than 6 years after the treatment the patient was cured locally, had no difficulty in swallowing, and had no noticeable metastases. He had a slight hacking cough, became breathless, and had pain in the middle of his chest with exertion. These symptoms somewhat limit his capacity for work.

ROBERT R. BENZLIE, M.D.

#### MISCELLANEOUS

Scott, O. B., and Morton, D. R. Primary Cyst Tumor of the Diaphragm. *Arch. Path. Clin.* 1946 41: 645

The paucity of reports on primary diaphragmatic neoplasm indicates the rarity of this condition. In a recent review of this subject, the authors found reports of 33 benign and cancerous diaphragmatic tumors. Their series includes 4 cases; the diagnosis in these was not confirmed by operation or autopsy. It is anticipated that with the increased use of routine fluoroscopy and roentgenography of the chest, diaphragmatic tumors will be found with increased frequency. A report of this type of tumor is given in full.

The most constant symptom noted was pain in the chest, also in the hypochondrium and occasionally along the course of the regional intercostal nerves toward the shoulders. Cough was a complaint occasionally and hemoptysis, once. Bulging intercostal masses as well as masses in the right and left upper quadrants of the abdomen have been noted. Dyspnea is sometimes present and pleural effusion may occur. The diagnosis is finally made on roentgenographic evidence. Pneumoperitoneum may aid in outlining the position of the tumor.

EMIL C. ROSENBERG, M.D.

# SURGERY OF THE ABDOMEN

## ABDOMINAL WALL AND PERITONEUM

and F N Fundamentals of Technique in the Transverse Abdominal Incision *Surgery* 1946, 20 217

After a 30 year controversy as to the best type of parotomyl wound both the vertical and transverse approaches have stood the test of time. The author gives a detailed description of the all purpose transverse incision and answers some of the criticisms of the transverse technique.

When one or both rectus muscles are cut some filaments of their nerve supply is probably sectioned. However, as this innervation is more plexiform than generally imagined and since one thoracic nerve can be sectioned without evidence of rectus paralysis clinical evidence of weakness seldom follows an incision. If the laparotomy is performed so as to visualize these nerves they can usually be spared. If nerves are cut the rectus may bulge and in the lower incision the functional integrity of the inguinal ring may be jeopardized.

If the muscle is cut across healing occurs as readily as if the rectus is split. The excellent sheathing of both sides of the muscle holds the sutures together when it is cut transversely and mitigates reaction of the muscle. Such an incision leaves a functionally insignificant scar.

The larger transverse incisions may close more easily but eversion is less likely with straining during closure than when the vertical incision is used. The expenditure of a few minutes of the surgeon's time is of no importance when considering the patient's welfare.

It has been claimed that the transverse incision does not give adequate exposure in the presence of a narrow costal angle. Adequate extension into the flanks will overcome this objection. The vertical incision is subjected to extreme strain and is difficult to close under these same circumstances.

The transverse incision should be thought of as a belt line incision being restricted to the band between the crest of the ilium and the costal cartilage. There is no loss of the advantage of lateral extension into the flanks. The incision should be placed an inch above or below the umbilicus. Incorrect placing of the incision has resulted in the discouragement of many surgeons trying this approach.

The technique of the low right transverse incision such as is useful for work on the appendix cecum or lum is described.

1. The line of incision is selected above the brim of the pelvis just below the umbilicus.

2. The skin is incised from beyond the midline to the right flank. The external oblique muscle at the lateral end of the wound should be well exposed.

3. In the same plane as the skin incision the anterior rectus sheath is incised and extended later

ally through the aponeurotic fibers of the external oblique muscle. When the muscular portion is reached the incision turns upward slightly to split the muscle.

4. The lateral edge of the exposed rectus is lifted and the eleventh thoracic nerve or a branch of it is visualized. The muscle is then freed from the posterior sheath for a distance of 1 or 2 inches above and below the plane of the incision and retracted medially. The lower edge of the external oblique muscle is retracted downward and laterally at the lateral edge of the wound.

5. The thin sheath of the internal oblique muscle is divided next, the incision beginning at the lateral edge of the rectus sheath and extending laterally and downward in the direction of the muscle fibers.

6. The posterior rectus sheath and peritoneum are opened at the lateral margin of the sheath and the incision is extended medially almost to the midline. Lateral extension of the incision is accomplished principally by hand the internal oblique and transversalis muscles being split in the direction of their fibers. The twelfth thoracic and iliohypogastric nerves run beneath the internal oblique muscle. They should be identified and retracted laterally. The peritoneum is split laterally to the end of the wound.

7. The rectus muscles may be cut across if more exposure is necessary. The deep inferior epigastric artery and vein lying on the posterior surface of the rectus a little lateral to its center should be tied before the muscle is cut. If still more exposure is necessary the same step by step procedure is carried out on the opposite side and the patient is hyperextended. The upper abdominal incision is similar and is placed just above the umbilicus to clear the lowest portions of the thoracic cage. If the right rectus is sectioned the falciform ligament also must be divided.

The closure must be carefully planned. The medial half of the incision is closed in two layers—one for the peritoneum and posterior rectus sheath and one for the anterior rectus sheath. The lateral half is closed in three layers, namely one for the peritoneum and transversalis muscle, one for the internal oblique muscle, and one for the external oblique muscle. It is well to jackknife the patient before closure is begun. Interrupted sutures are recommended but if continuous sutures are used they should be locked when the outer margin of the rectus sheath is reached. If this is not done the relatively less rigid structures in this area may lead to puckering and cause the suture to loosen. The fat and skin are closed in any rational method. Subcutaneous retention sutures do no harm but have been largely abandoned. Deeply placed retention sutures are undesirable. A narrow transverse dressing with no abdominal binder is recommended.



This incision has several advantages. It can be readily extended—a 30 inch incision from flank to flank gives unrivalled exposure with a minimum of retraction, and postoperative complications are reduced. Costal respiration is less impeded by pain spasm than in a vertical wound. Effective coughing returns sooner. Early ambulation can be accomplished with less pain. It is believed that no fundamental principles are violated by this transverse incision sited as it is in the line of the body's most important flexion crease.

ROBERT R. BICKLOW, M.D.

### GASTROINTESTINAL TRACT

Kushlan, S. D.: Gastrointestinal Bleeding in Hereditary Hemorrhagic Telangiectasia; Historical Review and Case Report with Gastroscopic Findings and Rutin Therapy. *Gastroenterology* 1946, 7: 199.

The author traces the history of hereditary hemorrhagic telangiectasia from the time it was separated from the large group of hemorrhagic diseases of uncertain origin by Osler. The condition is uncommon although it is not rare. It is inherited as a dominant characteristic. The sexes are equally affected and either sex may transmit it although some generations may be skipped. Epistaxis beginning in childhood is often the first manifestation. Hemorrhage from the skin and oral mucous membranes is quite frequent. Gastrointestinal hemorrhages usually begin in the fourth decade. The criteria for diagnosis are definite heredity, visible telangiectases with pathological distribution and a tendency to bleed from the lesions.

The typical skin lesion is a sharply demarcated purplish red spot which may or may not be elevated. A single arterial vessel may connect with the spot, commonly called a "cherry angioma." When several branches are visible the lesion looks like an acquired vascular spider.

The basic pathology of these lesions is a thinning of the vessel walls particularly of the muscular coat which results in bulging of the wall in a defect which may be rather extensive. The lesions tend to be omnipresent in large numbers, both internally and externally, rather than in isolated groups.

The lesions are noted in the stomach and in the sigmoid colon.

Widespread bleeding from telangiectases in many different locations has been reported. It has also been reported that individual groups of dilated vessels are not permanent, but vary from time to time in number, size and tendency to bleed. Except for lowered erythrocyte count and hemoglobin values the blood findings are normal however the bleeding can result in a chronic anemia severe enough to be incapacitating and also a number of fatal hemorrhages have been reported.

Therapy has been difficult and unsatisfactory. The multitude of treatments advocated indicates the absence of any specific remedy. The only medica-

tion of proved value has been the administration of iron in full and continuous dosage to combat the anemia. A high protein diet is essential to help compensate for the chronic blood loss.

Transfusion becomes necessary in spite of the danger of reactions when the hemorrhage has been sufficiently severe or prolonged to lead to markedly low red blood cell counts or to the danger of circulatory failure. Vitamin C had no effect on these patients. Because of the character of the lesions and the effect of vitamin P in similar situations in which other medications failed rutin which is like vitamin P in that it is a flavone glucoside was administered with excellent results. Rutin may represent a remedy for this condition and certainly in view of its nontoxicity it should be tried in this and allied situations. EDWIN W. PAMANN, M.D.

Homb, A.: On Acute Regional Enteritis. *Archivum* 1946, 94: 343.

The author segregates cases of regional enteritis into those in which the ileum is affected, and those in which the jejunum is affected. Inflammatory processes in the upper parts of the intestinal tract run a more acute course than those in the lower parts. As to etiology it has been assumed that the inflammation is the result of infection by some microbe, but a specific bacterium has not been demonstrated. Since there is some question as to whether bacteria traverse an intact intestinal mucosa, it may be possible that irritations caused by foreign bodies such as fish bones and other gross material might initiate enteritis on which inflammation can develop. The author cites a case of ulceration of the ileum by a fishbone in which the pathological changes were identical with those encountered in acute regional ileitis.

The author's material includes 33 patients with acute ileitis and 8 with acute jejunitis. The symptoms in acute ileitis were for the most part identical with those of appendicitis. One third of the patients stated that they had had previous attacks similar to the present one. The average duration of the symptoms was 24 hours, but 3 of the patients had but slight discomfort for a period of 3 weeks. In one third of the patients the onset was sudden, while in two-thirds it was gradual. The initial symptom in most cases was pain, although no definite correlation was observed between the symptoms and the pathological findings.

Examination revealed right lower quadrant tenderness as a rather constant finding. Rigidity and tenderness on sudden release of pressure were demonstrated frequently. A palpable tumor in the right iliac fossa was found in only one patient. No parallel was found between the pathological findings and the temperature changes. Roentgenographic examination of the abdomen with a scout film was carried out in 11 patients. In 5 of these there were demonstrated the signs of peritoneal irritation i.e. small field levels in the ileocecal region.

The indication for operation in almost every case was suspected acute appendicitis. The findings at

Laparotomy showed exudate in the peritoneal cavity in 19 of the 33 cases. The changes in the ileum revealed infection of the serosa as a constant finding. Minor hemorrhages in the serosa were demonstrated in 8 cases, and a granulated or fibrin-coated surface was observed in 12. Most cases showed a thickening of the ileal wall with a rubberlike consistency. The lumen was constricted, but rarely to any great extent.

Interestingly enough, the author reports that although the appendix appeared normal in two-thirds of the cases, the operative treatment was as follows: appendectomy 29 cases, exploratory laparotomy 2 cases, walling off of the ileum with omentum 1 case and intestinal resection, 1 case. In the case of the last patient, it is believed that resection was unnecessary.

Postoperative follow up studies indicate that aside from a troublesome diarrhea in some instances, all of the patients recovered. These striking results might indicate that resection in most cases of regional ileitis is an unnecessary procedure.

In discussing his 8 cases of acute jejunitis the author points out that the symptoms are much more severe than in ileitis. The patients are more acutely ill and the pain occurs mostly in the epigastrium; the vomitus may be fetid and contain blood; diarrhea is a frequent symptom with occult blood or melena; leucocytosis and the sedimentation rate usually run higher than in appendicitis or ileitis.

Seven of the 8 patients were examined roentgenographically. Rather specific findings indicative of distended, gas-containing jejunal loops with very prominent plicae were noted on the films. In the erect position the distended jejunal loops showed fluid levels.

Laparotomy was performed on 5 patients with 3 deaths due to peritonitis. Resection was not done in any instance, but the involved loop of jejunum was simply covered with omentum. Three patients were not subjected to surgery and recovered under conservative management. From these observations it would appear that resection should have been performed in the cases which ended fatally.

HAROLD LAUFMAN M.D.

Humphreys, G. H., II: An Approach to Resection of the Esophagus and Gastric Cardia. *Ann Surg.*, 1946, 124: 288.

A considerable experience in dealing with tumors of the gastric cardia and the esophagus, and various older methods of dealing with these tumors are discussed. The cases of 75 patients treated at the Presbyterian Hospital, in New York, from January 1941 to January, 1946 have been reviewed.

1. Esophagectomy with cervical esophagostomy and gastrostomy (the Torek procedure). This procedure, through a right sided thoracotomy incision was carried out in 5 cases, with 80 per cent operative mortality and no cure. It is now considered justified only in lesions involving the lower cervical esophagus.

2. Esophagectomy with esophagogastrostomy lateral to the aortic arch was carried out through a left sided posterior thoracic incision in 5 cases, with 60 per cent operative mortality. One patient was well for a period of 2 years.

3. Esophagectomy with esophagogastrostomy below the aortic arch. In 9 cases this procedure was carried out through posterior thoracic incisions, and in 2 cases through an anterolateral combined abdominothoracic incision with a 45 per cent operative mortality. Two patients are well after a period of 8 and 6 months.

4. Esophagogastrastomy with intrathoracic esophagogastrostomy or esophagojejunostomy. In 2 cases operation was carried out through a posterior thoracic incision and in 10 cases through an anterolateral combined abdominothoracic incision. The operative mortality in this group was 50 per cent. Three patients are well after a period of from 5 to 15 months.

5. Partial or complete gastrectomy with intra abdominal esophagogastrastomy esophagojejunostomy or gastrorrhaphy. In 3 cases the operation was carried out through a combined abdominothoracic incision, and in 2 through the abdominal portion only. There was no operative mortality. Two patients are well 2 and 2 1/2 years after operation.

6. Palliative gastrectomy. In 19 patients operation was carried out without exploration in 11 after determination of inoperability by thoracotomy and in 7 after determination of inoperability by the abdominal portion of a combined incision. The operative mortality in this group of 37 cases was 8 per cent; the longest survival 20 months.

RICHARD J. BENNETT JR. M.D.

Walters, W.: Resection of Stomach. *J. Am. M. Ass.* 1946, 131: 1269.

In 3 of 5 cases in which hemorrhagic and ulcerative gastrojejunitis occurred after gastroenterostomy was performed for congenital pyloric stenosis, removal of the gastroenteric anastomosis, resection of the stomach and the Billroth I (von Haberer) type of anastomosis between the proximal end of the stomach and the duodenum produced relief. In 2 cases, hemorrhages occurred 6 and 9 years respectively after this procedure. In 1 case it followed overindulgence in food and in stimulants and gastric irritants. No further bleeding has occurred since the patient began to abstain from use of alcoholic beverages. Both patients were well when last heard from.

Two of the patients had undergone pyloroplasty after bleeding occurred without relief. Bleeding ceased after the gastroenteric anastomosis was taken down and partial gastrectomy was performed.

In 2 cases severe gastrointestinal hemorrhages apparently occurred in the presence of a relative achlorhydria.

In 1 case a gastrojejunal ulcer perforated 7 weeks following a thorough examination in which the patient was found to have a relative achlorhydria, and



of the swollen lymphoid tissue. Fecal particles may produce an ulceration of the mucous membrane without simultaneous obstruction and thus permit the entrance of bacteria. The noninfected ulceration may give rise to a so-called appendicitis appearing mainly in the form of a recurring or chronic appendicitis. Acute segmental appendicitis has been produced by ligation of the vessels of the organ. Therefore, embolic or thrombotic lesions of the vessels with resulting necrosis and infection due to the presence of bacteria in the lumen, may occasionally explain the sudden onset of appendicitis. In some cases trauma has been found to be the cause. The bacteria causing appendicitis are mainly *Bacillus coli* though enterococci and nonhemolytic streptococci do occur.

The author believes that it is easy to make the histological diagnosis of acute appendicitis in severe cases but in mild cases the differentiation between a normal and a pathological condition is difficult. The initial stage of acute appendicitis is a primary infection evidenced by the accumulation of neutrophilic leucocytes about a small defect in the epithelium at the bottom of a crypt. The epithelial defect is covered by a plug of leucocytes and fibrin. From this site, the inflammatory process spreads to the walls of the appendix and takes on the shape of a wedge with its base peripherally so that the leucocytes occur in largest numbers in the subserous portion. Various changes take place in the nerve apparatus of the appendix but no relationship has been established between the various changes and the different types of appendicitis.

In an attempt to establish a surer basis for the histological diagnosis of acute appendicitis the author examined 100 appendices (obtained at autopsies) of patients who died from unrelated conditions, and 100 appendices of patients who were operated upon for acute appendicitis.

A study of the normal material revealed the following:

1 In addition to eosinophils and plasma cells densely packed clusters of lymphocytes occur normally in the lymph spaces of the muscularis and subserosa.

2 Extravascular neutrophils must always be considered pathological.

3 A more or less marked fibrosis of the appendix was found in 64 per cent of the normal cases. In 25 per cent of these cases there was present a partial or complete obliteration.

4 An appendix is termed grossly normal when its surface is not particularly infected when it is not covered with fibrinous or purulent coatings and which when opened exhibits a light yellowish mucosa, which is only slightly granular, but may be the site of extensive ecchymoses. Questionable acute inflammatory changes are the thickening of the wall combined with some hyperemia of the surface and a red hyperemic mucosa which may be more or less swollen. Definite acute inflammatory changes are a distinctly congested and edematous wall, with purulent or fibrinous coating on the surface. The lumen

may be filled with pus. The mucosa is the site of necroses and ulcerations.

A study of the diseased material revealed

1 Of 154 cases histologically proven to be acute appendicitis, only 125 revealed simultaneous gross evidence of acute inflammation. Four cases were grossly normal.

2 Two cases showed an accumulation of neutrophils in the form of small foci in the mucosa. This type is described as a localized acute appendicitis.

3 One hundred and fifty two appendices exhibited inflammatory changes extending throughout the entire organ. This type is called diffuse acute appendicitis.

4 A fibrosis of the appendix was demonstrated in 124 cases.

It is extremely difficult to make a histological diagnosis of chronic appendicitis.

SAMUEL KAJER, M.D.

#### LIVER, GALL BLADDER, PANCREAS AND SPLEEN

Kajser R.: Concerning Cholangiography in Compression or Stricture of the Distal Portion of the Common Bile Duct with Remarks upon the Diagnosis and Therapy of Carcinoma of the Ampulla of Vater (*Über das Cholangiographiebild bei Kompression oder Striktur des distalen Cholecholelithabchnittes Nebst einigen Bemerkungen über Diagnose und Therapie bei Carcinoma papillae Vateri*) *Acta med scand* 1946 Supp. 170 p. 463.

The author divides his article into two parts: one concerning the cholangiographic picture in a wide variety of lesions of the common bile duct, and the other being a more or less complete review of the subject of carcinoma of the ampulla of Vater including a report of 3 cases. The former part is the more interesting as it is based on an extensive experience with cholangiograms taken on the operating table in a large variety of mechanical obstructions, both intrinsic and extrinsic. In several of the films the author was able to demonstrate calculi within the duct while other types of mechanical obstruction were present simultaneously. In 1 such film there were 2 stones within the duct and between them there was a constriction which was believed to represent an organic stricture caused by malignancy of the duct. In other cases there was obstruction caused by enlarged lymph glands which impinged upon the duct and narrowed its lumen. The author demonstrated a film which he believes is typical for the type of obstruction caused by fibrosis and stricture in the duct and another which is typical for the obstruction caused by carcinoma of the head of the pancreas.

In the second portion of the article the incidence, symptomatology, diagnosis, and therapy are discussed. The author is in agreement with the general literature except in regard to the reported incidence in the sexes, believing that the lesion is more frequent in the female, this is in contrast to Brunschwig's findings. The author believes that in the

clinical study there is not very much to guide one in differentiating icterus of carcinoma of the ampulla of Vater from the other more common forms of icterus. The various liver function tests may be of help in differentiation of the intrahepatic causes of jaundice. There is little, however, even at the operating table which will differentiate the ampullary neoplasm from either stricture or stone. The finding of occult blood in the stool and the roentgen study of the duodenum may be suggestive but is far from conclusive. At the operating table palpation may be of help but it is fraught with uncertainty. The probing of the duct may also be inconclusive. On the other hand, the author believes that the cholangiogram is typical. The shape of the curve of the contrast medium at the lower end of the duct is not blunt as it is in stricture nor does it show a convexity upward as in the presence of a calculus but rather it plays a definite filling defect with an irregular passage.

Two cases of carcinoma of the ampulla of Vater are detailed as well as 1 of icterus secondary to hyperplastic swelling of the glands of the hepatoduodenal ligament.

WILLIAM C. BRET, M.D.

Mallet-Guy, P., Jean-Jean, R. and Rouchet J.: The Prevention of Hemorrhagic Complications in Biliary Surgery by Vitamin K. (La prévention des complications hémorragiques en chirurgie biliaire par la vitamine K.) *Lyon chir.* 1944, 4, 60.

The authors have reviewed the records of 225 patients who were subjected to surgery of the biliary tract and have made the following observations concerning the relationship of the prothrombin time and hemorrhagic tendencies.

Before operation if the prothrombin time is less than 65 per cent of normal there is risk of spontaneous hemorrhage. During operation if the prothrombin time is less than 75 per cent there is danger of difficulty in obtaining hemostasis. After operation if the prothrombin time is less than 85 per cent there is danger of hematoma formation or of hemorrhagic complications.

The 225 patients were divided into three groups.

Group 1 (63 patients) had prothrombin times higher than the minimum normal. They had no preoperative vitamin K and no postoperative bleeding.

Group 2 (126 patients) had prothrombin times which were definitely subnormal. They received vitamin K therapy until the prothrombin time returned to normal and there were no instances of postoperative hemorrhage.

Group 3 (36 patients) had prothrombin times at the lower limits of normal. They would seem to need no vitamin K, but in 3 cases a postoperative hematoma occurred. This may be due to a disturbance of the prothrombin time caused by the operative procedure. The authors believe that this group should receive preoperative vitamin K therapy and that it should be continued for several days after operation.

Thus 163 patients (a large majority of the group) had an actual or potential hemorrhagic tendency and required vitamin K therapy.

Chronic icterus was present in 87 cases. Four of these patients had neoplastic obstruction, so they had particularly low prothrombin times. However, no hemorrhagic complications occurred in this group because all had received adequate vitamin K. The remainder of the patients with jaundice had cirrhosis, hepatitis, calculus, adenopathy, chronic pancreatitis or disturbances of the spleen. Oldie did not manifest severe disturbances of prothrombin time.

In conclusion the authors propose the following three types of treatment according to the prothrombin level.

1. An aggressive treatment when the deficit prothrombin time is at an alarming figure (50 per cent of normal or less) or when emergency surgery is necessary. Eighty drops of K thrombolytol in 24 hours with an injection of 10 mgm. of vitamin K 1, 2 or 3 days generally produces the desired effect.

2. A more leisurely treatment when the prothrombin time oscillates in the neighborhood of 50 per cent. This can be accomplished by giving drops for 4 to 6 days. If there is an associated icterus one gram of bile extract should be given with every 60 drops.

3. A maintenance treatment of 40 to 60 drops in 24 hours assures continuation of the vitamin K effect during the postoperative period.

EDWARD W. GORM, M.D.

Söderlund G.: A Contribution to the Causation of Inflammatory Pancreatic Cysts. *Acta med. scand.* 1946 Suppl. 179, p. 655.

The author reviews 3 cases of pancreatic cysts arising in connection with acute or subacute pancreatitis. All were inflammatory pseudocysts which were treated in one of two ways.

1. Marsupialization, or opening of the cyst and sewing the cyst lining to the anterior abdominal wall. With drainage thus established, shrinkage of the cystic cavity and obliteration were obtained. This method of treatment was employed in 3 of the 5 patients.

2. Gastric anastomosis. In the remaining 2 patients the cyst lay behind the stomach, firmly adherent to the posterior abdominal wall. Anastomosis of the cyst to the stomach was accomplished in these patients. The stomach was opened and an incision was made through the posterior wall directly into the cyst. The cyst lining was sutured to the stomach with closure of the anterior gastric opening to form a closed anterior drainage of the cystic contents with subsequent shrinkage and obliteration. A Welch tube where needed was employed in the anterior opening of the stomach to establish an external drainage of the contents which may be evacuated into the stomach.

The present article includes a detailed case history with daily progress notes of each patient (apparently) recorded on the original hospital chart.

STANLEY A. ZIMMER, M.D.

Jameshek, W., and Grassi M H: Infectious Lymphadenitis ("Mononucleosis") and Thrombocytopenic Purpura Recovery after Splenectomy *Blood J Hemat.*, 1946 1 339

Among the features of infectious lymphadenitis ("mononucleosis") which help to distinguish it from acute lymphatic leukemia is the lack of reduction in red blood cells and platelets. Conversely the association of a well defined anemia and/or thrombocytopenia with a marked degree of lymphocytosis in which abnormal lymphocytes are conspicuous almost certainly indicates acute leukemia. The present case is an exception to this rule.

The patient was a young woman with a severe purpura hemorrhagica a generalized lymphadenopathy and a lymphocytosis. The clinical picture suggested an acute lymphatic leukemia but the lymphocytes suggested infectious mononucleosis which was confirmed by a strongly positive heterophile agglutination. When the bleeding became uncontrollable splenectomy was performed followed by prompt recovery. The splenic histology was characteristic of infectious mononucleosis.

This case is of interest not only because of its rarity but because it brings up anew the diagnostic nature of infectious mononucleosis the question of "hypersplenism" and its relationship to thrombocytopenia, and the lymphocytosis observed in a number of cases of idiopathic thrombocytopenic purpura.

SAMUEL J. FOEELSON M.D.

Smith E. B., and Gueter R. P: Rupture of the Spleen in Infectious Mononucleosis. *Blood J Hemat.* 1946 1 317

Infectious mononucleosis has been regarded as a benign disease until very recently. Rupture of the spleen as a fatal complication has received little attention there being only 3 well established cases in the literature. This report adds 7 additional cases in which splenic rupture occurred. All of these patients were subjected to splenectomy, but only 3 recovered.

A characteristic histological picture was found in all of the patients. The splenic capsule was found to have virtually lost its identity. It was infiltrated with lymphocytes and large mononuclear cells. The capsule and the immediate subjacent pulp was edematous. The splenic trabeculae were infiltrated by mononuclear cells to an even greater degree than the capsule frequently having undergone dissolution. The splenic pulp was increased in bulk and its architectural pattern was blurred principally because of the excessively cellular cords of Billroth which compressed the sinuses and rendered them relatively bloodless. The predominant mononuclear cells varied from 12 to 15 microns and were round except when distorted by pressure the cytoplasm was homogeneous and faintly acidophilic. The centrally or eccentrically placed nucleus was sharply delineated by a thin membrane and chromatin was irregularly distributed to lend a mottled appearance.

The blood vessels of the spleen also showed a consistently striking histological change. The small ar-

teries were ensheathed by normal and abnormal lymphocytes which completely separated them from the surrounding trabeculae. These vascular lesions are similar to those frequently found in leukemia scarlet fever occasionally in chronic malaria and acute fulminating infections.

It is obvious from these histological descriptions that the basic structure of the spleen is weakened in infectious mononucleosis, and it is surprising that it does not rupture more often.

SAMUEL J. FOEELSON M.D.

Benhamou E. and Laffargue P: Sarcomas of the Spleen (*Les sarcomes de la rate*) *Presse Méd.* 1946 54 485

Statistics have always reported sarcoma of the spleen as being very rare but the authors have seen 9 cases in the past 6 years in Algiers which leads them to doubt its extreme rarity. Sarcoma of the spleen should be suspected if the spleen is enlarged without accompanying enlarged glands in subjects from 25 to 55 years of age, if the organ is hard and painful, if there is rapid emaciation persistent ansthenia, and irregular temperature. The diagnosis can be confirmed by the test of contraction of the spleen following the use of adrenalin and by histological examination of a smear from the spleen.

In the authors' cases there was hyperleucocytosis up to 16 000 with the proportion of the different forms of leucocytes practically normal. This served as a differential point from Banti's disease in which there is leucopenia with a tendency toward mononucleosis, from Hodgkin's disease in which the leucocytosis is predominantly eosinophilic, and from tuberculosis of the spleen in which there is sometimes an increase of the red cells.

In 5 of the authors' cases there was necrosis of the spleen with cavities resembling those of tuberculosis while in 2 other cases there was no macroscopic necrosis but necrosis was shown on microscopic examination.

Details are given in 1 case of a man of 27 who recovered after splenectomy and blood transfusion. The authors think that treatment is hopeful in these cases if the diagnosis is made early before the gland become enlarged and before the patient's general condition becomes too serious. Treatment consists of splenectomy, blood transfusion and deep roentgen therapy.

AUDREY C. MORGAN M.D.

## MISCELLANEOUS

Meyer H. W.: Acute Superior Mesenteric Artery Thrombosis Recovery following Extensive Resection of the Small and Large Intestines. *Arch. Surg.* 1946 53 293.

The author describes a case of acute superior mesenteric artery thrombosis treated by very wide resection and resulting in a good recovery. A 19 year old infantryman was recovering from minor shell fragment wounds of his left arm and right thigh in an evacuation hospital when on the third evening

after admission he developed symptoms of an acute surgical emergency. Subsequent history revealed that since 11 or 12 years of age he had been having attacks of cramplike pain several times a week to every few months which lasted a maximum of several hours. A similar attack started the day the patient was wounded but he did not mention it until the pain became unbearable. The severity of the pain was out of all proportion to the mild bilateral rectus spasm and midabdominal tenderness. The white blood count which was 17,000 at the onset of the severe attack reached 22,300 with 17 per cent stab forms and 72 per cent polymorphonuclear leucocytes by the following morning when the necessity for surgical exploration was established. At this time the patient's temperature was 100.2 F and his pulse rate 120.

At operation there was a pronounced odor of gangrene when the abdomen was opened and the presenting intestines were blue black but not distended. Gangrene extended from 20 inches distal to the proximal end of the jejunum to the midtransverse colon and when resected the thrombi were seen in the great vessels in the root of the mesentery. All of the gangrenous bowel was resected and an isoperistaltic side-to-side jejunocolostomy to the left half of the transverse colon performed. This left the proximal 13 inches of the jejunum, the left half of the

colon, and a nutritional problem seemingly without precedent.

Immediate postoperative care was essentially that of any other major abdominal procedure and surgical recovery was uneventful except for a right popliteal occlusion by a clot on the fifteenth postoperative day which was removed surgically without difficulty.

When oral feedings were started liquid stool was passed almost constantly which slowed to about 7 soft stools daily in several weeks. The urinary output was as low as between 500 and 600 c.c. daily as a result but it returned to normal in time. The stool improved until 9 months later he had 3 to 5 well formed stools daily. At this time the patient's weight was 120 pounds as contrasted with 151 pounds just before he was wounded. Throughout the postoperative period the patient's chemistry was maintained very close to normal limits. Mention is made of high vitamin and protein intake in the immediate postoperative course but no mention is made of the intravenous and oral chloride requirements.

On all diets late in his course large amounts of fat and starch were present in the stool, but it was determined largely by trial and error that he did best on a high carbohydrate, low fat and medium protein intake.

FREDERICK C. HOSKIN, M.D.

# GYNECOLOGY

## UTERUS

Dalgaard, J. B. The Blood Vessels of the Human Endometrium. *Acta obst. gyn scand.* 1946 26 342

The literature on the subject of the blood vessels of the human endometrium is reviewed and a new classification of the menstrual cycle is presented.

The material consists of 16 specimens of post-mortem examined human uteri. The technique of injection is discussed. India ink was injected arterially or venously in some of the specimens in others the Sjostrand method of blood corpuscle coloration was used.

A minute description of the histological findings in every specimen is given and the material is grouped according to menstrual phases with subheadings for cervical and atrophic endometrium.

The endometrial vessels are branches and continuations of the myometrial vessels. The endometrial arteries of monkey and man are of two types endometrial spiral arteries and endometrial basal arteries. The former arises as a continuation of the myometrial radial artery while the latter sometimes appears as a branch of the myometrial radial artery sometimes as a special vessel from the myometrium. The endometrial basal arteries supply the basal part of the endometrium, run obliquely or nearly parallel to the surface in the boundary zone but to a lesser degree in the basalis.

The endometrial spiral arteries are continuations of the myometrial radial arteries. The coils of these vessels are lowest, broadest, and present the most numerous coils per height unit in the basilar area. The author found that the endometrial spiral arteries already in the proliferative phase reach the surface, very few branches are given off. The diameters of the vessels diminish very little throughout the endometrium. They have a distinct elastic membrane. They continue directly into the venous lacunae through arteriovenous anastomoses. The lacunae are the superficial parallel network of vessels, most often seen in the phases of proliferation and early secretion. The venous plexus is interposed between the lacunae and the ordinary capillaries on one side and between the lacunae and the collecting veins on the other side.

An attempt is made to explain the anatomical findings with relation to the menstrual function.

T. FLOYD BELL, M.D.

Ritala, A. M. On the Methods of Treatment in the Presence of Pyometra. *Acta obst. gyn scand.* 1946, 26 225

The author states that in Finland the majority of patients suffering from cervical carcinoma seek medical advice when suppuration has developed and the diagnosis can be made by the typical pungent

odor alone. He makes a plea for earlier diagnosis before infection has become active even though he is aware that in his country patients wait for long periods before they are admitted to the hospital.

The author gives a survey of the pathogenesis and prophylaxis of pyometra. Infection of the uterus especially in cases of carcinoma is looked upon as a local disease and even as a point of entrance for numerous inflammatory processes tending to spread throughout the body.

The possibility of using modern local antibiotics is discussed. In this connection several new instruments devised for the drainage of pyometra are described. They consist mainly of a set of graduated dilators with multiple openings. Other instruments which permit the use of wet and dry intrauterine medicaments to be introduced without increasing the intrauterine pressure are illustrated by photographs and drawings.

HARRY W. FINE, M.D.

Danforth, W. C. Total Abdominal Hysterectomy A Study of 500 Cases. *Am J Obst.* 1946 52 218

In those cases in which it is preferable to perform hysterectomy by the abdominal route total excision of the uterus is being done with greater frequency in many of the more active clinics of the country. The author believes that removal of the cervix has definite advantages whether it is accomplished by the abdominal or the vaginal route. Although the reported incidence of cancer of the cervical stump is small, it is worthy of notice. A second reason for total excision is that many of the cervixes are diseased. These cervixes which are not entirely normal are often troublesome after a subtotal operation. Therefore, elimination of the cervix seems desirable provided that it can be done without increasing the mortality or morbidity rate or in any event, an increase not greater than the number of cases of stump cancer would account for.

Danforth reports a series of 300 total abdominal hysterectomies performed by a group of trained gynecologists, all of whom are members of the Department of Obstetrics and Gynecology of Northwestern University Chicago. The following conditions were considered essential indications for hysterectomy myoma, cancer of the corpus adenomyosis, and inflammatory residuals. A badly diseased cervix was noted in 70 cases.

There were 2 deaths, a mortality rate of 0.4 per cent. The death of one patient resulted from septicemia the second patient died of uremia with failure of urinary secretion, even though cystoscopy and ureteral catheterization proved the absence of ureteral obstruction.

Morbidity was estimated according to the standard of a rise of temperature to 100.4 degrees F on any of two days, excluding the first 24 hours. Using this rigid standard 141 patients (38.2 per cent) had



after admission, he developed symptoms of an acute surgical emergency. Subsequent history revealed that since 11 or 12 years of age he had been having attacks of cramplike pain several times a week to every few months which lasted a maximum of several hours. A similar attack started the day the patient was wounded but he did not mention it until the pain became unbearable. The severity of the pain was out of all proportion to the mild bilateral rectus spasm and midabdominal tenderness. The white blood count which was 17 000 at the onset of the severe attack reached 22 300 with 17 per cent stab forms and 72 per cent polymorphonuclear leucocytes by the following morning when the necessity for surgical exploration was established. At this time the patient's temperature was 100.2 F and his pulse rate 120.

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FREDERICK C. HOOKER, M.D.

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Morbidity was estimated according to the standard of a rise of temperature to 100.4 degrees F on any of two days, excluding the first 24 hours. Using this rigid standard 141 patients (38.2 per cent) had

a morbid recovery. Serious morbidity occurred only rarely. Thrombophlebitis occurred in 3 cases, all 3 patients recovered. Ureteral injury occurred in two instances and nephrectomy was necessary in both cases. In 4 cases the bladder was opened. Immediate suture plus the use of a permanent catheter yielded a smooth recovery.

The adnexa were treated conservatively unless gross disease was present. The author prefers to leave the appendix alone.

The simple technique is well described and amply illustrated. Fine chromic catgut is used and closure is accomplished without drainage. The author believes that in trained hands total abdominal hysterectomy may be used frequently or even almost routinely.

EDWARD L. CORVILL, M.D.

Heyman, J., and Benner, S.: Further Experience with Radiotherapy in Cancer of the Corpus of the Uterus. *Acta radiol. Stockh.* 1945, 27, 318.

The 5 year results in cases of cancer of the corpus of the uterus treated from 1934 to 1939 by the Radiumhemmet method of packing the uterine cavity with radium tubes is reported. The survey of the results is preceded by a brief summary of the classification, examination, and treatment.

Prior to 1930, cases of corpus cancer were treated by introducing into the uterine cavity a single tube containing between 35 and 45 mgm. of radium element. The patient was irradiated twice with an interval of 3 weeks between the first and the second treatment. Each time about 1,200 mgm. of element hours were administered. Because of unsatisfactory results obtained by using a single narrow and powerful tube the packing method was gradually elaborated between 1930 and 1934 and now the uterus is packed with less powerful tubes of equal size and shape and in sufficient numbers to get the uterine cavity completely filled.

Primary radiological treatment combined with surgery in case of failure is the routine method of treatment. Primary surgical interference is resorted to in occasional operable cases, for instance cases of corpus cancer combined with large fibroids or with an ovarian tumor. In each case, radium is applied twice with an interval of 3 weeks between the irradiations. The time during which the radium remains in the uterus varies with the number of filter chosen, applied and the size of the additional filter chosen. The treatment time is given in a table at the end of the original article.

During the period from 1934 to 1939 inclusive 698 patients suffering from cancer of the corpus were seen. In 28 cases treatment was considered unsuitable. A 5 year cure rate of 64.9 per cent of 316 patients treated by the packing method in a series of 316 patients treated compared with 45 per cent in 354 patients treated with a single tube. The authors believe that it is possible to obtain better results by radiotherapy alone than by surgery alone. Following the use of the packing method, 22 patients were operated upon after failure of radiotherapy.

Conclusions as to the value of primary hysterectomy plus postoperative irradiation, compared with that of primary radiotherapy plus hysterectomy in case of failure of the former should be postponed until significant statements concerning the results of the first mentioned method are available.

GROENES BRUGER, M.D.

Kahanab, V.: Carcinoma of the Cervix Uteri in Young Women. *Acta obst. gynaecol.* 1945, 2, 379.

The author's material consists of 28 cases of carcinoma of the cervix uteri in patients under 30 years of age, the youngest being 21 years. The statement that carcinoma of the cervix is being transferred to younger age groups has not been proved and seems improbable. The lack of pregnancy in the previous history does not exclude the possibility of the disease in a young woman.

The possibility that carcinoma of the cervix is general is especially malignant in young women does not seem likely. It is judged from the results of treatment. The author recommends local examination of young women which will avoid treatment at a late stage with its bad prognosis. The possibility of carcinoma in a young woman should always be considered in the event of irregular bleeding, and the kind of treatment suggested until examination has ruled out cancer.

T. FLOREN, M.D.

Ritola, A. M.: Clinical Investigation of a Complication: Fistula Rectovaginalis after Radium Therapy of Cervical Carcinoma. *Acta obst. gynaecol.* 1945, 25, 93.

During the past 20 years at the Womens Clinic of the University of Helsinki, almost 2,000 patients have been treated with radium for cancer of the cervix. This was done by the so-called Stockholm method in which the cervical or intrauterine dose is generally 2,400 mgm. hr and 4,500 mgm. hr respectively. Most of the patients, unfortunately do not present themselves for treatment until they are in group III or IV. There were 231 cases of grades I and II which received radium treatment. Only these cases were used as suitable material for investigation of the occurrence of rectovaginal and rectovaginal fistulas following radium treatment since in cases of grades III and IV the malignancy itself may have affected the surrounding tissues to the point of perforation.

In nearly one-half of the patients treated by radium in the usual way there developed symptoms of irritation, tenesmus, ulceration accompanied by hemorrhages, and frequently also stenosis in the rectum caused by induration. There were 8 cases of rectovaginal fistula. During the first 10 year period there were none and then 5 developed from 6 to 13 months after the irradiation. The perforation of the rectovaginal septum caused a long period of suffering, an 1 when it occurred in the rectum higher up led to general peritonitis and a hasty end.

Since the avoidance of injury to the rectum and the bladder is the central feature in radium treatment in gynecology the author discusses the problem of the advisability of increasing the present vaginal dose of between 4,500 and 5,000 mgm. hr. in order to obtain better end results in the treatment of cancer and at the same time diminish the danger of injury to neighboring organs, especially the rectum. He has come to the conclusion that this is possible.

HARRY W. FINE, M.D.

# ADNEAL AND PERIUTERINE CONDITIONS

Bohm E., and Englund, S: Results of Salpingostomy at the Public Maternity Hospital Stockholm, 1931-1942. *Acta obst gyn scand* 1946 36 379.

Martin in 1885 was the first to carry out a salpingostomy. Since then many reports have been given with varying results. The author reviews these reports. American gynecologists were mainly opposed to the operation because of the bad results obtained. According to the more comprehensive collection of material cited from 7 to 10 per cent of the cases operated upon resulted in pregnancy and the number of parturition pregnancies varied between 3 and 8 per cent.

The indications for salpingostomy are enumerated. In general they embrace chiefly cases with slight changes and only exceptionally those with more serious changes.

The material presented embraces 64 salpingostomies resulting in 3 cases of parturition 4 ectopic pregnancies and 1 abortion.

T. FLOYD BELL, M.D.

# EXTERNAL GENITALIA

Paracchi, P: Carcinoma of the Clitoris (II carcinoma del clitoride). *Tumori Milano*, 1943 38 102.

Meyer (in 1868) was the first to describe carcinoma of the clitoris as an entity. Reports of other cases followed so that up to the present time 358 cases of primary carcinoma of the clitoris have appeared in the literature. To these the author adds all cases treated in the Gynecological Section of the Istituto Nazionale Vittorio Emanuele, in Milan, Italy from May 1, 1928 to April 30, 1944, i.e., 12 cases of primary carcinoma of the clitoris, 21 cases of carcinoma of the external genitalia with involvement of the clitoris which was no longer recognizable anatomically and 6 cases in which carcinoma of the clitoris was metastatic from a primary uterine neoplasm. From his observations he comes to the following conclusions:

1. Carcinoma of the clitoris is not so rare when considered in relation to carcinoma involving the external genitalia. Of 3,116 cases of malignant tumors of the female genital organs treated in this Institute since its inception, 96 showed involvement of the external genitalia and of these, 39 (40.6%) had involvement of the clitoris.

2. In most of the cases the condition occurred between the sixtieth to sixty-fifth years of life. It occurs only rarely in the young.

3. The average beginning of menstruation was at 14 years and 1 month. In only 1 patient had menstruation started at the late age of 28 years.

4. Sexual relations are not considered an etiological factor.

5. Pregnancy and dystocia must be disregarded as a cause. Instrumentation at the time of delivery involves the vaginal fourchette, and this is not the primary location of the neoplasm. Two patients in whom the primary carcinoma was located in the posterior commissure were nulliparous.

6. The disease is more frequent in women who have had an early menopause.

7. Leucoplakia and kraurosis vulvae must not be considered a precancerous condition; its presence is only coincidental. It takes some imagination to conceive of a leucoplastic cell all at once becoming aggressive, proliferative, disorderly, anaplastic—in one word a cancer cell. The ovary plays no part in the etiology of primary carcinoma of the clitoris which occurs in old age and many years after the menopause. Smegma hidden under the prepuce of the clitoris may have to be considered a factor.

The clitoris anatomically consists of the body made up of erectile tissue as is the penis (the corpora cavernosa being surrounded by a tunica albuginea 1 mm. thick) and the gland made up of squamous epithelium and capped by the prepuce which is rich in glandular tissue. Therefore, in the clitoris 3 types of tumor may take place: epithelioma, sarcoma, and melanotic tumors.

The epithelioma originates from the squamous epithelioma of the gland and may be the (1) spinal cell type (55% of the cases) with hyperchromatic polygonal cells and more or less keratinization; the (2) basal cell type (36% of cases) characterized by much mitosis and atypicity of cells; the oblong nuclei being hyperchromatic and karyokinesis frequent; the (3) basal spinal cell type (9% of cases); the (4) adenocarcinoma, a rare type made up histologically of nests of cells surrounding a central cavity and arranged like the lobes of an acinous gland.

The sarcoma is rare; originates from the connective vascular tissue and is characterized by numerous young cells with atypical mitosis. This tumor is very vascular. No cases of sarcoma were found in the author's material.

The melanoma is rare. Frank has stated that pigmented malignant tumors of the external genitalia constitute 3 per cent of all pigmented tumors. The tumor varies in size from that of a pea to a hen's egg and tends to metastasize to distant parts of the body.

Tumors of the clitoris may assume any of the following forms:

Vegetative—cauliflower like with a base either sessile or pedunculated; bleeds easily. In the author's material 45 per cent of the cases were of this type. The lesion remains localized for a long time.

Ulcerative—craterlike with indurated edges and a vegetative bottom covered with sanguineous fluid (made up 40 per cent of cases). In advanced cases it will destroy the clitoris completely.

Infiltrative—tends to invade all tissues around it to such an extent as to obliterate the primary location (made up 15 per cent of cases). In 1 case the ischiopubic ramus was invaded.

In carcinoma of the clitoris the anatomy of the lymphatic drainage must be kept in mind, i.e., the lymphatics of the corpus clitoris end in the superficial lymphatic glands, while the lymphatics of the gland empty into the iliac glands by way of the inguinal ring or femoral canal and knowledge of this fact helps in the diagnosis and also determines the treatment. Neither should one forget that enlarged glands may be inflammatory and not a metastasis from a cancerous growth.

The most common symptoms are pruritus in the area of the clitoris, burning sensation of the vulva, and some slight pain in the inguinal region and legs occasionally hemorrhage may complicate ulceration. One of the author's patients developed a massive regional adenopathy followed by ulceration and a massive hemorrhage that killed the patient. The diagnosis is not difficult. In the ulcerative type luetic ulcer and tuberculous ulcer must be differentiated. The final diagnosis rests on biopsy and microscopic examinations.

The prognosis is always guarded. Without surgical intervention life may continue from 1 to 5 years. Three patients (75%) recovered completely 2 are living and well 10 years after operation 5 are living 3 years after operation 1 patient is living 2 years and 3 patients, 1 year after operation. Four patients failed to report so died the first year 6 died the second year and 1 died the fourth year after operation.

Basset and Taussing advise a two-stage operation i.e., removal of the inguinal gland at the first stage, and vulvectomy at the second stage. Whenever feasible, the author has performed a one-stage operation followed by radium and x ray therapy.

JOSEPH M. A. PAPP, M.D.

#### MISCELLANEOUS

Crux, H.: Surgery for Female Sterility (*Cirugía de la esterilidad femenina*). Arch. Soc. cir. hosp. Santiago, 1946 6 227

The author enumerates the etiological factors involved in sterility and the means necessary to correct them. Thorough examination of both partners, male and female, should always be done, each being considered equally responsible for the sterility until the exact cause is ascertained. The contributing factors are grouped into five classes:

1. Genital lesions which may be irreconcilable with fecundation these should have careful gynecological correction.

2. Cervical secretion hostile to the semen and in semination through the uterus.

3. Tubal pathosis which either partially or completely occludes the orifice.

4. Endocrine hormonal dysfunction which manifests itself in anomalies of the menstrual cycle and ovarian malfunction this can be determined by endometrial biopsy.

5. Sterility in the male partner. This necessitates complete semen examination.

A complete physical examination in order to ascertain the presence of any general systemic disorder such as syphilis or tuberculosis is necessary.

The genital lesions which cause sterility include genital malformations such as intact, rigid, or imperforated hymen, vaginal atresia or occlusion, a total or partial absence of the vagina, bicornual vaginal septa and bicornuate uterus.

Malposition of the uterus such as retroversion and retroflexion contributes to endocrine ovarian dysfunction which results either in reduction of the total number of ova or production of imperfect ova, or the development of an abnormal endometrium which prevents proper implantation.

Coexisting with retrodisplacement of the uterus may be such conditions as occlusion or constriction of the tubes, congestion and hyperplasia leading toward endosalpingitis, decreased resistance of the pelvic organs to infection, and endometriosis. Antibiosis may also cause stenosis of the fallopian tube in this manner prevent fecundation.

Myoma of the uterus has no absolute relation to sterility. When found, however investigation should look beyond the myomatosis for cause of the sterility. However sterility may result from mechanical occlusion or compression of the tubal organs, especially when there is endocrine dysfunction or coexisting inflammation of the tubes.

Various techniques of surgical treatment of uterine myomas are described.

Ovarian tumors are in themselves no barrier to pregnancy. The number of complications these tumors produce during pregnancy clearly demonstrates this point. The effect of ovarian cysts on sterility is an open question various authors cite percentages ranging from 6 to 17 per cent. The manner in which the sterility is produced is also in doubt. The surgical treatment of ovarian cysts need not require sacrifice of the ovary: various operative techniques are presented illustrating this point.

Inflammatory pelvic lesions constitute the most common cause of sterility in women, gonorrhea being the most frequent offender. Tubal tuberculosis, however, should receive special consideration for its surgical management permits of no conservation in treatment.

There are 2 cervical conditions inimical to fecundation: secretion of substances hostile to the spermatozoa, and closure of the cervical canal. These may be brought about by an endocervicitis, cervical polyp, or stenosis of the external os, and must have appropriate treatment before pregnancy can be expected.

Affections of the tube account for 47 per cent of the sterility in women, the most frequent cause being

gonococcal infections and subclinical tuberculous salpingitis. These contribute to ectopic pregnancy.

Insufflation according to the Rubin technique is considered most useful in the diagnosis of the condition of the tubes as well as being a therapeutic aid in correcting tubal obstruction under certain conditions. The indications and contraindications for hysterosalpingography are given. Surgical correction of tubal obstruction consists in salpingolysis, salpingostomy, resection of the isthmus with end-to-end anastomosis, implantation of the tubes into the uterus, transplantation of the tubal horn or transposition of the ovary into the uterus.

Endocrine dysfunction accounts for 25 per cent of the sterility in women. Suppression of ovarian function is primary and is brought about by some pituitary ovarian imbalance. There is insufficient secretion for inducing ovulation or luteinization or a postinflammatory fibrosis may exist which prevents normal secretion from causing follicular rupture. Polycystic disease follows and surgical methods are usually resorted to for relief.

The masculine element of sterility calls for complete examination of the semen among other factors but the author abstains from enlarging on this point as he considers it beyond the scope of his present theme.

STEPHEN A. ZIEGLER, M.D.

Perli, H.: The Treatment of Functional Traumatic Bladder Incontinence and Vesicovaginal Fistula at the Allmänna BB (Über die Behandlung der funktionellen traumatischen Blaseninkontinenz und der vesicovaginalen Fisteln in d. Allmänna BB). *Acta obst. gyn. scand.*, 1946, 25, 547.

Nineteen cases of women with functional bladder incontinence and 10 with vesicovaginal fistula are reported. Of the 19 patients, 16 exhibited a relative incontinence, that is the urine loss would occur only under special circumstances (heavy lifting, stooping, coughing, laughing), and 3 an absolute incontinence. In 1 instance there was evidence of diabetes insipidus which was, however, interpreted as a relative incontinence. Seventeen of these women had borne children, and in 9 of these the incontinence appeared immediately following the delivery. Of the 9 6 had had a spontaneous delivery in 3 forceps were used and the remaining patient had undergone extraction of a pelvic presentation. In 4 of the remaining 8 patients, in whom the incontinence had developed gradually in the course of from 5 to 15 years following childbirth, the condition appeared coincidentally with a prolapsus vaginae, and in the other 4 no immediate cause could be found. In 1 of the 3 women who had not borne children the condition appeared following emptying of the uterus, and in the other there was a retroverted myomatous uterus which appeared to have drawn the cervix up behind the symphysis.

Of the 10 cases of fistula, 8 had followed childbirth, with a long period of labor and with large children. In 1 of these 8 the delivery was spontaneous and in 6 obstetrical operations were carried out (3 forceps

deliveries, 2 perforations with extraction and 1 extraction of a pelvic presentation). Of the 3 remaining patients who had not borne children 1 had been subjected to extirpation of the uterus following radium therapy and the other had had a paraurethral abscess (urethral fistula).

In 17 of the 19 cases of functional incontinence an anterior colporrhaphy was done and in 13 of these the suture line was reinforced by a muscle plastic operation on the urogenital trigonum or pelvic diaphragm and/or plication or overlapping of the connective tissue of the bladder. The immediate results were good, that is, the involuntary loss of urine was stopped or as good as stopped, in 78.4 per cent of the cases. However the answers to follow up letters of those who responded indicated that there was permanent healing in only 54.5 per cent while the incontinence had recurred in 45.5 per cent, although in no case was it as great as it had been previously. The author believes that the surgeon may be somewhat to blame for these results in that he does not give the patient sufficient instructions for the postoperative period. The patient should not do any heavy work, should not have coitus, and should not even be examined vaginally or have a catheter passed for a period of at least 2 months following the operative repair.

None of the 10 fistulas was firmly adherent to the bony structures of the pelvis and this must be considered as indicating an especially favorable condition for surgery. Seven of these patients were operated upon according to the method of Fueth, or of Fergusson-Braquehave-Fueth with closure of the fistula in all. In one of these 7 a preliminary suprasymphysal fistula was created. In 2 of these 7 cases there was a concurrent urethral defect. In 1 of these 2 the fistula was first closed by the method of Fueth as mentioned and then at a second operation a new sphincter was formed from the pars publica levatoris muscle with satisfactory control of the urine. In the other case the urogenital diaphragm was used to reinforce the urethral defect, however the fistula recurred to a certain extent. In 1 case complete continence was obtained by overlapping with the levator ani muscles and 3 cases must be considered as failures although the fistulas closed spontaneously at a later date. In 1 of these 2 failures in a very corpulent woman section was first done and a suprapubic fistula created, then the bladder mucosa was freed and stitched transversally, this was followed by continued suture of the paravascular connective tissues. However a month later the incontinence had recurred and at the second operation the fistula was again carefully repaired. In a few days the condition had recurred in its original location and to the same extent. The patient was later treated repeatedly for infection of the bladder and stone formation and the fistula finally closed of itself and some degree of urinary control developed. In the second case of failure, 3 operations of repair failed but the fistula closed later of itself nevertheless the incontinence continued.

JOHN W. BRENNAN, M.D.

Stanley M M: Gonococcal Peritonitis of the Upper Part of the Abdomen in Young Women (Phrenic Reaction, or Subcostal Syndrome of Stajano; Fitz-Hugh-Curtis Syndrome): Report of Cases of 3 Patients Treated Successfully with Penicillin and Summary of Literature *Arch. Int. Med.*, 1946, 78: 1

Peritonitis of the upper part of the abdomen in young women occurring during the course of gonorrhea was first described as a definite syndrome in 1919 by Carlos Stajano. In 1930 Curtis called attention to the frequent coexistence of gonococcal salpingitis and "violin string" adhesions between the anterior surface of the liver and the anterior abdominal wall discovered at operation, conditions indicating presumably a chronic, healing, or healed perihepatitis. Fitz-Hugh, in 1934, described 3 cases in the acute stage. Since then numerous articles have appeared in the literature, and the clinical entity has been well documented.

The purpose of this article is to report 3 typical cases of gonococcal perihepatitis. All 3 patients were treated with penicillin and recovered rapidly.

Invariably women in whom the syndrome develops have had an antecedent gonococcal infection sometimes as much as 5 years previously. Often it will be impossible to elicit the usual symptoms of gonorrhea. However on direct questioning a history will frequently be revealed of menorrhagia or dysmenorrhea, burning on urination, vaginal discharge, or vague pain in the lower part of the abdomen during the few days or weeks preceding the occurrence of frank symptoms of peritonitis.

The onset is usually dramatic. There is the sudden occurrence of excruciating sharp pain in the upper part of the abdomen, usually on the right side, most intense anteriorly under the rib margin and often referred to the top of the corresponding shoulder. It is of the "pleuritic" type, exaggerated by deep breathing, coughing, laughing, and by movements of the trunk. Nausea may be troublesome. Nausea is of frequent occurrence, but vomiting follows less often. When symptoms are present in the lower part of the abdomen they are usually worse on the side of the phrenic reaction, but they are usually overshadowed by the more acute process in the upper part of the abdomen.

It has been repeatedly recognized that trauma to inflamed pelvic organs in the form of surgical procedures, gynecological examination, intercourse, or douching may precipitate the development of this complication. One of the most frequently observed types of reaction in the experience of Stajano was the postoperative variety.

The physical examination discloses an acutely ill but not prostrated patient. The temperature is usually somewhat elevated, although rarely above 103°F. There is pronounced tenderness and muscular spasm at the site of greatest intensity of the pain, usually in the right upper abdominal quadrant, which indicates an underlying peritoneal inflammatory process. Occasionally a friction rub is heard.

The suspicion of preceding gonorrhea aroused by the finding of slight or moderate tenderness in the lower part of the abdomen is confirmed when other evidences of gonococcal infection—inflammation of Skene's glands or the glands of Bartholin, urethritis, cervicitis, or salpingitis—are discovered. Small pleural effusions, confirmed by the aspiration of small quantities of fluid, are not uncommon.

Other stigmas of gonococcal infection, and as arthritis, tenosynovitis, or keratosis blennorrhagica, may be present.

Culture of the cervical or urethral secretions under proper conditions invariably yields gonococci. The observation is often not confirmed by the examination of stained smears, no matter how painstakingly carried out. Leucocytosis is the rule, although the total count is usually not elevated above 15,000 white cells per cubic millimeter of blood. A very slight, transient elevation of the bilirubin content of the blood may be found. A slightly icteric tinge has been noted. Duodenal drainages were performed on 18 patients in one series with uniformly negative results.

Röntgenological visualization of the gall bladder by means of radiopaque dye reveals a normally functioning organ, without stones, in nearly every instance. A nonfilling gall bladder may occasionally be found.

The roentgenogram of the chest is usually normal except for some elevation of the diaphragm on the affected side.

Although gonococci have not actually been cultured from material taken directly from the subphrenic space at operation, there can be little doubt that they are present. Localized, fairly dry peritonitis involving the anterior surface and edge of the liver, the adjacent peritoneal surface of the diaphragm, and the anterior abdominal wall has been noted. The peritoneum in these areas was injected and had the appearance of salt sprinkled on a moist surface. Presumably this acute inflammatory reaction subsides in a few weeks and leaves the "violin string" adhesions in the same location.

There appears to be almost no tendency toward abscess formation in the subdiaphragmatic space following its invasion by the gonococcus.

The route of extension of the infection from the pelvis to the subphrenic spaces, whether via the paracolic gutter or through the retroperitoneal lymphatics, is in doubt. Definitely in some instances, there is direct extension rather than metastasis.

When one is presented with the clinical picture previously described, especially in a young woman, the diagnosis can be made with a high degree of certainty by merely establishing the presence of gonococci in the urethra or cervix. This decision should be made on the basis of culture, and not of smears alone.

The most frequently encountered diagnostic problem is the differentiation of gonococcal peritonitis from acute cholecystitis. Other abdominal conditions from which this disease must be differentiated

include ruptured peptic ulcer, appendicitis with subphrenic abscess, and other forms of peritonitis.

An accurate diagnosis is important, especially in ruling out those diseases requiring surgical intervention, for not only is such interference unnecessary but it may actually be harmful.

There have been no deaths reported as resulting from this type of gonococcal peritonitis. The usual course when it is untreated is slow subsidence of the acute pain to a dull ache which gradually disappears, the whole process requiring from 1 to 4 weeks.

At the present time penicillin is the drug of choice with doses of 30,000 units administered every 3 hours intramuscularly; there is almost complete relief of symptoms after 24 hours of treatment.

Three typical cases of gonococcal peritonitis treated by penicillin are reported by the author.

DANIEL G. MORTON, M.D.

Ciotti, R. Umbilical Metastases from Tumors of the Female Genitalia. (*Metastasi ombelicali da tumori dell'apparato genitale femminile*). *Riv. ital. ginec.*, 1944, 27, 107.

Skin metastases are very rare in malignant tumors, especially in those of the female genitalia. No accurate statistics as to their frequency can be collected from the literature.

The author describes 2 cases of metastasis to the umbilicus. The first was in a woman of 56 who was operated on May 12, 1941, for an adenocarcinoma of the right ovary with extensive adhesions to the omentum and ascending colon. The laparotomy incision did not reach the umbilicus. The patient was readmitted to the hospital March 13, 1942. She was still in good general health with normal genital findings, but the base of the umbilicus was ulcerated and the ulceration was covered with a reddish fungoid growth which bled easily. Fragments removed from the umbilical region showed the same structure as that of

the primary tumor. She was given radium treatment and discharged from the hospital March 28. She is still living.

The second case was in a woman of 59. Curettage of the uterus February 13, 1941, showed adenocarcinoma of the body. The patient objected to operation and was given roentgen radium treatment and discharged on May 20, 1941. She was readmitted February 17, 1942, and reported that a small dark red nodule had been developing in the umbilicus for about 2 months. The nodule was the size of a cherry and surrounded by normal skin, but the surrounding tissue was infiltrated. Examination of a biopsy specimen showed the same structure as that of the primary tumor. Roentgen and radium treatment was given and the patient was discharged with the lesion almost entirely epithelialized. She died later however in another hospital.

In the first case the adhesions indicated that diffusion of the tumor to the abdominal cavity had already taken place at the time of the operation. From the parietal peritoneum the cells had passed by continuity to the skin following either the interstices of the tissues or the local lymphatic spaces.

In the second case the tumor had apparently not invaded the abdominal peritoneum. However when the patient was readmitted after a year in poor general condition, the liver was enlarged and it is probable that the tumor had diffused along the lymphatics of the falciform ligament and those of the round ligament and reached the skin. On the other hand it is possible that the lumbocortic lymph glands first became involved and that the process extended from there to the lymph glands of the liver secondarily, or the tumor may have extended through the lymph glands of the urachus to the umbilicus and then to the liver. These skin metastases do not take place through the blood circulation.

AUDREY G. MORROW, M.D.



# OBSTETRICS

## PREGNANCY AND ITS COMPLICATIONS

Newton, W. H., Theobald G. W. and Nixon, W. C.  
W : Discussion on Water Metabolism in Pregnancy. *Proc. R. Soc., M* Lond., 1946, 39 538.

W. H. NEWTON. The speaker first reviews briefly the general principles involved in the distribution of water in the blood stream, the interstitial spaces and the cells, and then analyzes the situation occurring during pregnancy. Various balance experiments indicate that during the latter part of pregnancy about 3 gm. of sodium are retained weekly. If this were all osmotically active it would require the storage of about 1 liter of water weekly to dilute it, but as this does not occur it must be assumed that all of the sodium does not exert osmotic pressure. With the increase in plasma volume there may be a decrease in plasma protein which in turn decreases the osmotic pressure in the blood stream and alters the fluid exchange. The legs constitute 37 per cent of the body weight, and the three fold increase in venous pressure in the lower extremities during pregnancy tends to force water out into the tissues. This may be counterbalanced by increased tissue pressure.

G. W. THEOBALD. The fluid balance in the body is ultimately controlled by the kidney but certain factors may interfere particularly during pregnancy. The increased blood volume may be compensatory for the increased vascular bed. Dilution of the blood decreases the effective osmotic pressure of the plasma proteins and therefore the protein intake should be high during pregnancy. Increased amounts of sex steroids are responsible for electrolyte retention during pregnancy and thus, likewise for water retention. Probably all of the sodium is not osmotically active since not enough water can be accounted for if this were true. The average weight increase is about 24 pounds, but estimates of the total nitrogen retention show an average of about 1 pound which is equal to 6 pounds of protein or 30 pounds of new tissue. Since this does not occur it seems obvious that much of the nitrogen is stored as such. Some of the weight increase is due to water retention since edema occurs and since so much water is lost rapidly after delivery. Weight gains which are significant in indicating water retention are sudden gains late in pregnancy. A slow increase over a long period of time is less significant. Excretion of ingested fluid during pregnancy is delayed with the patient in an upright position, therefore bed rest is the best position for the patient in whom there is abnormal fluid retention.

W. C. W. NIXON. Edema is the main clinical evidence of abnormal water metabolism. Pregnancy added to a deficiency state may be associated with edema, this is particularly true in the lack of vitamin B<sub>1</sub>. Vulvar edema may be due to protein deficiency. The mechanism of edema is not always understood. Edema is affected by posture, therefore the feet and

hands are common sites for the condition. This disappears when the individual lies down. Treatment depends upon the elimination of salt and water for the more severe cases (the fluid intake should be restricted and the patients given hypertonic glucose solutions intravenously). Plasma may likewise be used.  
J. ROBERT WILLIAMS, M.D.

Moscoso, C. J. : Large Ovarian Cysts with Torsion of the Pedicle Complicated by Pregnancy (Grandes quistes de ovario con torsión de pedículo embarazado). *Obst. gín. inf. amer. B. Abt.* 1946, 4 6.

This article relates the fundamentals necessary in diagnosis of an ovarian cyst in the presence of pregnancy, the necessity of distinguishing it from tumors of the liver, bladder, pancreas, mesentery and intestines, and the symptomatology when a twisted pedicle has occurred. The last depends upon whether or not the torsion is acute or chronic. If acute, three forms are possible: (1) cases in which there is internal hemorrhage with symptoms of acute anemia and rupture of the viscus; (2) cases in which there is peritonitis, with pain, distention, rigidity, nausea, and vomiting; and (3) cases in which there is mechanical obstruction, with symptoms of intestinal obstruction.

The case histories of 2 pregnant patients are presented, each of whom had a right ovarian cyst with a twisted pedicle.

At operation the tumor in the first patient was found to lie transversely and adjacent to the liver and that in the second patient fell over to the left side adjacent to the splenic flexure. Both tumors were removed without any disturbance of the subsequent course of gestation.

In the discussion of this rare affection it is thought that pregnancy predisposes to torsion, and when torsion is observed immediate operation is indicated.

STEFEN A. ZINCK, M.D.

Macafee, G. H. G., Phillips, L., Barnes, J. Young, J. and Others: Discussion on Placenta Previa. *Proc. R. Soc. M* Lond., 1945, 39 551.

C. H. G. MACAFEE. Since 1937 191 cases of placenta previa have been cared for by one staff member of the Belfast Royal Maternity Hospital. The maternal mortality was 0.53 per cent and the corrected fetal mortality 18.6 per cent. Since the main cause of fetal mortality associated with placenta previa is prematurity, carrying the patient to as near term as possible will reduce this rate. This can be done safely if the patient is watched in the hospital as the initial hemorrhage is rarely profuse. Eventually vaginal examination was carried out after all preparations had been made to deliver the patient, in order to determine the type of placenta previa so that an adequate plan of treatment could be outlined.

**L. PHILLIPS.** In 139 cases of placenta previa treated at Queen Charlotte's Hospital prior to 1933, the maternal mortality rate was 6.47 per cent and the fetal mortality 52.5 per cent. In the next 143 cases the maternal mortality was 1.4 per cent and the fetal mortality 58.7 per cent. The factors responsible for the reduction in maternal mortality were (1) the better condition of the patients on admission, (2) the increased use of blood transfusion, (3) the extended scope of cesarean section, and (4) the team work among the obstetrician, the resident staff, and the nurses. All cases were examined under anesthesia to determine the type of placenta previa. In those in which the os was completely covered or in primigravida with a long closed cervix, cesarean section was done. In incomplete placenta previa the membranes were ruptured in vertex positions and a foot was pulled down in the breeches. If bleeding continued vaginal tamponade was done. The mistakes that might have increased the mortality were (1) immediate examination in all cases which increased the fetal mortality (2) failure to have preparations made for cesarean section, (3) the use of dilators if the cervix was closed and (4) plugging of the vagina.

**J. BARNES.** In 140 cases of placenta previa the maternal mortality was 2.9 per cent and the fetal mortality was 52.2 per cent. Of the 71 infants lost, 38 died after a leg had been pulled down to control hemorrhage, prematurity and intrapartum asphyxia were major factors in infant deaths. Of the 4 maternal deaths 1 followed hemorrhage associated with bougie induction, 1 was due to pulmonary embolism on the seventeenth day, 1 was due to shock, and the fourth was due to septicemia. It is recommended that all patients be treated in a maternity hospital so that sepsis can be avoided and blood be available. Patients should be treated expectantly without vaginal examination in the absence of severe hemorrhage.

**J. YOUNG.** In 108 cases the total fetal mortality was 19.4 per cent during the first 6 years of the 10 year study the infant mortality was 29.2 per cent and in the last years 13.4 per cent. In 33 cases treated expectantly the fetal death rate was 9 per cent.

**M. KERR.** For the most part treatment of placenta previa should consist of rupture of the membranes for the less severe cases and cesarean section for the rest.

**A. W. PURDIE.** In 143 cases treated at the North Middlesex County Hospital there was 1 maternal death from hemorrhage. The fetal mortality was 31.97 per cent. Forty one cases were treated expectantly for from 12 hours to 67 days and in this group the fetal mortality was 25.6 per cent. In the entire series 11 more babies might have been saved by expectant treatment.

**R. C. THOMAS.** In 182 cases treated expectantly the infant mortality was 23 per cent. By delaying examination it was possible to carry 125 infants to at least 38 weeks and another 25 to at least 36 weeks. The mortality associated with scalp traction was

only 12.8 per cent in 47 cases as compared to 57 per cent in 7 breech presentations.

**J. HALLWORTH.** This speaker emphasized the fact that if the placenta is situated on the posterior wall descent of the presenting part may be delayed because of shortening of the true conjugate, and thus hemorrhage might not be controlled. He advocates cesarean section in such an instance.

**PRESIDENT.** Rupture of the membranes or cesarean section produces the best results with version, bringing down a foot or scalp reaction the mortality is too high. **J. ROBERT WILLSON, M.D.**

## LABOR AND ITS COMPLICATIONS

**Wrigley A. J.** *The Problem of Postmaturity* *Proc. R. Soc. M., Lond., 1946* 39 569.

The author after reviewing the available literature, both in textbooks and medical journals concerning postmaturity concludes that the diagnosis can be made only with difficulty and that there is no unanimity of opinion concerning the management of patients who go past the expected date of confinement. He states that the height of fundus, the circumference of the abdomen, engagement or non-engagement of the fetal head, and x rays are of little help in establishing the diagnosis. The only way in which postmaturity can be determined is by repeated examination of the patient near term with the following points in mind:

1. Unusual fetal size can usually be determined on repeated examination.

2. As the muscles of the fetus develop they acquire more force and the fetus becomes rigid; this is not characteristic of premature or term infants.

3. Since the quantity of liquor amni does not increase the enlarging fetus becomes more readily palpable and appears to fill the uterus completely.

When these signs are present the author assumes that the infant is postmature regardless of the duration of amenorrhea and suggests that the pregnancy be terminated by medical induction of labor followed by surgical induction if the former procedure fails.

**J. ROBERT WILLSON, M.D.**

**Brown H. O., Thomson, J. M., and Fitzgerald J. E.** *An Analysis of 500 Obstetrical Cases Managed under Continuous Caudal Anesthesia with Pontocaine Anesthetics* 1946 7 355

The authors review the recent literature concerning the techniques, results and dangers of caudal anesthesia, and present a detailed analysis of a series of 500 obstetrical cases in which continuous caudal anesthesia with pontocaine as the anesthetic agent had been used. They contend that since only one-tenth as much of the agent is necessary as compared with procaine, the sixfold increase in toxicity of the former drug makes it safer than the latter, the total comparable doses being smaller. In addition to this the use of 1:1000 suprenalin as a vasoconstrictor prolongs the anesthetic action, thus further diminishing the total amount of anesthetic agent needed.

## INTERNATIONAL ABSTRACTS OF SURGERY

The initial test injection (8 c.c. of 0.10 per cent solution) contained 8 mgm. of the drug. Subsequent injections were 30 to 35 c.c., as necessary. The first dose after the test injection usually relieved pain for from 3 to 5 hours but subsequent doses lasted for shorter periods of time.

Caudal anesthesia is indicated for relief of pain during the latter part of the first stage of labor for delivery of primigravida, to afford rest in prolonged labor to prevent the need for inhalation anesthesia in premature labor in cardiac disease and in eclampsia. The contraindications include inexperience of the operator, local infection, obstetrical complications such as placenta previa, premature separation, cephalopelvic disproportion and contemplated need for uterine relaxation, as for version and extraction. In addition, obesity, deformity, debility, anemia, neurologic disease, hysteria, syphilis, sensitivity to local anesthesia, and pilonidal dimples may be contraindications.

The needle is inserted with the patient in Sims or modified knee-chest position, and is replaced, by a catheter after which the test dose is injected. The criteria used to verify accurate placement of the needle or catheter in the caudal canal are as follows: (1) typical sensation on inserting the needle, (2) contact with bone superficial to the midline of the back, (3) the needle parallels the midline of the back, (4) ease of injection, (5) freedom from impact back, (6) ease of injection, (6) negative impact test over sacrum when 3 c.c. of the fluid are forcefully injected, (7) absence of subcutaneous crepitation when air is injected, (8) sciatic pain with rapid injection, and (9) ability to pass the catheter freely beyond the tip of the needle.

The incidence of operative deliveries was 69.8 per cent as compared to an average of 8.55 per cent of forceps extractions in a total of 6,997 deliveries; occiput transverse or posterior presentation occurred in 19.8 per cent of cases.

Ten babies died however in 9, factors unrelated to anesthesia were thought to be responsible. One baby died from aspiration due to the early onset of respiration. There were no maternal deaths. In 46 (9.2%) of the patients, a fall in blood pressure of more than 30 points was noted and in 18 the fall was greater than 50 points.

The complications were as follows: The dura was penetrated in 3 instances, the needle broke 4 times, 5 superficial skin infections occurred and in only 4 was severe chills following the injection and in only 4 was there associated fever. Motor and sensory weakness persisted longer than 24 hours in 4 patients (for 6 months in 1 patient). One patient had fecal and urinary incontinence for 11 days in another patient urinary incontinence lasted for 6 weeks.

Satisfactory anesthesia and analgesia were obtained in 428 cases. Failure to insert the needle occurred in 13 cases, in 16 inadequate time or dosage was responsible for the failure, in 16 technical difficulties occurred, and in 6 the needle was removed for other reasons.

Mendelson, C. L.: The Aspiration of Stomach Contents into the Lungs during Obstetric Anesthesia. *Am. J. Obst.*, 1946, 53, 19.

In a series of 44,016 pregnancies at the New York Lying In Hospital, the author observed 66 (0.15%) of aspiration of stomach contents into the lungs during obstetric anesthesia. Gastric retention of solid and liquid material is prolonged during labor and the aspiration of vomitus into the lungs may occur while the laryngeal reflexes are abolished during general anesthesia. Bronchial configuration favors right-sided respiration, but massive aspiration readily involves both lungs.

Aspiration of solid material produces the clinical picture of laryngeal or bronchial obstruction leading to massive atelectasis with dyspnea, tachypnea, cyanosis, mediastinal shift, and signs of consolidation over the collapsed area. X-rays reveal a homologous density in the affected area and varying degrees of mediastinal shift.

Aspiration of liquid contents produces an atelectatic syndrome. There is cyanosis, tachypnea, and dyspnea, but no mediastinal shift of masses and wheezes, rales, and ronchi are heard over the affected portions of the lungs. Impairment of the affected portions of the lungs is shown in the roentgenogram. This syndrome is due to the irritation of gastric hydrochloric acid which produces bronchial spasm, and a peribronchovascular and congestive reaction. Animal experiments were carried out.

The author believes that the aspiration of stomach contents into the lungs is preventable, and recommends appropriate precautions. Active treatment that of relieving obstruction in the first group, and the use of oxygen, amorphous phylline, adrenalin, and atropine to relieve the bronchomotor spasm in the latter group.

EDWARD L. CORNELL, M.D.

Odell, L. D., and Pless, E. D.: Intrapartum Fever. A Preliminary Study. *Am. J. Obst.*, 1946, 51, 19.

Fever during labor may be due to dehydration, extragenital disease, or birth canal infection. The last is diagnosed by excluding the other two, or by the discharge of foul material from the tract. The primary lesion in infections of the genital tract is the amnionitis (placentalitis) which subjects both the mother and the child to serious sequelae. In the mother, puerperal infection frequently develops and may be fatal, while aspiration into the placental vessels by direct extension into the child.

In this series of 187 febrile labors, 139 of the mothers presented evidence of birth canal infection alone or in combination with an extragenital factor. In the latter group 8 mothers and 46.9 per cent, respectively. Dehydration fever was followed by maternal or fetal deaths, but pyrexia of extragenital origin (no evidence of uterine infection) led to a maternal death rate of 36.8 per cent and a fetal mortality rate of 42.2 per cent.

J. ROBERT WILSON, M.D.

Treatment of dehydration fever and of extragenital diseases followed the usual methods. On the other hand therapy of intrapartum birth canal infections has been significantly and favorably altered by recognition of the dangers involved and by the use of the newer antibiotics, the sulfonamides and penicillin, prophylactically and curatively.

EDWARD L. CORNWELL, M.D.

## PUERPERIUM AND ITS COMPLICATIONS

Vara, P: Puerperal Infections and Sensitiveness to Streptococcal Toxins. *Acta obst gyn scand.*, 1946 56 413.

This article deals with an attempt to determine (by means of the Dick skin test) which obstetric patients may be more susceptible to puerperal infections.

The author presents a statistical review of puerperal infections observed in the Women's Division of the Helsinki University during the 20 year period from 1925 to 1944. This review reveals a definite reduction in the incidence of the mild forms of endometritis but none in the incidence of septic endometritis with the hemolytic streptococcus and blood stream invasion.

The results of intracutaneous tests performed on 1,000 women at term were as follows:

Incidence of Reaction to Dick Test Per cent	Incidence of Infection Per cent
+ 6.9	5.88
= 13.6	4.38
- 80.5	1.30

Serious infections were likewise more common in the first two groups. Internal examinations and manipulations raised the incidence of infection in all groups, but to a less degree in the Dick negative

group. The author concludes that the test should be made routine so that the Dick positive and Dick positive/negative group may be handled with greater care and provided with prophylactic chemotherapy.

JAMES F. DOXNELL, M.D.

## MISCELLANEOUS

Quigley, J. K.: An Analysis of Maternal Deaths for 12 Years in Monroe County Including Rochester. *N York State J M* 1946 46 199.

The analysis of maternal deaths for a 12 year period in Monroe County New York is presented. A total of 232 deaths are recorded among 81,446 births for the period from 1933 to 1944 or a maternal mortality incidence of 2.8 per 1,000 births. Accidents and complications incidental to early pregnancy accounted for 50 deaths which would materially reduce the term or near term incidence. Thirty-two deaths were directly due to infected or septic abortion, 3 to abortion without sepsis and 15 to ectopic pregnancy.

Puerperal septicemia accounted for 15.9 per cent of all the deaths, puerperal hemorrhage for 12 per cent, and toxemias for 12.5 per cent. There were 26 instances of eclamptic death of which 15 were judged to have occurred following adequate prenatal care. However, a more critical breakdown of statistics showed that from 1933 to 1937 there were 16 deaths due to eclampsia among 29,607 deliveries, or 1 in each 1,850 while from 1938 to 1944 there were only 10 deaths among 51,839 deliveries or 1 in each 5,184.

Phlegmasia and embolus with sudden death occurred 26 times, or in 11.2 per cent of the total. There were 40 deaths (17.2%) due to extrapuerperal causes such as heart disease, pneumonia, and various surgical complications. GEORGE BRADBURY, M.D.

# GENITOURINARY SURGERY

## ADRENAL, KIDNEY AND URETER

**Sabadini, L.: The Value of Early Pyelography and Functional Tests in Contusions of Kidneys** (Valeur de la pyélographie précoce et l'intérêt des examens fonctionnels au cours des contusions du rein) *J. urol. med. Par.* 1944-1945, 52, 305.

The danger of infection by the contrast medium and the aggravation of hemorrhage by traumatism militate against pyelography in renal contusions, according to the prevailing opinion. The author does not share this view because the contrast medium is sterile and even possesses bactericidal properties, and the procedure does not cause any trauma.

He employed early pyelography in 8 patients with intrarenal and 7 patients with extrarenal lesions. The opaque medium was injected in the course of a few hours after the accident, after termination of blood shock. Ureteral catheters were never occluded by blood clots. In spite of the fact that no prophylactic measures had been employed, no infection followed pyelography and the slight elevation of temperature observed in only one patient was attributable to pulmonary complications.

Even repeated procedures did not aggravate the symptoms nor produce any infection or recurrence of hemorrhage.

As to the value of pyelography in renal contusions, the studies may reveal the location of the lesion and involvement, if any, of perirenal tissues. In minor injuries negative x-ray findings strengthen the sense of security, while in more serious injuries absence of evidence of grave lesions in roentgenograms suggests conservative treatment. Finally in very serious injuries the corresponding findings corroborate the clinical diagnosis. Occasionally pyelography may reveal serious lesions not detectable by clinical examination.

Elevation of the left side of the diaphragm and its immobility combined with the presence of dullness in the lower left thoracic region, confirm the diagnosis of perirenal hematoma.

Functional tests of kidneys are also valuable for the evaluation of the condition particularly from the medicolegal viewpoint.

The author emphasizes the relatively small diagnostic value of hematuria even a considerable amount of relatively long duration does not indicate a grave contusion.

The opaque medium should be injected very slowly through ureteral catheters, with the patient in Trendelenburg position. If an intrarenal cavity is disclosed a perirenal hematoma is small or absent and the patient is in good general condition no exploration is indicated.

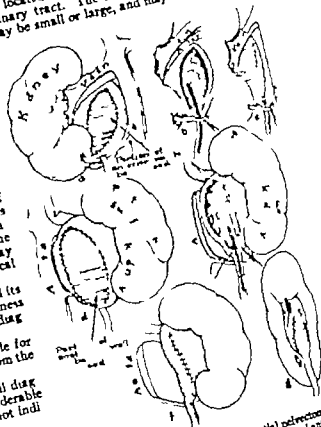
If the contrast medium enters the renal parenchyma and perirenal tissues, a suture of the kidney is indicated if the contusion is not very extensive and

the general condition of the patient is serious. If a perirenal hematoma is apparently not very extensive, the contusion of the renal parenchyma is marked and the general condition of the patient satisfactory an expectant treatment is indicated; repeated x-ray studies are desirable.

JOSEPH K. NAKAT, M.D.

**Hinman, F.: Hydronephrosis. The Surgical Treatment** *Surgery* 1945, 20, 337

The author presents a comprehensive review of accepted methods of treating hydronephrosis. He stresses the fact that the first principle in treatment is diagnosis, which includes not only the proof that the condition is present but a demonstration of its cause, degree and complexity. Obstruction to urinary flow may be unilateral or bilateral and may be located in the upper or lower portion of the urinary tract. The resulting back pressure may be small or large, and may be accompanied by



**Fig. 1 (Hinman, F.) Method of partial pyelotomy after pyeloureterolysis.** a. Oblique area to be excised anteriorly corresponding oblong area posteriorly (seen through anterior opening) to be excised. b. Appearance after closure of a, and c. closure of posterior wound, d. points reduced to almost normal size with good ureteropelvic anastomosis.

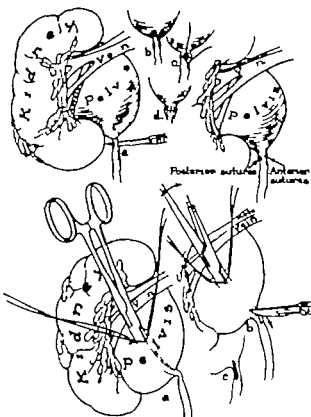


Fig. 2. Longitudinal incision with closure after method of Hencke-Mikulicz. Lower diagrams illustrate a. Insertion of tip of curved clamp through an opening in pelvis into the area of constriction b. Incision made upon tip of this clamp as a guide and c. Incision before closure. Upper diagram illustrates how a double incision (a and b) with closure (c and d) will secure additional dilatation, as (Gibson)

secondary effects elsewhere which add to the degree of renal obstruction independently and thus complicate the therapeutic problem.

The aim of treatment is always the preservation of renal tissue with the least risk. Occasionally non-interference is wisest but usually there is a choice between doing one or more of several different procedures.

Two distinct types of hydronephrosis are recognized an insular hydronephrosis, which is an isolated pyelectasis and hydronephrotic atrophy of pure ureteropelvic origin and a hydronephrosis similar pathologically but due to obstruction and accompanied by changes below the ureteropelvic junction.

The point of view that any hydronephrosis not completely functionless should be repaired is condemned. The patient gains little from the repair of a kidney which would not be able to maintain renal function in the event of the loss of the opposite kidney. However if an uninfected hydronephrotic kidney is capable of performing anywhere near one-fourth to one-fifth of total function, and it is believed that after relief of the obstruction the renal parenchyma of the hydronephrotic kidney has reserve potentialities which would permit its renal units to hypertrophy upon stimulation as would happen

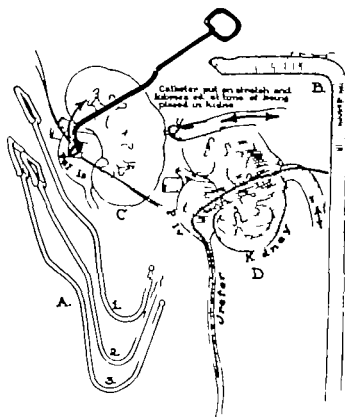


Fig. 3. The nephrectomy tube and ureteral splint a. The metal guides of various sizes and shapes (1, 2, and 3) the one which is most suitable being selected b. Nephrostomy tube (angulated suprapubic drain) c. The metal guide inserted retrograde through an opening in the pelvis with the tube (suprapubic drain) tied to its end by heavy silk suture d. tube and splint in place. (The metal guide pulls the tip of the tube to the pelvic opening. The heavy silk tie is cut. The catheter-splint is passed down the tube through a slit in it at a, and is then threaded on down the ureter through the opening of the pelvis which is then closed, as shown here by 2 interrupted sutures.)

when some disaster struck its compensatory mate repair of the hydronephrotic kidney is indicated. In cases of bilateral hydronephrosis repair of the poor side first is the rule because (1) postoperative renal insufficiency and the danger of anuria will be less and (2) an optimal degree of repair of both kidneys will be secured. In the event of a decision to perform bilateral repair the second operation should not be delayed too long.

A classification of plastic repair operations for insular hydronephrosis is presented and each procedure is listed and illustrated. These procedures have been grouped as follows:

1. Pelvioureterolysis with retrograde dilatation division of aberrant vessel partial pelvectomy or pelvic plication (Fig. 1)

2. Incision of the stenosis (when the obstruction has not been removed by pelvioureterolysis) by simple longitudinal incision (Fig. 2) Y incision

W incision or multiple longitudinal incisions or the ureteral wall down to the mucosa at the site of stenosis without suturing



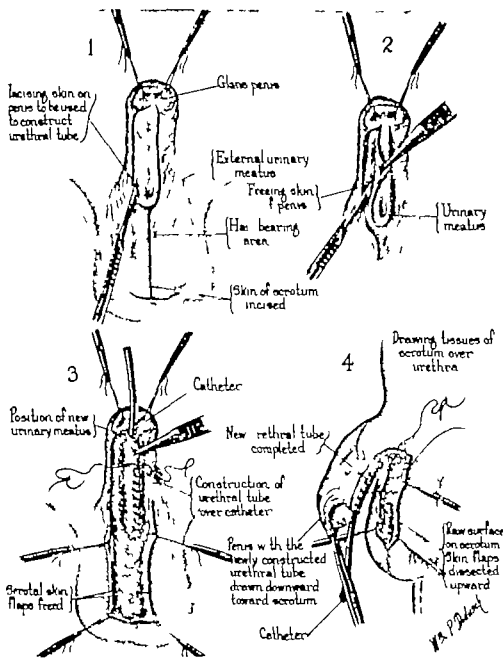


Fig. 1 (Cecil, A. B.)

the scrotal skin is sutured over the urethra, and the skin defect remaining in the scrotum below is sutured.

The author states that slight variations of this operation make it applicable to the cure of one or any number of urethral fistulas, no matter of what degree.

CLARENCE V. HODGES, M.D.

# GENITAL ORGANS

Hansen, T. S.: Fertility in Operatively Treated and Untreated Cryptorchism. *Acta chir scand.* 1946 94 117

The object of this work was to investigate the fertility in operatively treated and untreated cryptorchism on the basis of sperm examinations carried

out according to modern methods. On the basis of the sperm examinations, the presumed impairment of fertility is classified as slight, moderate, and severe; the frequency of abnormal heads, the amount of the ejaculate, and the motility being at the same time taken into consideration. Sterility has only been inferred in cases of aspermia. The material comprises 124 patients in all.

Examination of the sperm from 9 patients with untreated bilateral cryptorchism revealed aspermia in all cases, and thus sterility.

Examination of the sperm from 25 bilaterally cryptorchic men treated with orchidopexy revealed 14 cases of sterility, 4 of presumably severe, 2 of moderate, and 3 of slight impairment. In 2 cases only no sign was found of an impairment of fertility.



These results show that the fertility in bilateral operatively treated cryptorchism is essentially poorer than the literature would seem to show.

Examination of the sperm from 36 patients treated with orchidopexy owing to unilateral cryptorchism, showed 3 cases of sterility, 4 of presumably severe, 4 of moderate and 10 of slight impairment of fertility while 15 exhibited no signs of an impairment of fertility.

Examination of the sperm from 35 patients with untreated unilateral cryptorchism revealed 1 case of sterility, 7 of presumably severe, 3 of moderate and 11 of slight impairment of fertility while 13 exhibited no signs of an impairment of fertility.

A comparison of the two materials of unilaterally cryptorchic men shows that both the separate items of the sperm examination and the fertility estimates are very nearly identical. In addition it is seen that the patients in the author's material produce, on an average, half as many spermatozoa as the men of a large normal American material. This result and the identity between the examinations of treated and untreated cryptorchic men would seem to show—like the examinations of the operated upon bilaterally cryptorchic patients—that no essential production of spermatozoa takes place in the operated testes.

On the basis of these investigations certain lines of treatment are suggested which are deemed advisable in the various forms of cryptorchism. Unilateral cryptorchism requires no treatment with a view to fertility. In bilateral cryptorchism a possible spontaneous descent should be awaited, occasionally in connection with hormonal treatment. Bilateral orchidopexy should not be performed lest it result in bilateral testicular atrophy.

JOHN E. KIRKPATRICK, M.D.

Hultberg, S.: Results of Treatment with Radiotherapy in Carcinoma of the Prostate. *Acta radiol.*, Stockh., 1946, 7: 339.

One hundred and sixty-seven cases of carcinoma of the prostate treated by irradiation at Radium hemmet from 1929 to 1940 are reviewed. Of these, 107 were inoperable and these received radiation therapy alone, 46 cases received postoperative radiation therapy, and 15 of these had been subjected to a previous radical operation. In 14 patients with local recurrences or metastases after a previous operation, radiation therapy was given. The author believes that the perineal approach gives a better exposure and the opportunity to diagnose prostatic carcinoma at an earlier stage. By this route a more radical removal of the lesion and a better ultimate result is attained.

Of the inoperable patients, 16 per cent survived for more than 3 years, and 5½ per cent for more than 5 years. Of the patients who were operated upon, 38 per cent survived more than 3 years and 20 per cent more than 5 years.

Seventy patients received only x-ray therapy, 25 teluradium and 65 a combination of both. Of those treated with x-ray alone, 13 per cent lived for more

than 3 years and 1.4 per cent for more than 5 years. Among the cases which were treated with telurium alone or in combination with x-ray, 24 per cent survived for more than 3 years, and 12 per cent for more than 5 years.

Those patients who had metastases at autopsy or who subsequently developed them had a mean period of survival of 12.9 months from the time when the metastases were first demonstrated.

FREDERICK A. LUTIN, M.D.

Vest, S. A., and Frazier T. H.: Survival following Castration for Prostatic Cancer. *J. Urol.*, L., 1946, 56: 97.

Vest and Frazier state that from a study of the literature reasonably correct evaluations of some of the itemized topics are evident, while in other instances data are presented which give diametrically opposed impressions.

- 1 Symptomatic improvements (a) relief from pain for varying periods of time (b) relief of symptoms of urinary tract obstruction to a varying degree (bleeding, residual urine, improvement of infection) (c) improvement of general well being (strength, vigor, appetite, weight, anemia)
- 2 Value of hormone control therapy in producing regression of the local and metastatic growth of prostatic cancer
- 3 Value of serum acid and alkaline phosphatase in diagnosis and prognosis
- 4 Histological changes in the cancerous area following hormone control therapy
- 5 Therapeutic effects relative to grade or differentiation of the cancer
- 6 Changes in the hormone excretion pattern in the urine from both quantitative and qualitative standpoints
- 7 Response to orchectomy in patients of different age groups
- 8 Results of treatment when compared to the duration of disease before the treatment was instituted
- 9 Evaluation of orchectomy as prophylaxis against local growth, extension of the tumor and metastases
- 10 Consideration of the results in so-called prophylactic cases or those with early metastatic cancer as compared with those in cases with metastases
- 11 Value of castration versus estrogenic therapy
- 12 Value of the various estrogenic substances alone, before, with, or after castration
- 13 Effect of various estrogenic substances on tissues other than the prostatic cancer
- 14 Effect of x-ray therapy directly to the adenoma and pituitary gland in combination with other hormonal control methods
- 15 Life expectancy or survival after hormone control therapy as compared with that following the many other therapeutic procedures that have been used to combat this disease

In a study of the literature it is evident that much more time must pass before many of the numerous questions concerning effects following hormone control therapy can be answered. One of the most important questions concerning orchiectomy for prostatic cancer is the possible effect on survival time following treatment. The survival time in the last analysis is certainly the best statistical measure of any therapeutic procedure. There exists a complete lack of uniformity in presenting statistics pertinent to survival rates following hormone control therapy. Many others fail to report closed series of cases and following closure at least 2 years must elapse before any report of value can be made.

Another extremely important question following orchiectomy or estrogenic therapy is whether or not treatment should be instituted early in the course of the disease before metastases have occurred, or whether treatment should be withheld until late in the disease when the symptoms extension and metastases are severe. A number of years will be necessary as well as a larger number of cases before definite evidence can be obtained as to the survival of life in patients following orchiectomy for prostatic cancer. The final basis for any conclusions or deductions must necessarily be based upon comparison with results in cases treated by methods before the use of hormone control therapy.

The authors report their series of 74 closed cases (series closed December 31, 1943) and try to compare these with the 5 other reports in the literature. They suggest that authors in the future report the number of patients that died in successive 6 month intervals. There is no reported series of cases before the advent of hormone control therapy that is comparable to the series reported at present with the result that a reasonable evaluation of this modern hormone control treatment cannot be made. More studies of survival time are stressed and authors are urged to report cases so that comparative studies and conclusions can be made. DAVID ROSENTHAL, M.D.

Neelbit R. M. and Lynn J. M. Malignant Testicular Neoplasms. *Surgery* 1946 20 273.

This study is based on 80 cases of malignant disease of the testicle which have been followed up for 4 years or longer.

The youngest patient was 2 years of age, the oldest 66 and the average age for all the patients was 35.7 years. The average duration of symptoms before diagnosis was 20.5 months, the shortest duration of tumor was 1 week, and the longest 15 years. Neoplasia in an undescended testicle occurred 4 times. Attention should be called particularly to the 3 patients in this group whose presenting clinical picture and history closely resembled acute epididymitis.

Malignancies of the testes are known to metastasize early although no dissemination could be clinically demonstrated in 51 of the group of patients when they first came under observation.

The ideas of various writers with regard to hormone assays on the urine have differed rather widely

in the past. Ferguson once believed that the type of tumor that would be diagnosed microscopically and the presence of metastases could be rather accurately predicted in many cases from the prolan level. More recent work however by Dean Hinman and others indicates that a negative response to a test for prolan means nothing but that a positive response dictates a grave prognosis. The titer of prolan A should be at least 500 mouse units or luteinizing hormone should be present before the test is considered significant since low levels may be due to the follicle stimulating hormone present in the urine of castrates.

The question arose as to whether a tumor which gave rise to a negative Aschheim Zondek test before therapy would ever cause a positive reaction after treatment. Since metastases from teratoma testis are often more malignant microscopically than the primary focus from which they originated one would postulate an affirmative answer to this query.

If the Aschheim Zondek test is positive the outlook for survival is grave. Of 8 patients having hormone levels above 500 mouse units before treatment, only 2 are living. One of these patients had chorioepithelioma and there was no recurrence 12 years after operation. (The case is being reported completely elsewhere.) All 8 patients with positive determinations after therapy are dead.

Nineteen patients were treated by simple orchiectomy, and 5 (27.4 per cent) are alive after an average period of 9.3 years. The authors definitely agree that persons with testicular malignancies other than chorioepithelioma should have postoperative x-ray therapy to the pelvis and abdomen whether or not metastases can be demonstrated.

The assertion has been made that if neoplastic disease of the testicle could be diagnosed early enough a great many more of the patients could be saved through the benefit of early operation. Accordingly the 51 patients without demonstrable metastases were divided into two groups: those who were treated within 2 months of onset of symptoms and those treated more than 2 months after the onset of symptoms. Six of 10 treated "early" and 13 of 41 treated late are living. Application of the chi square formula to these figures reveals no significant difference and although one might assume that early treatment would yield better results, the authors were unable to prove that such is the case.

The use of preoperative irradiation for the testicle which is the site of a neoplastic process has been a point of considerable controversy, and a conclusive answer to the question can probably not yet be given. Arguments against preoperative x-ray treatment are as follows: (1) the leaving in situ of a very malignant neoplasm which is known to metastasize early and (2) the possibility of incorrect diagnosis because x-ray therapy sometimes renders subsequent microscopic interpretation difficult or impossible.

In the literature one finds frequent mention of radical retroperitoneal lymph gland dissection for testicular cancer—the Chevassu Hinman operation.

It has been demonstrated that in 90 per cent of bodies there is a communication of the retroperitoneal lymph chain with glands above the renal pedicle and into the chest and for this reason most surgeons have abandoned this procedure.

In studying the series of cases one conclusive fact has been brought to light that a metastatic neoplasm which fails to regress or which becomes clinically evident following initial irradiation will not respond favorably to additional deep therapy. The average survival of patients was 12 months.

For the clinician chaos is the only word which adequately describes the present conflict of opinion regarding the pathology of testicular neoplasms. For this reason no attempt has been made to correlate survival method of treatment, and the pathologist's opinion of tumor tissue examined microscopically. The chief difference has been that some hold to the theory that all testicular tumors are teratoid in origin (advocated by Ewing and followers), while others maintain that the seminoma is a distinct entity not arising from totipotent cells (Chevassu and disciples).

JOHN A. LOFF, M.D.

Korhonen, A.: Nonspecific Acute Epididymitis (Sarles epididymitis aigue non spécifique). *Acta chirurgica* 1946, 93 270.

During wars infectious diseases which in normal times occur only sporadically are often observed in almost epidemic proportions. One of these is nonspecific acute epididymitis.

The author discusses a series of 40 cases observed in the Finnish army during active service in the last war. The disease starts with low grade fever of about 1 week's duration and pains and swelling in

the caudal part of the epididymis, it is painful, always unilateral. Although the fever never exceeds 8 days, the swelling subsides very gradually, its restitution ad integrum taking place usually within from 4 to 6 weeks. The swelling may increase up to the size of a hen's egg but almost always it involves the caudal part only. In rare cases, secondary involvement of the superior part and of the ductus deferens occurs. As to the laboratory findings, the most significant one is a rise of the sedimentation rate to between 20 and 30 (Westergren) which is observed in all cases. In no case was there any discharge from the urethra, nor was any pathologic change in the prostate gland ever observed. The urine was normal in all cases except for a few white cells. Bacteria were never found in the urine.

The treatment included bed rest, cold applications, and small doses of sulfathiazole during the first week. The prognosis is good, and recurrences are very rare.

As to the etiology the author rejects the theory that the disease is caused by staphylococci of low virulence; he believes that the epididymitis is a hematogenous infection caused by an unknown virus. It seems to be highly contagious under poor hygienic conditions although the way of transmission is unknown. In overcrowded places as in underground shelters, contact infection seems to play the most important role.

Treatment should always be strictly conservative. Surgery is definitely contraindicated unless the disease becomes chronic, but this did not occur in any of the author's cases. In its course and epidemiology the disease shows great similarity to infectious hepatitis.

WALTER M. SORAN, M.D.

# SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

## CONDITIONS OF THE BONES, JOINTS, MUSCLES TENDONS, ETC.

Mathez, J. A.: The Problem of Osteochondritis Dissecans. The Cause of the Constant Convexity of the Base of Its Niche and the Explanation of Its Frequent Occurrence in Cretinism (Le problème de l'ostéochondrite disséquante la raison de la convexité constante du fond de sa niche explication de sa fréquence relative dans le crétinisme) *Presse méd.*, 1946 54 211

Dequervain and his associates observed that osteochondritis dissecans very frequently occurred in cretins. Based on the experiments of a number of authors it is well established that osteochondritis dissecans is caused by a force of vibration. A vibrating force of moderate intensity exerted on the femoral condyle forms a zone of Looser. A more intense force causes a discrete separation of the osseous tissue.

Osteochondritis dissecans is always found at the apex of the curved femoral condyle and opposite one or the other of the tibial spines. It occurs most frequently opposite the medial tibial spine. If one compares a femoral condyle with a ball one readily understands what takes place in a knee afflicted with osteochondritis dissecans. A force exerted on the femoral condyle (or a ball) will show the greatest amount of compression in the center of the impact. The slope of the compression levels off radially from the center of the impact. This theory also holds true in cases of osteochondritis of the elbow joint and of the hip joint.

There are cases of osteochondritis dissecans which are not associated with any pain. As long as the pathological changes are confined to the "Zone of Looser" the condition usually remains asymptomatic. When the osseous structures are fissured pain usually is present. Barth believes that the posterior cruciate ligaments are responsible for the occurrence of osteochondritis dissecans. The author raises the question as to how the posterior cruciate ligament can be made responsible for the constant convexity of the base of the niche.

Osteochondritis dissecans most frequently occurs in the knee joint. The menisci are the stabilizers and shock absorbers of the knee joint. Therefore, it is clear that a torn medial meniscus will diminish the resistance of the femoral condyle to the force of vibration." Bircher reported in 1929 the frequent occurrence of torn meniscus and osteochondritis dissecans in the same knee joint. Henschen has demonstrated that the soft tissues of the body are liable to be fractured by vibration just as well as by the firm bony structures. Fromme reported in 1921 that the "zone of Looser" responds very satisfactorily to rest and it was his belief that prolonged complete rest could lead to disappearance of the osteochondritic lesions.

The occasional occurrence of bilateral symmetrical osteochondritis dissecans lesions make it impossible to accept Axhausen's theory of vascular impairment or the theory of Barth that osteochondritis dissecans is caused by the posterior cruciate ligaments. It is the author's opinion that in these cases the congenitally sharply pointed curvatures of the femoral condyles favors the occurrence of symmetrical osteochondritic lesions in both knee joints.

The histological findings also favor the author's point of view. The picture is that of necrosis rather than that of inflammation.

In the surgical clinic at Zurich Howald has shown that in cases in which the x rays show bony fragments within the osteochondritic lesions he was never able to find loose intra-articular bodies. At operation he found that the articular cartilage covered the lesion and that it was therefore hard to find. The fragments visible on x-ray examination represent necrotic bony fragments which often become completely absorbed. Howald states that when this occurs loose bodies appear within the joint cavity. Soon after the bony fragments become absorbed the overlying articular cartilage detaches and lies freely in the joint cavity.

All this can be explained along the lines of the author's theory of the pathology of osteochondritis dissecans. A trauma will loosen the less flexible bony structures sooner than the elastic cartilage. The loosened bony fragments are deprived of their source of nourishment and will readily undergo necrosis. The articular cartilage however will continue to get it a nourishment by osmosis from the synovial fluid.

The fact that osteochondritis dissecans occurs in cretins with thyroid and parathyroid disturbances can be explained by the fact that because of these disturbances the bony structures become weakened. The cubitus varus, so frequently observed in cretins is due to a deformity of the distal humeral epiphysis. This deformity is caused by the fact that the child walks on its hands and knees and that the weakened bony structures of cretins become deformed. The same reason holds true in the formation of coxa vara in cretins. Feistman examined 34 hip joints of cretins and found 32 of them deformed. Bircher has found that the ossification of the long bones is disturbed in cretins. There is an irregular number of ossification centers in the long bones of cretins. Wegelin reports that the normally found areas of softening and degeneration of the articular cartilage were greatly increased in cretins.

The weakness of the cartilage of grown cretins is illustrated by the defects found in the cartilage which have occurred after the ossification of the epiphysis had been accomplished.

In conclusion the author points out that the constant occurrence of a convexity at the base of the

niche" is due to the architectural structure of the femoral condyle. The base of the "niche" represents the "zone of Looser" of a vibration fracture.

GEORGE L. RENZI, M.D.

Kleinberg, S.: Incipient Epiphyseolysis of the Hip. Its Diagnosis and Treatment. *Am. J. Surg.* 1946, 72: 190.

Epiphyseolysis of the hip indicates a slipping of the head of the femur. Based on the gross pathology and therapeutic possibilities there are four stages (1) the incipient stage, (2) the stage of moderate slipping (3) of severe slipping and (4) of acute slipping. The final outcome of types 1 and 2 is usually very good and results in a normal hip. However the result in types 3 and 4 is usually unsatisfactory. The disability is so severe in these cases that major surgery such as transpositional osteotomy arthroplasty and arthrodesis of the hip joint becomes necessary. The etiology of this condition is as yet not well established. Endocrine disturbance such as Frohlich's disease, vascular disturbance of the femoral head case, and many other reasons have been cited to trauma, and many other reasons have been cited to be responsible for epiphyseolysis of the femoral head. Children usually between the ages of 10 and 13 are affected by this condition. Obesity is very often observed in these patients. There may or may not be a history of trauma. In the beginning there is mild pain on walking and a slight lump which occurs intermittently. Gradually these symptoms become worse and continuous.

On physical examination the patient appears to walk with a slight limp and keeps his affected leg in outward rotation. The extension and outward rotation of the hip joint usually is normal. Often a slight flexion contracture is observed. Inward rotation is very definitely and always restricted.

The x-ray examination reveals that the femoral head has slipped downward backward, and inward, but remained intimately attached to the femoral neck. Normally the head projects a little beyond the superior border of the neck and forms a "shoulder". This projection is usually reduced or completely obliterated. The epiphyseal plate, normally from  $\frac{1}{4}$  inch to  $\frac{3}{4}$  inch thick in its appearance. The neck appears shorter and wider because of its relative anteversion. The bone in the immediate surrounding of the epiphyseal plate shows rarefaction or/and sclerosis.

Once the diagnosis of incipient epiphyseolysis of the femoral head has been made the treatment should be instituted immediately. It is the author's contention that if the epiphyseal plate is made to fuse, further complications such as traumatic arthritis can be averted. There are several methods in use to accomplish fusion of the epiphyseal plate. The author however, uses drilling as a means of fusing the femoral head to the neck.

The postoperative care consists of the application of a plaster hip spica which is left on for 3 months. During this time the patient stays in bed. He re-

turns to the hospital at the end of this period which time a roentgenogram is taken. The epiphyseal plate is, as a rule, found to be thicker physical plate is, as a rule, found to be thicker shows partial absorption. Another plaster of Paris spica is applied and left on for an additional 3 months. The hip spica extends to the middle of the leg and walking with crutches is allowed. Ten months later another roentgenogram is taken. At this time the epiphyseal plate usually is very thick and the juxtaepiphyseal sclerosis has disappeared. The patient is given a Thomas leg brace with ischial seat bearing. This brace is worn for an additional 6 months or longer until the roentgenogram shows complete fusion of the femoral head and neck. By the use of physical therapy the knee and ankle kept mobilized during the latter period of treatment. In conclusion the author presents 4 cases with corresponding roentgenograms and mentions the fact that he has treated 12 additional cases in the same manner with very satisfactory end-results.

GEORGE L. RENZI, M.D.

Brachetto-Brian D.: The Origin and Evolutionary Cycle of Giant Cells of Tumors of the Bone. Benign Variety. Preliminary Communication. (Origen y ciclo evolutivo de la microploidia de los tumores de los huesos, var. benigna. Comunicación previa). *Arch. Soc. argent. anat.* 1944, 6: 55.

While studying a hemorrhagic zone in a giant cell tumor from the upper epiphysis of the humerus, the author discovered a certain syncytial cell having large nucleus one or two nucleoli, basochromatin reticulum, and a basophilic cytoplasm. Mitosis observed and also an amitosis prior to the division of the nucleus and formation of daughter cells. The latter were termed juvenile myeloplasm or myeloplasmactoid because the nucleus was much the same as the nucleus of the syncytium.

The evolutionary cycle of these cells was studied under the headings of (1) origin and growth; (2) adult form; (3) old age; and (4) death. In the first (myeloplasmactoid I) the cells contained from 10 to 100 nuclei. Direct division was frequently observed as was the independence of the cytoplasm. In the second class (myeloplasmactoid II) augmentation of the basophilic cytoplasm prior to fission and pleocytosis were seen. In these cells the nuclei may reach 100. In the old age class (myeloplasmactoid III) the nuclear volume decreased the ovoid shape of the nucleus changed to an irregular polyhedron, the basochromatin became condensed, nucleoli were no longer visible, and pyknosis was present.

The architecture as well as the osteolytic character of blastomas becomes clarified if the evolution of blastoma as outlined is accepted. The fundamental substance of blastomas is understandable the absorption that occurs and the contribution to the breakdown phenomenon and epiphyseal disturbance have a basis in fact in the light of the evolutionary cycle of giant cells as discussed in this article.

STANLEY A. ZIMMER, M.D.

Marique, P: Polycystic Xanthoma of the Meniscus (Xanthome meniscal polykystique) *Acta orthop Belg* 1946 12 231

Pathological conditions of the menisci of the knee are chiefly traumatic ruptures. Congenital malformations and cysts are less frequent and tumors are rare.

The author describes a case of polycystic xanthoma of the external meniscus of the left knee in a woman of 35. Cysts are twice as frequent in males as in females. She had suffered a blow on the left knee some years before and the tumor had developed gradually accompanied by pain. Examination showed a tumor the size of a filbert in the middle of the external interline. It was quite hard and protruded much more on extension than on flexion. It did not interfere greatly with movement. There was considerable atrophy of the muscles of the thigh.

Operation was performed under spinal anesthesia and the meniscus was extirpated completely. The wound healed by first intention. A plaster cast was applied and kept on for 15 days. When it was removed the joint was rigid but flexion to 90 degrees was recovered in 2 months and complete flexion of the heel against the thigh in 3 more months.

Illustrations are given showing the gross and microscopic appearance of the specimen. The solid tumor which was the size of a cherry was in the central part of the specimen and was surrounded by a large cyst and a number of smaller ones. The abundant fatty matter in the tumor was shown to be made up of cholesterolin esters. The xanthomatous nature of the tumor was further demonstrated by a positive Liebermann reaction.

Polycystic tumors affect the external meniscus in 80 to 85 per cent of the cases. They are generally multilocular with a mucus content. Several cases of xanthomatous deposits associated with such cysts have been described. They generally show a rich hemosiderin content, many polynuclear giant cells, xanthomatous cells, and lobulation. The described case differed from this typical picture in not showing giant cells or hemosiderin pigment. Henschen explains these xanthomatous deposits as being due to an arthrotropic cholesterinophilia.

AUDREY G MORGAN M.D.

Lerner, H. H., and Gazin, A. I. Interarticular Isthmus Hiatus (Spondylolysis) *Radiology* 1946, 46 573

The authors believe that interarticular isthmus hiatus is probably the result of a hyperflexion injury or fracture through the cartilaginous isthmus sustained either at birth or shortly thereafter. The literature, embryology, and anatomy are carefully reviewed.

In 1853 Killian first described the entity spondylolysis, of Greek derivation meaning slipping of a vertebra. Neugebauer (1892) is to be given credit for the widespread recognition of this condition. Much has been written on this subject by Willis, Mall, Batta, Hitchcock, Chandler, Meyerling, Kleinberg, and others.

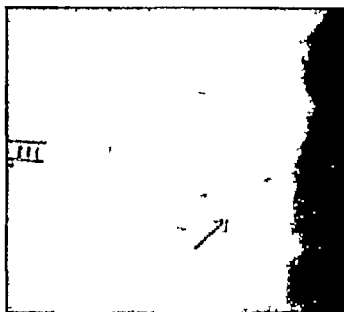


Fig. 1 (Lerner, H. H., and Gazin, A. I.) Lateral view isthmus hiatus of third lumbar vertebra.

The diagnosis of interarticular hiatus with or without slipping is based upon the roentgen findings of which there are 5

- 1 Demonstration of the hiatus
- 2 Underdevelopment of the vertebral body
- 3 Displacement of the vertebra in relation to the adjacent segments
- 4 Increased total anteroposterior diameter of the vertebra
- 5 Buttress formation at the anterior lip of the sacrum when the fifth lumbar vertebra slips.

DANIEL H. LEVINTHAL, M.D.

#### SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS ETC.

Greeley P. W.: Reconstruction of the Thumb *Ann. Surg.* 1946 124 60.

Thirteen cases of reconstruction of the thumb provide the material for this article. The operation for deepening the web between the existing thumb stump and the adjacent metacarpal was done on 3 patients.

Pollicization of a remaining partial finger was not done in this series nor was transplantation of a toe considered desirable.

Ten cases were treated by lengthening the existing thumb stump. The procedure consists in constructing first a tubed pedicle flap of skin and fat from a hairless area on the flank (Fig. 1). This is attached to the thumb stump when circulation from the abdominal end is known to be adequate. Later, when the circulation from the thumb attachment is known to be adequate the abdominal attachment is severed and the tube splinted to prevent strangulation. This new thumb is allowed to become well softened in its new position and then it is made rigid by inserting a perforated bone graft, obtained from the twelfth rib

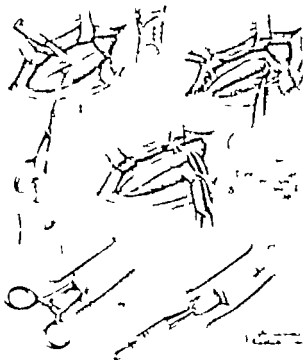
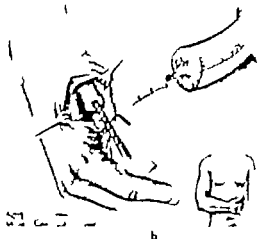


Fig 1 (Greeley) a, Explains the operative technique for removing the fifth rib. In this case the bone graft was placed first into the tubed pedicle while it was still attached to the abdomen at each end. b, Later the distal end



of the tube was attached to the thumb stump and at the same time the base of the bone graft was sutured into the metacarpal. This order of procedure has been stable because of the difficulty in holding the hand in position without accidentally pulling the bone graft out from the new bed. c and d, Illustration of the case involved. c, Shows the roentgenogram of the bone graft 16 months after transplantation. Good bony union is noted. (This patient had suffered a greenstick fracture at the base 3 months before the injury occurred during basketball play.) The patient plans to return to a civil occupation as a maintenance instructor in University. The authors feel confident that the restoration will enable him to hold a piece of chalk. (Courtesy of J. B. Lippincott Co.)



c



d



e

into the core of the tube and fixing its proximal end into a hole drilled into the medullary cavity of the remaining portion of the first metacarpal bone. About 6 months is required for complete bone healing and splinting is continued during this period.

A troublesome complication, noted 8 times was gangrene of the tip of the tube, which appeared from 10 to 18 days after the abdominal attachment was severed. It required excision of the resulting ulcer.

In 3 cases infection and necrosis of the bone graft occurred. The graft had to be removed and later replaced from the remaining twelfth rib. Accidental fracture occurred in 1 patient who played water basketball before healing was complete. The graft healed in approximately 2 months.

The photographs which illustrate this article show that a thumb, satisfactory from both the cosmetic and functional viewpoints can be produced by this method, but phalangeal joint activity is not provided. There is sufficient range of motion at the metacarpal joint to allow for good opposition against the remaining fingers. NEWTON C. MEAD M.D.

Kallio E. E.: Plastic Operations on the Thumb  
(Sur les opérations plastiques du pouce) *Acta chir scand.*, 1946 93 231

In spite of the disability and inconvenience caused by the absence of a thumb a review of the literature does not impress one that much attention has been given to plastic procedures for surgical correction. Most surgeons have an experience covering only 1 or at most 2 or 3 cases. The author presents a series of 10 cases which he divides into two groups, according to whether the material for plastic replacement was taken from the immediate adjacent tissues of the hand or transplanted from other parts of the body.

Huguler in 1852 was the first to practice phalangization of the first metacarpal. This operation involves an incision of the skin fold of the thumb extending dorsally along the arched skin fold at the thenar base thus forming a cutaneous dorsal and volar flap. The first interosseous muscle and the transverse head of the adductor muscle of the thumb are removed. The dorsal cutaneous flap is sutured into the base of the palm and the volar flap to the dorsum of the hand. In 1938 Koester reported 3 cases operated upon by this method and collected 45 similar cases from the literature. The results were unsuccessful in only 2 of the 38 cases in which results were stated. In his opinion this operation constitutes the easiest and most rapid method of producing a thumb with sensibility mobility and power. If one or two other digits besides the thumb were missing, Perthes found phalangization could be rendered more satisfactory by removal of the second metacarpal, or if only the metacarpals remained, as much of the second and third metacarpals as necessary were removed to provide a broader cleft. Schossener however removes only the second in either event. Luksha, in 1903 described an operation in which a finger of the same hand was transplanted to take the place of the thumb. Buzello transplanted the index

finger and a portion of the second metacarpal. Iselin also reported successful results by this method in 3 cases. Meyer proceeded in this manner to replace a missing thumb by the midfinger. The disadvantage of these methods is that the hand already disfigured, has to be further damaged with sacrifice of otherwise normal digits and the creation of further cicatrices. In a case in which the thumb and index finger were absent, and the remaining fingers had been amputated, Spitzky and Jenner removed the proximal portion of the second metacarpal transplanting it as an elongation of the distal end of the second metacarpal. In the present series 3 cases were treated by simple phalangization. In the first of these in which only the little finger remained intact with very little of the first phalanges of the thumb and index finger phalangization seemed definitely indicated. In the other case in which only the thumb was defective and the rest of the hand normal the first interosseous muscle and the greater portion of the adductor muscle were likewise removed. The new thumb presented good power of adduction. With this incision it was possible to close the defect without undue tension on the skin. A strong sensitive thumb was obtained in both cases with perfect mobility even though in one the thumb was rather short due to the length of the metacarpal. In 2 cases, the author performed a phalangization of the first metacarpal removing the second metacarpal according to Perthes with excellent results.

Nicoladini's first method of correcting defects of the thumb by transplantation of grafts from other body parts consisted of the formation in one or two stages of a tubular skin flap containing bone producing a thumb by uniting it with the first metacarpal. His own attempts did not yield successful results but later writers obtained good results with flaps taken from the abdomen or chest and bone from the tibia, fibula, rib, clavicle, metacarpus or iliac crest. This method was used in 5 cases in the present series. The transplanted bone in the skin tube was absorbed in 4 cases, necessitating repeated bone transplantation and loss of time. The thumbs thus produced were most satisfactory as regards sensibility mobility and strength. All of these thumbs were sensitive to touch and pin prick except at the ends, and four were even sensitive to heat.

In 1 case in which the thumb and first metacarpal were missing excellent results were obtained by a distant plastic performed in three stages. In the second stage a free bone graft was inserted directly into the multangulum majus and after fixation it was introduced into a skin tube formed from abdominal skin at the first stage and simultaneously this tube was then sutured to the hand. This method replaces Nicoladini's first method which should be abandoned.

It is suggested that in estimating disability for compensation claims, this should be judged as between 10 and 15 per cent higher when the first metacarpal is missing. Plastic operations are capable of reducing this disability from 5 to 10 per cent.

EDITH SCHAMBER MOORE



Haggart, G. E., and Hare, H. F.: Combined Roentgen Radiation and Surgical Treatment of Large Benign Giant Cell Tumors of Bone. *Ann. Surg.*, 1946 124, 218.

The authors present the therapeutic technique and results obtained in the management of 7 patients with proved benign giant cell tumor of bone which presented difficult problems in treatment. The treatment consisted of roentgen radiation which was followed by surgical removal of the tumor with thorough curettage and filling of the defect with bone grafts. Neither chemical nor thermal cauterization was employed.

For those benign giant cell tumors of the bone which are readily accessible and can be removed without sacrifice of function, immediate and complete excision is recommended. Examples of such tumors are those observed in the vertebral spinous and transverse process. The preoperative radiation given is described. Postoperative radiation was not given, except to 1 patient who had a 2 stage operation because of his extremely poor physical condition.

The operative process is described and the report of the 7 cases is given in detail with a summary of the results. In each instance the extremity was saved and there has been no evidence of recurrence of the tumor. The affected extremity is now a useful member. The roentgen radiation therapy did not interfere with the reparative process of the tissues following surgery. *Emil C. Rossmeyer, M.D.*

Altman H., and Trott, R. H.: Muscle Transplantation for Paralysis of the Radial Nerve. *J. Bone Surg.* 1946 28 440.

Among war injuries many compound fractures of the lower two-thirds of the humerus present an associated paralysis of the radial nerve. In cases of irreparable damage to the nerve, tendon transfer at the wrist has resulted in functional recovery of the hand and wrist in 2 or 3 months. The authors present 28 cases in which permanent radial or dorsal interosseous nerve lesions indicated tendon transplant.

The technique of Billington with the right angle incision on the extensor surface of the lower forearm employed in the early cases resulted in edema of the hand and elbow in the angle of the incision. Modification of the approach reduced the trauma incident to the handling of the tendons and enabled patients to become ambulatory in 48 hours.

In a few cases this procedure was carried out in addition to nerve repair. This makes the hand useful in a few weeks and most efficiently supports the wrist during the period of nerve recovery.

The surgical technique is presented in detail, transverse incisions proximal to the dorsal carpal ligament are used for isolating the tendons. The pronator teres tendon is threaded through and sutured to the tendons of both radial extensors of the wrist. The tendon of the ulnar flexor of the wrist is similarly attached to the extensors of the index, middle, ring, and little fingers by the buttonhole tech-

nique of Mayer. The radial flexor of the wrist likewise passed through and sutured to both extensors and the long abductor of the thumb.

The tension with which the tendons are implanted approximates the physiological as close as possible. A plaster splint is applied to the wrist in extension and the hand in 30 degrees of dorsiflexion.

The pronator teres transplant is not needed if the lesion involves the dorsal interosseous nerve. The arm is elevated from 1 to 2 days after operation when the patient is allowed up with the arm in a sling if the edema is gone. Fingert motion in the splint, is begun at once, and after the splint is removed at the beginning of the fourth week, full active use of the transplants is begun. The splint is worn only at night during the fifth week, and discarded at the sixth week.

Good results were obtained in all cases, each patient leaving the hospital with a functioning hand that had a strong grip. Complete extension and abduction of the thumb were secured in all cases, complete extension at all interphalangeal joints; extension to within 15 degrees of normal at the metacarpophalangeal joints of the other digits. Dorsiflexion at the wrist was possible to 25 degrees beyond neutral. *Francis E. Brannock, M.D.*

## FRACTURES AND DISLOCATIONS

Colzani, F.: Fractures of the Upper End of the Radius. (Fracturas de la extremidad superior de radio) *Bol. Soc. de Quir.* 1945, 11: 305

This form of fracture is more common than is usually believed. Among 5,319 cases of trauma examined by the author from 1912 to 1945, 1,053 were fractures of the upper extremity and of these 43 were fractures of the upper end of the radius. There were 11 fractures of the upper end of the radius consisting 3.6 per cent of all fractures of the arm. Of a total of 176 fractures of the elbow 40 (22%) were of the upper end of the radius, while 43 (24%) were of the supracondylar region of the humerus.

In fracture of the upper end of the radius the external condyle of the humerus is frequently injured also even if it is not fractured there are erosions of the cartilage which may later cause rigidity of the joint. All contused tissue should be removed by operation. The roentgenogram does not always show the extent of injury in these fractures.

Among the author's cases, 26 (65%) were complete fractures, 4 (10%) partial fractures, and 1 (25%) complete fractures. In the incomplete fractures the author immobilizes the part with a plaster cast for 2 or 3 weeks, followed by active mobilization and Bier's local hyperemia. He had good results in 88.8 per cent of these cases. In recent partial complete fractures he simply extirpates the bony fragment two-thirds of the circumference of the head is retained. In total complete fractures he extirpates the whole head. He had satisfactory results in 87.5 per cent of the surgical cases.

A table of the 40 cases is given showing the name, age and sex of the patient, and the date and mechanism of the fracture. (In 44.4% of his cases the violence was direct while in 55.5% it was indirect. Most authors report a great majority of cases caused by indirect violence—a fall on the hand with the elbow generally extended but sometimes flexed.) The table also shows the variety of the fracture, the treatment, and the early and late results.

AUDREY G MORGAN M.D.

Nohrman B. A.: Fractures of the Elbow with Particular Regard to the Distal End of the Humerus. *Acta radiol* Stockh., 1946 27 409

A series of 324 persons with 328 fractures of the elbow were observed during the years from 1932 to 1941 and the follow-up examinations were carried out in 1943 and 1944. Sixty-one per cent of the fractures involved the distal end of the humerus. Forty-one per cent of the fractures were in adults and 59 per cent in children. Supracondylar fractures as well as fractures of the humerus are most common in children. Fifty-six per cent of the total were in males and 44 per cent in females. Forty-one per cent of the injuries involved the right arm and 59 per cent the left. Among the supracondylar fractures 78 were of the extension type and 13 of the flexion variety. In those cases in which the reduction was satisfactory a very good result occurred.

The condyle and epicondyle fractures represented about one third of the total material. Fractures of the epicondyle comprised about 50 per cent of the lateral condyle 40 per cent and of the medial condyle 10 per cent. Among 20 cases of epicondylar fracture reduced without surgical intervention the position was not perfect and the bone healed in only 4 of these. Myositis ossificans was seen in 6 fractures of this group.

RICHARD J BENNETT JR., M.D.

Pieri G.: Management of Habitual Dislocation of the Shoulder (Sulla cura della lussazione abituale della spalla) *Chir org movim* 1943 29 134.

Existing methods of dealing with the problem of habitual dislocation of the shoulder are directed toward (1) the articulation, (2) the muscles and tendons, or (3) the skeleton. The author describes a method which consists essentially of suspension of the humeral head by means of a slip of the deltoid muscle which is passed through a tunnel from the front to the back and subsequently through an opening in the spine of the scapula. The muscle slip is then secured to the superior surface of the spine.

This method was used in 7 cases 6 of which presented satisfactory results. One case only showed limitation in power of abduction, which was probably attributable to an extended period of post operative immobilization.

EDITH B FARNSWORTH, M.D.



hours. The author strongly favors the Henle Coenen test to determine the desirability of an anastomosis or venous graft. In all cases in which proper attention was paid to the presence of back bleeding from the distal segment, no difficulty ensued if this was obtained. This is not as valid in early stages in which there may be spasm and thrombosis in the collateral vessels. These elements are then evaluated with difficulty.

LEROY J. KILPATRICK, M.D.

Mustard W T: The Technique of Immediate Restoration of Vascular Continuity after Arterial Wounds. *Ann. Surg.*, 1946, 124 46

When confronted with the problem of revascularizing the dangerously ischemic limb one is at once impressed by the unsolved problems in anatomy physiology and pathology. It is therefore, essential to define the extent of ischemia affecting the wounded extremity. The dangerously ischemic limb is one which has been deprived of its blood supply to such an extent that vital processes no longer take place and gangrene results. The forerunner of this state is ischemia, and whether the ischemia progresses to recovery or not depends upon the volume of blood the limb receives, the pressure at which it is delivered, the length of time the ischemic state has existed, and the metabolic demands of the limb itself. It is only by a consideration of the general condition of the patient, the time interval and both the function and appearance of the limb that the degree of ischemia can be determined.

The variability of the circulation through the main and collateral channels renders dogmatic anatomic statements worthless. Even though the distal pulses are absent it is reasonably certain that a limb will survive if active movement of the digits is present and the digital skin has some warmth some sensation, and is not of an unnatural color. If however, active motion of the digits is no longer present and the digital skin is cold, insensitive and of an unnatural color then the limb is dangerously ischemic.

Active surgical interference is to be avoided when possible, if recovery of the limb is to be expected. In the dangerously ischemic limb however operation becomes a matter of some urgency whatever the local arterial lesion. In the absence of arterial spasm and of occlusion of the vessel by extravascular compression the type of surgery is limited to ligation or some attempt at re-establishing the circulation.

Ligation of the main vessel removes the hazard of further bleeding but does little to improve the blood supply of the limb. Experience has shown us that it is the procedure of choice in certain circumstances particularly as a lifesaving measure, and if heparinization is impractical. The administration of heparin requires qualified supervision including careful nursing and repeated estimations of the clotting time. It is contraindicated in multiple wounds and in wounds involving the cranial pleural or abdominal cavities.

Ligation is also to be used if the limb has been avascular longer than 10 hours. The survival time

of avascular tissue has been investigated by many observers and the general view (with which the author's opinion coincides) is that if warmth to the limb is avoided skin will survive 24 hours muscle 6 to 10 hours, and nerve a shorter period.

If trauma has been extensive, ligation will be in order however experience with traumatic amputations and with crush injuries would lead one to believe that no attempt at revascularizing a crushed limb should be made until more is known of this pathological condition.

Ligation is also the procedure of choice in the upper extremity. The collateral circulation in the arm is rarely sufficiently damaged to warrant anastomosis of the main vessel.

Re-establishment of the circulation in the dangerously ischemic limb is a practical procedure and may be accomplished by any of the classical methods. The author discusses the procedure he uses, stressing the indications for the use of inert materials and the technique involved in placing the tube in the arteries. He also discusses the difference of technique in the operative procedure for anastomosis of the vessels the technique in complete division the technique in incomplete division and traumatic thrombosis along with the postoperative care and the technique of secondary operations when they are indicated. He summarizes the data of 15 patients upon whom immediate restoration of vascular continuity was undertaken after they had acquired arterial wounds and gives the following summary of his experience.

In the dangerously ischemic limb re-establishment of the circulation by artificial anastomosis is practical under conditions in which heparinization is possible. The technique of the operation is simple but postoperative care is difficult. The operation has been performed 15 times with heparin thrombosis does not occur in the tube if the clotting time is kept sufficiently elevated. Careful administration of this anticoagulant with repeated estimations of the clotting time is necessary to insure success. During the critical period the blood loss must be carefully considered and the blood pressure must be maintained by repeated transfusions of whole blood. The limb must be elevated to prevent muscle edema warming of the limb is to be avoided and care must be taken with dressings. The tube may be left safely in the vessel up to 6 days. The second stage of venous graft has been performed 6 times the nonsuture method twice and the suture method 4 times. Other factors being equal the success of the graft is in inverse proportion to its length. Following venous transplantation heparinization should be continued for at least 4 days.

A rigid tube is preferable to a venous graft as a temporary arterial bridge in acute ischemia of the limb. The results of this type of anastomosis have not been impressive and success has been an unusual achievement in war surgery in the Forward Area. It is, however only a beginning in a new field and its application to elective arterial surgery may be of some importance.

PAUL MICHAELI, M.D.

Serralle, M: Thrombosis of the Iliac Arteries and Bifurcation of the Aorta (A propos des thromboses arterielles des iliaques et du carrefour aortique) *Rev chir Par* 1946 65: 227

The treatment of arteritis comprises two procedures (1) resection of the thrombosed segment which serves as a source of vasoconstricting reflexes and (2) section of the sympathetic lumbar chain supplemented, if necessary by splanchnicectomy or left suprarenalectomy.

In the first series (3 observations) the author performed only sympathectomy with or without splanchnicectomy. In each instance a secondary arteriectomy of the involved iliac artery was required. The first stage of the operation was not followed by great relief and the patients had to submit to a second operation.

Therefore, in the second series (4 cases) the author performed iliac arteriectomy and complete lumbar sympathectomy in one stage. All 4 patients stood the operation well.

The author points out that sympathectomy is indicated in arteritis only if a thrombosed segment can be located.

As to the technique, the author advocates the so-called progressive section suture. The first 4 lumbar ganglia are removed.

Obiteration of the external, or the common iliac, artery does not give as grave a prognosis as the obiteration of the femoral, popliteal, or posterior tibial artery. JOSEPH K. NAKAT, M.D.

Catalano, G: Intra-arterial Injections in the Treatment of Endarteritis Obliterans (Le iniezioni intra-arteriali nel trattamento dell'endarterite obliterante) *Ann. Ital. chir* 1946, 23

Because intra-arterial medication has a direct action on the sympathetics the author advocates its

use in endarteritis obliterans. In a study of 7 patients, 4 of whom had received an intra-arterial mixture of acetylcholine and padutin, while the remaining patients were treated with intra-arterial nicotinic acid, favorable results were obtained in all cases. Not only was there a disappearance of pain in the part involved but there was a rapid appearance of a line of demarcation in gangrenous cases. Rapid healing following removal of the gangrenous part, and an increase of cutaneous temperature, confirm the beneficial effect derived from this form of treatment. This intra-arterial therapy is better tolerated than treatment by the subcutaneous or intravenous route and there are no contraindications.

In the acute crisis of endarteritis obliterans gangrene can be prevented by the arterial injection of acetylcholine, padutin, and nicotinic acid, and if gangrene is present it will be arrested with evidence of a line of demarcation.

The technique is simple. After finding the position of the femoral artery, a fine needle attached to a 10 c.c. syringe is inserted through the skin, 1 to 2 cm. below the arch of the femoral vein. The femoral vein is entered after the pulsation of the vessel as the needle is felt and the solution is injected slowly. The patient experiences a severe burning pain, and an intense vasodilatation with a rise of skin temperature, first up to the knee then down the leg.

With the intra-arterial injection of nicotinic acid no pain is felt however, in the 3 patients so treated, hyperemia was not evident. Although there was an increased pulse rate for a few minutes, the fall in blood pressure was not great. The author cannot evaluate which of the two treatments is better and he therefore advocates a combination of the two, giving daily injections for the first 5 days, followed by no more injections given on alternate days.

ARTHUR F. CIPOLLA, M.D.

# SURGICAL TECHNIQUE

## OPERATIVE SURGERY AND TECHNIQUE POSTOPERATIVE TREATMENT

King, L. S., and Myers, H. C.: Use of Routine Bed Exercises following Major Surgery. *South Surgeon* 1946 12:36

Up to the year 1939 little effort was expended toward the prevention of postoperative complications due to bed rest. Turning patients or changing their position in bed were the only routine measures employed. During 1939 one of the authors attended a series of lectures by R. Watson Jones of England. Mr. Jones stressed to each patient the need for active exercise of all available joints and muscles and the author noted that the patients of Jones had less osteoporosis, joint stiffness and adhesions and better muscle tonus and morale than the average patient immobilized in plaster.

The following routine was then begun in all patients with casts, and was used later with slight changes, as a routine procedure in all surgical cases.

The patient should (1) turn himself in bed each hour immediately following reaction from anesthesia (2) take twelve deep breaths, filling the lungs completely every 3 hours and (3) exercise actively and vigorously every joint of the extremities for 5 minutes every hour (This was accomplished by active flexion and extension of the hips, knees, ankles and toes adduction and abduction of the shoulders flexion and extension of the elbows, pronation and supination of the forearms and flexion and extension of the wrists and fingers.)

Much time and effort must be expended in repeatedly instructing patients in these routines, as simply writing orders for exercise or routinely instructing the patient to take exercises is inadequate.

Nurses must be admonished to see that all patients carry out the exercises in a satisfactory manner. The surgeon must, by repetition demonstration and insistence again and again impress each patient with the necessity for complying religiously with these orders. Some patients fail to co-operate in spite of all these measures.

The authors believe that patients who adhere to this régime faithfully convalesce rapidly. In many patients the results are intangible there may be an improved sense of well being improved morale, more apparent resistance to disease and a greater determination to recover.

The authors review their series of 1,476 major operations on 1,009 patients from January 1, 1939 to January 1, 1946. For comparison they reviewed 150 major operations performed on 123 patients from January 1, 1938 to January 1, 1939. There were 2 cases of postoperative thrombophlebitis among the 123 cases in 1938 an incidence of 1.6 per cent. There were 8 cases, an incidence of 0.79 per cent (a decrease of nearly 50 per cent) among those operated upon

from 1939 to 1946. Two of the 8 could not be persuaded to exercise properly.

One case of wound disruption occurred in 1938 an incidence of 0.81 per cent. There were 5 cases in the second group an incidence of 0.48 per cent. In none of these cases could the active exercise be held responsible for the disruption.

Six cases of pulmonary complication (4.8%) occurred during 1938 and 16 cases (1.5%) during the subsequent period a decrease of 69 per cent. The end result was fatal in one-half of the patients operated upon during 1938 and in one-fourth of those operated upon in the second period.

One case of hemorrhage was found in 1938 and 6 cases in the later series—a decrease in incidence from 0.81 to 0.59 per cent. In no case was there any evidence that postoperative exercises caused hemorrhage.

Wound hematomas were not numerous enough to be significant. There were 30 deaths in the entire series of 1,132 patients operated on consecutively from January 1, 1938 to January 1, 1946. Twenty six autopsies were done and in no case was the death attributable to exercises in bed. For the 1938 series the death rate was 4.8 per cent and for the later series 3.3 per cent with an overall mortality of 2.6 per cent.

The authors review some of the literature and stress the value of early ambulation and exercises in bed.

The reports of most authors were very favorable to early postoperative activity with certain exceptions in which a note of conservatism was expressed. The experiences of those who have followed the treatment of early ambulation or bed exercises have been very satisfactory.

The authors believe that early postoperative activity is justified by the increased rate of venous and lymphatic return accelerated wound healing, lessened pulmonary complications, and improved patient morale.

The degree of activity must depend on a number of things including the gravity of the operation, the suture material used, the presence of local infection or ischemia of the tissues, and upon the judgment of the surgeon.

The authors are still carefully selecting their cases for early ambulation. However they believe that definite benefits are to be had from postoperative bed exercises alone, and that they may be practiced as outlined in almost every case without regard to suture material used or the severity or type of operation.

RONALD R. BROXTON, M.D.

Spence, H. Y., Evans, E. L., and Forbes, J. C. The Influence of a Special High Protein Diet on Protein Regeneration in the Surgical Patient. *Ann Surg* 1946 124: 131.

A negative nitrogen balance usually occurs postoperatively. This is correlated with loss of weight

prolonged wound healing, and extended convalescence. A positive nitrogen balance unquestionably can be instituted in these patients by the use of intravenous substances such as amino acid mixtures, plasma, and whole blood. Most of the work on protein replacement therapy has centered around the substances which can be given intravenously. The authors have attempted to shift the emphasis to a diet that can be given orally and to determine the value of inexpensive protein material which can be made readily available to surgical patients. In spite of the controversy over whether administered protein is assimilated during the catabolic phase following traumatic injury or surgical operation these diets were supplied soon after surgical operation.

Nine suitable surgical patients were considered in this report, and the dietary period was started from the third to the twentieth postoperative day. Clinical summaries of several illustrative cases are given.

The diet was made up of 150 gm. of dehydrated beef and liver protein mixture, 150 gm. of powdered whole milk, 50 gm. of corn oil, 150 gm. of dextrin-maltose, 35 gm. of chocolate and 1,000 c.c. of water (plus vitamins A, B, C, and D and iron). This allowed a total intake of 3,000 calories each 24 hour period. The diet was given in liquid form with the insoluble material in fine suspension. Several patients had to be tube-fed for the first few days. Frequent feedings during each 24 hour period were employed. Blood plasma protein determinations were carried out at the beginning, after from 3 to 4 days and at the end of each period. The nitrogen intake could be calculated from the volume of diet administered. Daily urine and fecal nitrogen were determined, and the nitrogen balance was calculated. Total circulating plasma and protein hemoglobin were estimated from the blood volume. Each patient was studied at least 7 days.

Nitrogen retention was good in all cases and averaged, in some subjects, over one-third of the nitrogen intake. Positive nitrogen balance was established in all patients studied. In cases in which malnourishment and anemia were prominent, hemoglobin, plasma protein, and tissue protein formation paralleled the results of Robson and Robbins with hypoproteinemic dogs that is, for every gram of plasma protein formed, 2 to 4 gm. of hemoglobin and 10 to 30 gm. of tissue protein were formed. Well nourished patients in whom blood loss was prominent used a greater percentage of the retained nitrogen for plasma protein and hemoglobin formation. Protein regeneration tended to be more marked in the tissues in which competition was greatest for the available amino acids.

Blood regeneration in cases in which acute infection was present revealed suppression of hemoglobin formation even to the extent of hemoglobin loss, and even though nitrogen retention was quite satisfactory. Plasma albumin and globulin regeneration was variable although it tended to be suppressed. Some cases, however, manifested accelerated plasma globulin formation in the presence of infection.

The authors' results in relation to plasma protein concentration and plasma volume are in accord with those of Lyons, Madden, Whipple, and others. Little correlation could be established between plasma protein concentrations and plasma volume, and in turn, total circulating plasma protein. Plasma protein and hemoglobin determinations per se do not reflect plasma protein and hemoglobin regeneration. Both values tend to show the same directional shift, but much variation is apparent.

The authors believe that it is feasible to administer a high protein, high caloric, high vitamin diet in liquid form in selected postoperative patients. This type of diet is well utilized and probably could be used to advantage in some cases in which more expensive modes of nitrogen intake are contemplated. The ease in determining the protein intake of this uniform liquid diet facilitates nitrogen balance studies.

ROBERT R. BAZZOW M.D.

Annersten, S. and Norinder, E.: Postoperative Blood Changes with Regard to Shock. *Acta chir scand* 1946 94 320

Eight varieties of blood tests were performed routinely during the first 3 postoperative days in a series of 73 patients subjected to one of the following types of surgery: gastric, gall bladder, thyroid, thoracoplasty, breast, renal, laparotomy or minor surgical repair. The purpose of this investigation was to find any changes in the blood which might serve as an indicator of shock. The blood tests were serum CO<sub>2</sub>, serum Cl, total base, serum protein, serum potassium, serum lactic acid, hematocrit, and blood sugar. Except for statistical elevation of lactic acid and sugar the other postoperative tests showed no significant change. The rise in blood lactic acid appeared to be directly proportional to the degree of tissue laceration caused by the operation.

In 2 cases resulting in death, the values of serum lactic acid were very high, indicating a relationship of the latter to shock. The postoperative increase in blood sugar was described as a reaction of the sympathoadrenal system and hence involved in the early compensatory mechanism of shock.

Because hematocrit and serum protein showed insignificant variation, the authors believed that the increase in capillary permeability and the fall in serum protein were phenomena of the late phases of shock. Surgical operations failed to cause changes in the cation content of the blood, and cannot be relied upon to predict the onset of shock. Depletion of alkali reserve was not observed in any case. Neither did the postoperative acidosis parallel the increase in lactic acid, which proves that the latter was a factor of minor importance in early shock.

BENJAMIN G. P. SAKATOFF M.D.

Davis, J. S.: Present Evaluation of the Merits of the Z-Plastic Operation. *Plast. Reconstr. Surg.* 1946 1:26

The author sums up in a general way his personal experience with the Z-plasty. The ideal place for a

Z-plastic is in those instances in which the skin is of normal texture cases in which a web exists in certain cases of partial syndactylism and sometimes cases in which congenital grooves appear around the fingers, arms, toes, and legs. In the vast majority of cases however the Z-plastic operation is used to correct the scar contracture deformity which occurs for the most part as the result of healed burns.

The preliminary preparation includes first, an adequate evaluation of the general physical condition. The author states that a great many of these scar contractures are operated on much too early and the failure of the Z-plastic results from the in opportune selection of time rather than from an inherent fault in the procedure. Local infiltration lowers local resistance to infection interferes with circulation, and retards healing.

The operative procedure includes, first marking out the lines of incision and attempting in so far as possible to create a 60 degree angle between the central and arm lines of the Z. An angle of 30 degrees can be used and the selection of this angle should depend in part at least on the elasticity of the scar infiltrating the surrounding skin on the thickness of the flaps on the location of the contraction and the contour of the part.

After the incisions are made and the flaps are mobilized and the underlying scars excised the bleeding is carefully controlled. The flaps are then shifted and sutured. A pressure dressing is applied. This includes 3 per cent xeroform ointment covered by dry gauze and a sterile seasponge some waste and elastic adhesive plaster in addition to a soft bandage. The loose stitches are removed on the third or fourth day and the remainder are removed by the tenth day. Massage is started after 3 weeks and continued for several months.

A Z-plastic may sometimes be used in series rather than singly. They can be used individually or they can be connected one with the other. The author believes that multiple Z-plastics are being used much less frequently than they should be. Occasionally after a period of 6 months when the tissues have been softened and the circulation improved by massage, the same area can be further relaxed by a similar procedure. This is particularly useful in growing children.

Some of the advantages of this procedure are that it is simpler than other methods in certain cases tissues are successfully utilized which would otherwise be discarded the appearance compares favorably with other types of reconstruction additional scarring of unscarred areas is avoided and contractures can be permanently relieved.

LOUIS T. BYARS, M.D.

Zilliacus, H.: The Results of 5 Years Treatment of Thrombosis and Pulmonary Embolism at a Series of Swedish Hospitals during the Years 1940 to 1945. *Acta med scand.*, 1946, suppl. 171 p. 13.

The author studied the problem of thromboembolism in Sweden by critical analysis of the hospital

records of 14 institutions and by personal follow up of 765 cases traced from the charts. The material embraced the years from 1940 through 1944 the era of heparin and dicumarol therapy and was compared against that of the earlier years of conservative therapy and bed rest.

The incidence of thromboembolism in these years was from 0.37 to 0.51 per cent among all types of cases. Compared with the earlier statistics the latter incidence was less by almost one-half. However the death rate from pulmonary embolism determined on a basis of the total number of thromboembolic patients has remained rather stationary. Most of the cases of pulmonary embolism occurred in thrombotic patients who were treated only by conservative therapy. Cases of pulmonary embolism occurred rarely in patients receiving heparin and/or dicumarol therapy. Since 1941, the mortality rate from thromboembolism in Swedish surgery was reduced to 1 per 1,000 and in obstetrics and gynecology to 0.1 per 1,000 patients.

The number of patients with thrombosis in the lower leg only and the number in whom the disease process progressed to the thigh were dependent on the type of therapy. Five of every 6 patients given conservative therapy suffered extension of the disease into the thigh whereas in those who were given specific therapy the process was confined to the leg in every second case. Further, as a result of heparin therapy disappearance of the acute thrombotic symptoms was rapid as compared with the average of 21 days of elevated temperature in patients who were treated conservatively. Spread of the thrombosis to the other leg occurred in 30 per cent of the patients treated conservatively while in those given specific therapy the incidence of spread was only 1.4 per cent. The complication of pulmonary embolism was 15 times more frequent in the conservatively treated cases and 9 of every 100 patients died whereas only 1 of every 200 thrombotic patients given specific therapy died.

Sudden pulmonary embolism without signs of thrombosis was noted in 282 cases. In 114 of the latter thrombosis was not diagnosed clinically until the embolism occurred. On postmortem examination of 60 of these cases fresh thrombi in the deep veins of the lower extremity were found. It was the author's contention that the latter fatalities could have been avoided by daily careful examination of the lower extremities and the early institution of specific therapy. Among 103 patients with sudden pulmonary embolism treated with heparin and dicumarol, no deaths resulted and only 11 were found to have any swelling of the legs as a post-thrombotic sequela. In another series of 65 cases of pulmonary embolism treated conservatively there were 21 deaths following repeated attacks of embolism. Hence, every patient with pulmonary embolism should be immediately heparinized in order to prevent the reformation of a thrombus at the site of first dislodgment and to counteract the growth of the embolus.



In the follow up study of patients who had recovered from deep vein thrombosis the sequelae after thromboembolism were classified as follows: (1) no signs or symptoms, (2) subjective symptoms only—tenderness an aching pain cramps heaviness, (3) signs and symptoms after exertion—swelling, discoloration (4) chronic swelling of the lower leg or some part of it, (5) chronic discoloration, eczema, or varicose veins, (6) leg ulcers (7) swelling of the thigh after exertion, and (8) chronic swelling of the thigh.

The sequelae were much worse in the cases in which the thrombosis had extended to the thigh than in those in which it was restricted to the leg. Anticoagulant therapy was twice as favorable from the standpoint of sequelae as conservative therapy. In the cases receiving the latter, symptoms developed rapidly within a year after the acute attack. The majority of these patients were found to be in classes 4, 5 and 6 suffering from chronic swelling discoloration, varicose eczema, and leg ulcers. The average classification in the 184 cases treated conservatively 1 to 5 years after recovery was class 5. The sequelae in patients with deep vein thrombosis of both the leg and calf were equally severe with many in class 5. The post thrombotic sequelae in patients with involvement of the calf or leg treated with heparin were mild and more than half were in class 1.

Chronic swelling discoloration, varicose veins, and ulcer must be regarded as a direct continuation of the disease process after subsidence of the acute thrombotic process. During the latter period a thrombus originates in one of the small veins of the calf and then expands in the direction of the blood stream. From venographic observations it is known that the small vein thrombi continue to grow and extend into larger veins until they finally fill these veins. The only 3 large deep veins in the lower leg, the anterior tibial vein, the posterior tibial vein, and the peroneal vein, flow into the popliteal vein which continues on into the thigh as the femoral vein and is the only deep vessel of the thigh. When the thrombotic process has involved the popliteal vein, stagnation occurs as the result of the obstruction of the remaining deep veins. Thereafter the superficial venous system must compensate for the return venous flow. This added burden on the superficial veins accounts for the discoloration, edema, and varicosities and depends upon the degree of involvement of the popliteal and femoral veins.

It is the author's belief that the surgical treatment of deep venous thrombosis by vein ligation, femoral, iliac or inferior vena cava, is less satisfactory than by treatment with anticoagulants. The only advantage that operation offers is an elimination of the risk of pulmonary embolism. The same risk can be eliminated also by means of heparin. Furthermore, heparinization has an added advantage because of its action on clinically undiagnosed thrombi. Finally postoperative sequelae result from the ligation of a main stem vessel and this can be avoided by means of the use of heparin.

A detailed report was made of the cases of deep venous thrombosis at the Malmsted Hospital in Sweden during the period from January 10, 1936 to September 9, 1945. Of 16,495 patients admitted 504 developed venous thrombosis and pulmonary embolism. Diagnosis in every case was confirmed by venography and treated immediately with heparin. The latter series was compared with 564 cases of deep vein thrombosis at the same institution seen from 1929 to 1938 when conservative therapy was in vogue. It was found that 18 per cent of the conservatively treated patients died whereas only 14 per cent of the heparin treated patients died thus the mortality rate from pulmonary embolism was one-tenth as large when specific therapy was given. The average number of hospital days in bed with conservative treatment was 40, while with specific therapy it was 4.7 days. Follow up examination revealed that 60 of the 76 heparin treated patients recovered completely without any sequelae. It was also noted that when heparin therapy was started upon early diagnosis the disease was limited to the lower leg spread was prevented, and pulmonary embolism and thrombotic sequelae were avoided.

For the early diagnosis of thrombosis it must be remembered that the disease process begins in one of the following areas the lower leg calf, the plantar surface of the foot the adductor region of the thigh, or the pelvic veins. The physician should not wait for an elevation of temperature but should always take the initiative and examine and palpate the legs of a bed patient long before swelling becomes manifest. Nurses and patients should be instructed to report any pain in the extremities. The deep veins of the leg are best palpated when the patient lies on his back with his knees elevated. The examiner stays at the foot of the bed and simultaneously palpates the muscles of the calves of both legs. An increase in consistency can readily be determined by this method. As the thrombotic process advances the findings become more positive. Thrombosis in the plantar veins is determined by tenderness in the sole of the foot. The adductor region in the thigh are examined in the same manner as are the calves of the legs. Rectal and vaginal examination should be done to detect thrombosis of the pelvic veins. The early diagnosis of thrombosis must always be followed immediately by specific therapy.

Heparin should be given at once to obtain an immediate anticoagulant effect. It should also be used in a sudden attack of pulmonary embolism. The effectiveness of heparin is due to its antithrombotic effect. The coagulation time of the blood is prolonged by the intravenous injection of from 115 to 150 mgm. of heparin 4 times daily. Active movements are begun with the first injection. Deep breathing exercises and free movements in bed are enforced. When the temperature becomes normal the patient is allowed to sit up in a chair and heparin is reduced to 3 doses—100, 50, and 100 mgm.—per day. When the patient is allowed to walk an elastic

bandage is applied from the foot to the knee and the heparin is further reduced to 2 doses a day 100 and 125 mgm., respectively. Increasing activity is encouraged and a single dose of 200 mgm. of heparin is given once daily. After discharge from the hospital, the patient is instructed to wear an elastic bandage as long as discomfort or swelling exists. The patient is also warned not to overstrain the leg. If the primary illness confines the patient to bed heparinization must be continued for a longer period while the patient is in bed.

Dicumarol exerts an anticoagulant effect by inhibiting the formation of prothrombin. The effect is obtained only after from 12 to 48 hours of administration and the degree of inhibition varies in different individuals. The prothrombin time is the index of the amount of dosage. On the first and second days an average of 0.25 gm. of dicumarol is required. When heparin and dicumarol are combined in therapy the heparin should not be discontinued until the dicumarol effect is obtained as determined by the prothrombin time.

BENJAMIN G P SEAFROFF M D

#### ANTISEPTIC SURGERY TREATMENT OF WOUNDS AND INFECTIONS

Smyth, H. F.: Anthrax: Its Diagnosis and Treatment. *Occup M* 1946 8

There were 408 reported cases of anthrax in this country from 1939 to 1943. Of these 316 occurred in tanneries or woolen mills in 6 northeastern states. The disease was diagnosed early and the patients were properly managed by trained personnel with a resulting relatively low mortality. The remaining patients were usually seen by different physicians with little or no previous experience in the recognition and treatment of anthrax. The latter group suffered a higher mortality incidence.

This article was prepared for the benefit of those who on occasion may encounter a case of anthrax. The salient features of the incidence, clinical diagnosis and bacteriology were discussed, and emphasis was placed on the necessity of instituting treatment promptly even before the diagnosis can be substantiated. The oftentimes fatal bacteremias and malignant forms of anthrax can thus be aborted.

Local treatment has been condemned generally as being unnecessary and even undesirable. Since the advent of the use of serum at the turn of the century the mortality rate has been reduced but because of alarming reactions other agents have superseded the use of serum. One of these has been neocarphenamine either alone or combined with serum. The author recommends the former course, since, in 62 instances not a single fatality occurred when the arsenicals were used alone. A mortality rate of 4.7 per cent resulted in 64 collected cases though penicillin drugs were the sole agent. All few cases have as yet been reported to allow any conclusions.

DAVID H. LYNN M.D.

Ellingson H. V., Kadull, P. J. Bookwalter H. L. and Howe, C.: Cutaneous Anthrax. *J Am M Ass* 1946 131 1105

The early treatment of anthrax was given by means of cautery or excision, and was attended with a fatality rate ranging from 30 to 60 per cent. After the introduction of Sclavo's antianthrax serum, radical local treatment was gradually abandoned with improvement in the recovery rates. Lucchal and Gildersleeve reported 67 cases treated with serum neocarphenamine, or both without a single death. Gold reported 60 cases of cutaneous anthrax treated with serum, neocarphenamine, and various sulfonamides with only 1 death.

The treatment of anthrax with penicillin was suggested in 1941 when Abraham and his associates reported the in vitro sensitivity of the *Bacillus anthracis* to this antibiotic.

The authors give a report of their observations on 25 consecutive cases of cutaneous anthrax. The *Bacillus anthracis* was recovered from the blood of 3 of the patients. All were treated with penicillin and 3 were treated with sulfadiazine in addition to the penicillin. All recovered uneventfully. They were under close medical surveillance at all times and general treatment was initiated while the lesions were in relatively early stages.

The lesions were located for the most part on exposed areas of the body.

HARRY W. FINE, M.D.

Gay E. C.: Skin Dressings in the Treatment of Debrided Wounds. *Am. J Surg* 1946 72 313

A series of 101 cases of the application of split thickness skin grafts is presented and the relationship of this work to general surgery and to orthopedic surgery is discussed. Six of the cases are reported in brief with photographs. Successful takes of the grafts were obtained in 87 per cent of the cases.

The entire effort is based on an attempt to convert large tissue defects received in war injuries into rapidly healing closed wounds which shortens the patient's period of hospitalization and convalescence, and returns him early to limited or full military duty or allows for more comfortable evacuation to the Zone of the Interior.

In conclusion the author states that the optimum time for the use of split skin grafts as a "skin dressing" to large tissue defects, received as war injuries, is between the fifth to the tenth day after injury.

These grafts are practical in the presence of excessively exuding wounds, and also in the presence of mild surface infection. They may be used in combination procedures involving drainage of dependent areas, partial secondary closures and skin grafting. The application of dressings at forty-eight-hour intervals offers the greatest opportunity to combat excessive exudation which is a predominant feature of massive war wounds. This technique gives the greatest protection to the grafts applied.

Grafts used for this purpose should be very thin since the thin split thickness graft shows a higher percentage of complete takes in the presence of



output is improved. When lactate solution is the only electrolyte given there may be a tendency to overcorrection of the acidosis even to the point of clinical alkalosis, as noted in some of the cases. Electrolyte therapy should consist of a mixture of lactate and saline solution, or bicarbonate and saline solution. Oral administration should be started as soon as vomiting has ceased.

Replacement therapy in burn shock should be directed toward the restoration of all deficits in the circulating blood. These include red cells, plasma proteins, water, and electrolytes. Whole blood transfusions fulfill these requirements more closely than any other single agent. The presence of anemia is a recognized indication for blood transfusions during the healing stage of burns but when hypoproteinemia is more severe than the red cell deficit, it is generally believed that plasma, albumin, or amino-acid infusions are indicated. The authors suggest that whole blood rather than blood substitutes, is more effective in maintaining nitrogen balance and that a moderate excess in red cell mass may be indicated during the healing stage of severe burns. Several reasons for this stand are given:

- 1 When the viscosity of the blood is reduced by the depletion of plasma proteins, a moderate excess in red cell mass will increase the viscosity of the blood and thereby contribute to more normal hemodynamics.

- 2 As a source of protein, whole blood contains almost twice the concentration of an equal volume of plasma, since the hemoglobin content represents roughly  $2\frac{1}{2}$  times as much protein as the plasma content of whole blood. When a unit of blood is given its plasma component is immediately available to augment the plasma proteins or body reserves its red cell mass if in excess of normal, represents a rich store of protein readily available.

- 3 Experimental work on dogs by the authors suggests that an excess red cell mass may have an immediate sparing action on body proteins by displacing plasma volume and thereby reducing the amount of plasma in wound healing. Whole blood alone failed to precipitate pulmonary edema in the experiments but this condition was encountered when saline solution was given with the transfusions.

- 4 Patients in this series in whom anemia was quickly corrected or overcorrected assimilated more protein given by mouth than those in whom the anemia was not controlled.

- 5 The patient in the process of forming a large granulating surface may have a physiological increase in his total blood volume to aid in the process of healing.

Provided whole blood transfusions are given water and electrolytes can be administered more effectively by mouth than by vein and will be absorbed in adequate amounts. Sodium chloride solution in combination with lactate or bicarbonate is a more rational electrolyte mixture than sodium lactate solution alone in view of the tendency to alkalosis and hypochloremia, which may result from vomiting and overalkaliniza-

tion in burn shock. In general plasma losses will predominate in extensive second-degree burns while in third-degree burns, the red cell mass lost from the circulation may equal or exceed the losses in plasma volume. If the anemia of the postshock phase of a severe burn is not prevented by giving adequate amounts of whole blood in the shock period it should be corrected once recognized for delay of even a few days may be disastrous. During the healing phase of a severe burn whole blood should be administered in amounts adequate to theoretically overcorrect the anemia. When this is done the problem of nitrogen balance will be simplified. In the presence of an anemia and hypoproteinemia uncontrolled electrolyte therapy by mouth or by vein is contraindicated since it will increase cellular edema and in some cases may lead to fatal pulmonary edema.

JOHN H. MCHAMPT M D

Howes, E. L.: Prevention of Wound Infection by the Injection of Nontoxic Antibacterial Substances. *Ann. Surg.*, 1946 124: 268.

A mixture of streptomycin (200 units per cubic centimeter) and sulfamylon (5 per cent) was found previously to be bactericidal as well as innocuous to tissues. To ascertain whether this combination was an ideal subcutaneous antiseptic and if it was capable of preventing infection in wounds several experiments were performed on rabbits. The results are evaluated in this paper.

If crushed wounds were contaminated and not treated infection always followed. On the contrary if the wounds were treated immediately infection seldom occurred, but if treatment was instituted 3 hours or later after the wound was made and contaminated infection resulted. Additional injections or washings once infection occurred, did not resolve the process although the bacteria remained susceptible to the antibacterial agent. Debridement and treatment did prevent infection.

In an attempt to find an explanation, biopsies were taken of the loose connective tissues directly under the skin, and of the muscle. Microscopic examination showed that many leucocytes had already invaded the tissues and every leucocyte contained many bacteria. The most logical explanation of the failure to prevent infection after 3 hours is that many of the bacteria were no longer extracellular and were thus not reached by the antibacterial agent. While phagocytosis is helpful in combating infection yet, if the leucocyte is killed before the bacteria are destroyed the micro-organisms are free to contaminate the wound again.

Resolution of an established infection requires, in addition to a potent bactericide, adjunct chemotherapy—to dissolve slough to explode leucocytes and to provide chemical drainage. A word of caution must be said about the clinical use of these antibacterials to prevent infection in wounds. The method of their employment must not be substituted for good surgery. Necrotic tissue and infected foreign bodies should always be removed.

Other antibacterials can be substituted for sulfamylon and streptomycin. Injection of antiseptic substances locally points to new possibilities in the local treatment of wounds. DAVID H. LYNN M.D.

Egoroff, B.: New Lingual-Oral Method of Administration of Penicillin. *Prachobnoe Delo* 1946, p. 355.

Hydrochloric acid and intestinal bacteria inactivate penicillin administered through the digestive tract. The author avoids this drawback by applying penicillin to the tongue. Saliva, and especially ptyalin, do not destroy penicillin. One thousand Oxford units of dry penicillin are dissolved in 1 c.c. of water normal saline or 40 per cent glucose. One drop of the solution contains 5,000 units of penicillin. One to 2 drops are applied to the tongue every 30 to 60 minutes and the patient is instructed not to swallow but to distribute the solution with the tongue over the palate lips and gums. Patients prefer such a procedure to frequent injections. If larger doses are required, 10 drops may be administered at once.

If desired, 100,000 units of penicillin may be dissolved in 3 c.c. of alcohol, which irritates the mucous membranes and creates hyperemia, which in turn stimulates absorption.

If the tongue is coated, it should be cleansed with a toothbrush before the administration of penicillin.

Stomatitis, gingivitis, and pharyngitis do not form a contraindication to a local application of penicillin. Some patients prefer a sublingual administration of penicillin but the presence of a relatively large amount of saliva in that region retards the absorption of penicillin.

While absorption of penicillin from lozenges is very slow the drug reaches the circulation very promptly after its application to the tongue in liquid form. Penicillin is absorbed by the tongue the lips, the gums, the mucous membranes of the oral cavity the palate tonsils, pharynx, and possibly also the esophagus. The three routes of absorption are through the veins, the lymph vessels, and the perineural and endoneural paths.

JOSEPH K. NARAT, M.D.

Rowe, A. H.: Delayed Healing of an Abdominal Wound Due to Food Allergy. *West. J. Surg.*, 1946 54 3-3.

The author reports the case of a 13 year old boy who had cramping abdominal pain associated with other gastrointestinal symptoms for a period of 5 years. Appendectomy followed by failure of wound healing and a recurrent serosanguineous discharge, had been performed 2 1/2 years before his referral to the author. After 2 years another surgeon reopened, curetted, and resutured the wound with equally unsuccessful results. There was a family history of allergy. Physical examination was negative except for moderate diffuse abdominal tenderness and a membranous bulging fluctuant wound in the right lower quadrant. The usual scratch tests were nega-

tive, and there were no abnormal reactions following cutaneous and subcutaneous implantations of various suture materials. Gastrointestinal x-ray studies, wound cultures, and histological studies were not made.

The patient was placed on an elimination diet. Within 2 weeks the gastrointestinal symptoms disappeared, the wound healed and has remained healed for 1 1/2 years. Subsequent studies indicated an allergy to milk which disappeared when the patient changed from a maritime to an inland environment.

The author concludes that the control of food allergy was responsible for the healing of a wound of 2 1/2 years duration and also for the control of lifelong gastrointestinal symptoms. There was no local wound treatment, no removal of any foreign substance, nor of retained sutures, no drugs or vitamins were given and there was no increased protein or caloric intake.

The assumption is made that accumulation of antibodies and allergens of the allergic foods, and/or a decrease in collagen and fibroblasts resulting from the localized allergy was responsible for the delayed healing and recurrent discharge from the wound.

It is suggested that allergy be considered as one cause for delayed healing or necrosis in wounds in any part of the body as well as abnormal sensitivity in abdominal wounds, particularly in patients with personal or family histories of allergy.

S. LLOYD THURMAN, M.D.

Leigh, O. C.: A Report on Trench Foot and Cold Injuries in the European Theater of Operations. *Ann. Surg.* 1946, 124 301.

This article reports a detailed study of 500 of the 5,000 cases of trench foot observed at the 108th General (U.S.) Hospital, (E.T.O.) during 1944 and 1945.

Trench foot is a term used by the United States Army Medical Corps to describe the cold injury resulting from prolonged exposure to just above freezing temperatures (34 to 40°F). It has occurred almost exclusively in combat infantry riflemen who were forced into immobility by enemy action.

Frost bite is used to describe the cold injury resulting from exposure to below freezing temperatures—either of the ground type occurring in the ground forces or high altitude type, occurring in combat air crews. Immersion foot designates the cold injury resulting from prolonged exposure of the feet to cold water. These injuries are usually described as different clinical entities, although the evidence indicates that they all present similar pathological changes and can be treated identically.

The incidence varied from 3 to 50 per cent of battle casualties, depending upon near freezing or freezing temperatures, wetness, immobilization of ground forces, inadequate and ill fitting foot gear, and failure or inability to enforce strict foot discipline. Company commanders most successful in avoiding casualties required each soldier to exchange

# SURGICAL TECHNIQUE

wet socks for clean dry ones and relieved a few soldiers from each group daily for a short time during combat activity.

Etiologically three factors were always present (1) wet cold (2) prolonged exposure in a relatively immobile position and (3) physical activity following the exposure. Of these factors, wet cold is the most important.

In trench foot the sequence of events leading to injury are fairly constant. The combat infantry soldier is forced into immobility in a wet foxhole for a prolonged period of time. He first complains of a tingling or stinging sensation in his feet which may become quite intense. After a period of exposure the feet become numb and finally anesthetic. When the attack is ordered or he is relieved walking causes severe burning pain and on removal of his shoes the feet become swollen and warm. Many soldiers complained that their shoes were too small after several days of exposure.

The immediate reaction of the skin to cold is a blanching in color. The blanching is caused by contraction of terminal arterioles and veins. The sensation of cold appears as the skin temperatures are reduced to 35° and then to 35° C. At these temperatures the skin develops a bluish color (cyanosis) which indicates local oxygen deficiency. As the temperatures are lowered to 30° and to 28° C the bluish color changes to purple and finally to a bright red or pink. These color changes indicating excess oxygen locally are the result of decreasing tissue metabolism and a lower oxygen dissociation from the blood at these temperatures. Each of the color changes may be transient or prolonged according to the degree of cold, duration of exposure and speed of wind currents. If the surrounding temperature is returned to normal after a short exposure, no further reaction will occur. If prolonged, secondary pathological reactions follow.

In first-degree injuries (36.4% based on 500 cases) the color changes and sensations encountered during exposure are quite similar to those described above. When placed in a warm environment, the foot develops a bright red flush. The larger vessels show increased pulsations for a few hours and the skin appears thicker from edema. Tingling of the feet is felt early and later itching burning or mild throbbing pain. This hyperemic or inflammatory stage subsided within 3 days (1-6 days) after which the foot assumed a normal appearance. All patients to 10 days) after exposure. This group of patients was returned to full duty after a short period of rehabilitation.

In the second-degree injuries (55.6%) the reaction after exposure is more severe with hyperemia pulsation of the larger vessels and throbbing pain, which may last for several days. Blisters appear and intracutaneous ecchymosis develops on the weight bearing surface of the foot and toes. The edema subsided on the average in 8.4 days (from 6 to 10 days) and was followed by varying degrees of scaling the

skin was sensitive and perspired profusely. The feet became warm and painful on exercise and in a warm environment. Exposure to cold is more comfortable for the patient. Most of these patients were returned to limited duty but many were later discharged as unfit for any kind of duty.

In the third-degree injuries (8%) the initial reaction is intense in 3 or 4 hours after the foot is placed in a warm environment. All the cardinal signs of inflammation are present—marked edema heat redness, and burning throbbing pain. Large blisters intracutaneous ecchymosis and superficial skin necrosis are present. The inflammatory stage averaged 12.4 days (from 7 to 32 days) only rare cases showing persistent edema for more than 14 days. The superficial layers gradually mummified and desquamated, leaving a pink sensitive skin. On dependency the skin assumed a dusky cyanotic hue and disability during the 3 month period of observation and were unfit for further duty. One severe case required amputation of the feet. Digits were lost in 1 per cent of 500 cases.

Once hyperemia has developed treatment is directed toward preserving the superficial injured layers of epidermis which forms a tough dry protective covering of the viable layers beneath. The foot is exposed to a cool, dry environment and kept elevated on pillows. In the earliest stages of hyperemia pressure bandages over cotton decrease edema and relieve pain. Surgical amputation should never be done in the early stages except for gross secondary infection. Dry gangrene of the toes occurred in only 1 per cent of the carefully followed cases. If infection is present sulfa drugs and penicillin should be used as in any other infection. Tetanus toxoid is given in open wounds. After the edema has subsided the treatment is directed toward the prevention of foot deformities caused by atrophy of the muscles and fibrosis. Supervised exercise of the feet physiologic measures and guarded ambulation should be initiated at the earliest possible moment. The use of vasodilator drugs and lumbar sympathetic block was investigated these measures did not give relief from pain and did not decrease the convalescent period. The pathological and physiological changes in trench foot are similar to frost bite but less severe. The basal germinal layer of epithelium remains intact in trench foot but is lost in frost bite.

JOHN H. MORGENTHAU M.D.

Kling, P. F.: Erysipeloid: Survey of 115 Cases. *Lancet* Lond., 1946 2 196

The material studied consisted of 115 unselected cases of erysipeld among 2,500 cases of all types seen in the septic hand clinic at Charing Cross Hospital from May 1941 to the end of December 1945. The condition was first described in 1873 by Baker and renamed erysipeld in 1884 by Rosenbach. The causal organism is the gram positive bacillus *Erysipelothrix rhusiopathiae* which causes erysipelas in pigs. The cutaneous form is the common

though intestinal and generalized forms have occurred. The infection results from contact with organic matter usually mammals, fish, shellfish, bones, flesh or shells but vegetable material or any form of nitrogenous products may also bring on the condition. The lesion occurred in 5 per cent of the septic hands at this clinic and was almost restricted to people employed at catering thus it was an occupational disease.

The lesion manifests itself from 2 to 7 days after the initial injury, which may be a cut, scratch, or puncture of the skin. It is characterized by a dark purple red zone, sharply defined and raised in the center of which the site of injury is often found to be healed. It usually occurs on the fingers, and from about the third to the fifth day the lesion extends peripherally the change being most noticeable toward the upper part of its distribution. After about a week the central part of the rash fades and desquamates, while the periphery continues to extend. It is common for the spread to reach (1) the palm or dorsum of the hand (2) the neighboring webs, (3) the adjacent sides of the neighboring fingers, and (4) the proximal phalanges of the neighboring fingers. The lesion appears to be commoner on the middle fingers and the thumb particularly of the right hand.

The rash is accompanied by a sensation of heat, burning and irritation of the part, which may become considerably swollen, and gives rise to a feeling of local tightness. Stiffness of the interphalangeal joints is common with resulting limitation of movement. Pain is common, especially early and becomes worse where the lesion extends, while at the same time it eases centrally. It may be throbbing, burning or smarting. There is a subcuticular extravasation of blood sometimes.

General symptoms are inconstant. Regional lymphangitis and lymphadenitis may occur. Of the 115 cases, only 5 showed lymphangitis and only 1 localized adenitis. There may be arthritis of the interphalangeal joint and this may lead to stiffness.

Erysipeloid is characterized by regressions and relapses. The average duration of the disease treated in this series was under 17.4 days but any time from 14 to 28 days is common. The variation was between 51 and 7 days. In the latter stages the lesion fades from the periphery inward. The lesion must be differentiated from erysipelas.

Erysipeloid has a seasonal incidence concurrent with epidemics of swine erysipelas and thus the greatest seasonal incidence is during the summer and early autumn. The author believes it is possible that the fly may be a vector carrying the organism from the feces of infected pigs and contaminated organic material.

Of 115 cases, 95 occurred among persons employed at catering and including housewives. The highest incidence occurred among cooks (50.8% if one considers each housewife in this class). Barmen, waiters, kitchen hands, and others account for 22.6 per cent, and fishmongers, poulterers and butchers for a

further 9.5 per cent. In this series, of the 20 persons not employed in the catering trade, 6 were infected from an animal source, 6 from a plant source, and 1 from an unknown source.

There seemed to be no special age and sex distribution.

Immunity is not conferred by one attack. Of the present patients 2 had second attacks.

The treatment is entirely medical with rest of the part as the fundamental principle. This is best obtained by not allowing the patient to work, using a high sling to keep his hand and forearm relatively immobile and applying hot wet boric dressings. The author believes that penicillin given systemically may be of considerable value although he did not use it.

LEROY J. KLEMMER, M.D.

### ANESTHESIA

Poe, M. F., and Karp, M.: *Seconal as a Basal Anesthetic Agent in Children: A preliminary Report. Current Res Anesth.*, 1946, 25: 152.

Basal narcosis is especially useful in the management of children undergoing surgical procedures. It spares the child the psychic disturbance attendant upon the trip to the operating room and induction of anesthesia. It reduces the amount of inhalation anesthesia as much as possible and it provides a period of postoperative rest and amnesia.

Seconal, a short-acting barbiturate, was chosen for trial as a basal depressant because of its quick action and its relatively short duration. The basis for estimating dosage was the age and weight of the patient, but consideration was given to the child's general condition, body build and vigor and nervous reactivity. A calculated dose of from 0.14 to 0.15 grain (9-9.5 mgm.) per pound gave the optimum degree of narcosis. It was planned in all cases to use local infiltration, and the basal anesthesia was employed to provide a manageable patient. Whenever pentothal sodium or other supplement was anticipated, atropine sulfate was administered subcutaneously as part of the postoperative medication. Seconal is rapidly absorbed when given either by mouth or by rectum. Oral administration was employed when feasible.

Seconal was used in 22 neurosurgical and in 3 ophthalmological procedures in children ranging from 3 months to 6 years of age. The majority of children in this group were in good physical condition, the procedures being performed for diagnosis. Side effects observed were a rise in pulse rate, some decrease in respiration, and a fall in blood pressure.

MARY FRANCES POE, M.D.

McAllister, F. F.: *The Effect of Pentothal Sodium on Mean Arterial Blood Pressure in the Presence of High Spinal Cord Paralysis. Ann. Surg.* 1946, 124: 338.

The effect of pentothal sodium on mean arterial pressure in the presence of high spinal cord paralysis produced experimentally in dogs, is reported. The

increasing use of intravenous barbiturates in conjunction with spinal anesthesia, and the fact that ether is known to act unfavorably on blood pressure when the spinal cord impulses are interrupted at the level of the sixth thoracic segment or above it prompted this study.

Spinal cord transections were made aseptically in the lower cervical region between the sixth cervical and the first thoracic segments. Control determinations of blood pressure were done on normal dogs.

The author's experiments on dogs indicate that when the function of the spinal cord has been interrupted in the lower cervical or upper thoracic region intravenous pentothal sodium produces no serious depression of the blood pressure. Thus this anesthetic is quite different from ether which is known to cause a pronounced fall in the blood pressure of such animals. Experimentally then when the suprasegmental vasomotor control has been eliminated intravenous pentothal is a safer anesthetic than ether.

JOHN H. MOWARD, M.D.

Booker W. M.: Observations on the Carbohydrate Metabolism during Prolonged Pentothal Anesthesia in Dogs: The Blood Sugar and the Liver Glycogen. *Anesthesiology* 1946 7 405

In view of the dearth of experimental work clinical as well, on the far-reaching effects of prolonged pentothal anesthesia, it seemed important that studies in this connection be launched to determine the feasibility of prolonged pentothal anesthesia keeping in mind those effects which may tend to vitiate the recovery powers of the animal or the patient.

The work reported here was done on approximately 45 dogs. Glycogen determinations were made on livers of all animals routinely 36 to 48 hours after the period of anesthesia. In a few of the early experiments liver function tests were also performed. Animals were anesthetized with a 3 per cent solution of pentothal sodium injected into the antecubital vein. Blood sugar on 0.2 c.c. of blood was determined by the Gibson micro method which is a modification of the Folin Wu method. The Benedict method for glycogen determination was employed. The results bring to our attention the interesting point that when pentothal is administered at frequent and regular intervals a point at about 3 hours is reached when the administration falls off both in frequency and amount. One of two things is occurring either the machinery for handling the pentothal has become embarrassed and more and more pentothal is building up in the tissues or the nervous system has become more adapted to its state of depression so that less and less amounts of anesthetic are necessary for maintenance of that depression. Full cognizance is taken of the fact that the fate of pentothal is controversial.

In the experiments reported in this paper there were a few instances in which the ureters were tied off immediately after the first injection without any difference noted in the frequency or amount of anesthetic administered throughout the period of anes-

thesia (4 to 6 hours). In one experiment the kidneys were removed entirely but the frequency and dosage did not vary from the usual pattern. This is good indirect evidence that in the dog pentothal is not excreted appreciably by the kidneys. Liver function tests tend to show that as anesthesia progressed, the ability of the liver to remove bromsulfalein from the blood is lowered. This would seem to indicate that the liver is undergoing some type of strain or taxation during the progress of the anesthesia so that its removal of bromsulfalein from the blood lags. The rise of blood sugar is in agreement with the observation of Marshall, who called attention to a mild hyperglycemia followed by a hypoglycemia in recovery phases under pentothal anesthesia. Whether or not this represents a damage or a strain on the liver may be open to controversy. It may be agreed however that something occurs in the liver to cause glycogenolysis with a resultant increase in blood sugar. Could it be that the enzyme system responsible for converting and maintaining glucose to glycogen is interfered with so that control of the liver glycogen is temporarily lost?

The influence of prolonged pentothal anesthesia on the glycogenolytic-glycogenic activity seems to be shown further in the inanition experiments. When animals deprived of food were given sugar just prior to anesthesia and were anesthetized for 4 hours it was found that the blood sugar was extremely high remained high throughout the experiment and was still high 24 hours later. It seems that the liver of the animals in the anesthetized series is unable to handle the excess glucose, even though its glycogen has been markedly lowered by deprivation of food. It may be that an explanation lies in the interruption of the glucose-glycogen pathway somewhere in the intermediary metabolism.

The high carbohydrate series of experiments was undertaken to determine whether or not good glycogen storage could withstand the depletory effect of pentothal. We see that although the livers of this series store glycogen in extremely high quantities (no pentothal experimentation) livers of animals on high carbohydrate diet (prolonged pentothal anesthesia) are markedly lowered in glycogen. It seems questionable therefore, whether or not the liver can be protected in prolonged administration of pentothal by either building up the patient with a high carbohydrate diet or injecting glucose concomitant with the anesthesia. We are of the opinion that in prolonged anesthesia glucose when administered in a very high quantity is not converted into glycogen and stored in very high quantity and preanesthetic glycogen stores are lowered by prolonged anesthesia.

MARY FRANCES FOX, M.D.

Appar V. Experience with Curare in Anesthesia. *Ann. Surg.*, 1946 134 161

Two hundred anesthetics were supplemented by curare and the author's experiences are recounted.

In all cases the anesthetic was administered by physician anesthetist after at least 3 months of



active resuscitation. The technique of curare administration is described in detail. The curare (intocostarin) used was found to mix freely with saline, glucose, or blood, but a precipitate with all pentothal concentrations was formed. The cases were tabulated as to type of surgery performed, type of anesthetic used, reason for the use of curare, amount of curare used, respiratory and circulatory effects of curare, and the return of reflexes.

One death was believed to be related to the use of curare and due to accidental overdose and too vigorous resuscitation.

The results obtained in the 25 ton ileotomies in which pentothal and curare were administered were appreciably better than a parallel series of cases without curare. Recovery in the group who had not had curare was prolonged and marked by extreme restlessness, necessitating much more nursing care than the group who had received curare. Only 3 per cent received prostigmine in 0.5 mgm. doses and no effect was observed in these patients.

The main disadvantage to the use of curare has been the difficulty experienced in teaching the signs of anesthesia. The demand for the drug during upper abdominal operations has increased to such an extent that it may not be necessary to teach third and fourth plane anesthesia. It is believed that curare has already assumed a permanent place as a supplement to anesthesia.

MARY KARP MD

Holaday D. A.: Nitrous Oxide-Cyclopropane-Curare Anesthesia; A Review of 200 Cases. *Anesthesiology* 1946 7 425

The recent advent of a purified, uniform extract of curare has provided the means by which an increasing number of anesthetists are obtaining relaxation during light general anesthesia. Curare acting peripherally paralyzes skeletal musculature progressively and quantitatively. Thus the differential paralysis of all somatic muscles save those necessary for respiration, may be procured. The mode of action is interference with the chemical transmission of impulses to the motor end organ, where such mechanism is cholinergic, and affects neither the normal conductivity of the nerve nor the contractility of the muscle fiber. In increasing dosage curare appears to affect the autonomic nervous system and probably the central nervous system. Lunn and co-workers have observed that in vagotomized animals a bradycardia results from administration of beta-crythroidine, a tertiary ammonium base closely related pharmacologically to curare. There is evidence that curare also affects the central nervous system. Puck and Lunn think it is likely that this is the result of an interference with synaptic transmission within the central nervous system. That it is apparent that curare has no simple peripheral action but rather a multiplicity of effects on the nervous system. Curare was adopted by the author as an adjunct to anesthesia with the thought that it would more safely provide relaxation for long operations. A review of the first 200 cases in which it was used is

presented. About one-seventh of these patients were poor risks and more than one-third were only fair risks.

The first cases were conducted by a method similar to that described by Cullen. It shortly became apparent that second plane anesthesia was not necessary for fully curarized patients. Anesthesia was then induced with cyclopropane and later lightened with a mixture of nitrous oxide and cyclopropane. The postoperative course of these patients was improved in that they reacted sooner and showed less depression of blood pressure and pulse rate.

This technique was later modified to eliminate the induction with cyclopropane. Doses of from 10 to 30 mgm. of morphine sulfate and 0.5 to 1.0 gm. of hyoscine hydrobromide were given for premedication. Additional morphine sulfate was administered at approximately hourly intervals during the longer operations to maintain a basal narcosis. Anesthesia was induced with 85 to 90 per cent nitrous oxide and maintained in light first plane by a mixture of 60 to 70 per cent nitrous oxide and 1 to 2 per cent cyclopropane in oxygen, delivered into a semi-closed carbon dioxide absorbing system. Curarization was initiated with 40 to 60 units of curare at the time of incision of the skin.

The course of the patients in the operating room was satisfactory. Postoperatively however respiratory depression sufficient to require nasal oxygen and other supportive treatment was frequently encountered. Thereafter the initial dosage of morphine was reduced to from 10 to 20 mgm. with no additional dose being given except in a few cases in which the operation lasted more than two hours. Too light anesthesia with concurrent curarization however has its complications. Reflexes of sufficient strength to produce spasm of the muscles of respiration can be initiated by excessive stimulation in the operative field. Additional curare may correct this, but may also produce undesirable respiratory depression. A more satisfactory method for interrupting these reflexes is to deepen the plane of anesthesia. We found it expedient therefore, to insure adequate premedication with morphine and to increase the concentration of cyclopropane in the anesthetic mixture to from 5 to 8 per cent during the initial phases of the operation. Cyclopropane can usually be reduced to 1 or 2 per cent concentration as soon as the curarization has been completed and discontinued entirely after 60 to 90 minutes.

Curare and cyclopropane or nitrous oxide were used to supplement an inadequate spinal anesthetic. Curare was combined with sodium pentothal in 5 cases without the appearance of severe respiratory depression or any noticeable augmentation of the curare effect as has been reported. Either was the principal anesthetic agent in 5 cases in which curare was used. The experience of the author with these cases supports the conclusions of other writers that either potentiates strongly the action of curare. For 4 cases in which basal anesthesia was established with avertin 20 per cent less curare was required to pro-

duce intercostal paralysis than for corresponding cases in which inhalation anesthesia was employed without avertin. Curare was administered intramuscularly in 7 cases. The full effect develops over a period of 15 to 20 minutes but the duration of effect is about 40 minutes. It must be emphasized that the rate of absorption of drugs administered intramuscularly is a function of the state of the circulation. If the blood flow should be impaired in any way while a significant amount of curare remains in the tissues subsequent improvement in the circulation may produce a dangerous degree of curarization at a time when the patient is not properly attended.

Various patients included in this study were selected because they were poor risks. These included some patients on whom a surgical procedure would not have been attempted except for the availability of an unusually favorable type of anesthetic. The average operating time was 119 minutes. The smallest intravenous total dose of curare was 20 units the greatest total dose was 300 units. The average total dose was 152.7 units. The average initial dose was 74.65 units. Curare was usually given in divided doses over a period of 10 minutes starting with 40 or 60 units. Maintenance doses were 20 units given every 20 to 30 minutes.

Pulmonary complications were encountered post-operatively in 8 cases. Severe respiratory depression requiring intermittent compression of the rebreathing bag to assist ventilation occurred nine times in the series. In every case in which it was required, artificial ventilation by this method was adequate to carry the patient over the period of depression. In certain cases however especially those involving elderly arteriosclerotic individuals having a tendency toward hypertension, the blood pressure rose as much as 100 points during a period of apnea and returned to normal only after full, spontaneous respiration was resumed. This was interpreted as indicating first that the most skillfully applied artificial method for ventilation is not as efficient as the patient's own unimpeded respiratory movements and second, that curare apparently does not interfere with the normal compensatory mechanisms of the cardiovascular system for combating hypoxia. Five cases are presented in detail.

The type of anesthesia developed during this study by permitting the use of unusually light planes of anesthesia, may be employed to advantage for almost any type of operation. Its greatest bene-

fits, however lie in its use in long shock-inducing abdominal operations in which relaxation is a prerequisite, and in providing safe anesthesia for poor risk patients. It possesses few of the disadvantages inherent in other methods. The degree of success with which balanced nitrous oxide-curare may be used depends upon the skill of the anesthetist. The dangers associated with its use result from overcurarization, or under anesthetization.

MARY FRANCES POE, M.D.

Sarnoff S. J., and Arrowood, J. G.: *Differential Spinal Block. Surgery* 1936 20 150.

Six patients were given light procaine solutions into the lumbar spaces by means of the continuous intraspinal method of Lemmon. Eight thermocouples were then placed as follows: 1 on the plantar aspect of each great toe, 1 on the lateral aspect of the dorsum of each foot, 1 each on the palmar aspect of the right thumb and middle finger and 2 in different parts of the room. The thermocouples were connected to a device which continuously recorded their temperatures. The initial dose of 10 c.c. of a 0.2 per cent solution of procaine hydrochloride was run in about 3 minutes. Thereafter 15 drops per minute were allowed to run in until the desired effect or height of block was attained.

Blood pressure pulse and neurological observations were made at regular intervals. Neurological examination included the appreciation of pin prick, proprioceptive vibration, heat and cold sensation and motor activity. An increase of skin temperature from 24 C. to 31.5°C., or above, was assumed to have caused a complete block of the vasoconstrictor nerve fibers in that area.

It was concluded from these experiments that it was possible to introduce a concentration of procaine into the subarachnoid space which would block the fibers carrying vasoconstrictor impulses to the periphery and also those concerned with pin prick without materially affecting fibers concerned with touch, proprioception, vibratory sense, or motor power. This was termed differential spinal block. Hypotension was considered a result of the interruption of sympathetic vasoconstrictor fibers and not due to muscular flaccidity or diminished thoracic excursions. It was found also that the level of loss of sensation to skin prick only very approximately parallels the level of block of other kinds.

MARY KARP, M.D.

# PHYSICO-CHEMICAL METHODS IN SURGERY

## ROENTGENOLOGY

Lofstrom, J. E., and Nurnberger, C. E.: Irradiation Sickness: Histamine Effect Treated with Benadryl A Preliminary Report. *Am. J. Roentg.* 1946 56 211

The authors recommend the use of benadryl (beta-dimethylaminoethyl benzhydrol ether hydrochloride) for irradiation sickness. Eighteen cases of irradiation sickness are summarized to demonstrate the relief of symptoms of anorexia, nausea, vomiting, weakness and headache by the use of benadryl. All of the cases were improved by this medication. The degree of relief varied from patient to patient.

Both oral and intravenous administration of benadryl were tried with the impression that oral administration will yield the desired amount of relief in most cases of irradiation sickness. The fundamental causes and mechanism of this condition are not known. The basis of this study and theoretical explanation of the results rests upon the contention that histamine-like bodies are developed in the blood of patients subjected to roentgen therapy and upon the hypothesis that benadryl neutralizes these if substances by virtue of its antihistamine action. Elevated blood histamine was found in the 1 patient in this series of whom the blood was examined.

The conclusion the authors draw from the small series of cases is that the use of benadryl in the treatment of irradiation sickness is beneficial.

FRANK L. HUSSEY, M.D.

Harper, R. A. K.: Some Observations on Roentgenography of the Pancreas. *Proc. R. Soc. Med. Lond.* 1946 39 534

Roentgenography of the pancreas is of limited value at present and will remain so until excretory pancreatography is perfected. Since the diagnostic value of the symptomatology of pancreatic disease is disputable also roentgenological examination is given preference for diagnosis even in its present form.

Known methods of examination of the pancreas by x-rays are Pneumoperitoneum (largely abandoned), gastric pneumography (largely abandoned), demonstration of opacities on abdominal films, barium studies of the stomach and the duodenum along its entire length for location of displacement, indentation, compression, invasion, and disturbance of the mucosal pattern, and barium studies of the small intestines for motility.

The conditions thus demonstrable are postinflammatory calcification of the pancreas, calcified pancreatic duct stones, pancreatic cysts, enlargement of the gland due to chronic pancreatitis, anomalous head of the pancreas surrounding the duodenum like an annular tumor, primary carcinoma of the pancreas, metastatic carcinoma, and lympho-

sarcoma, Hodgkin's disease, and retroperitoneal sarcoma involving the gland or stimulating pancreatic enlargement.

The differentiation between these conditions is rarely possible on a roentgenological basis. The differential diagnostic points are discussed.

GERHART S. SCHWARTZ, M.D.

Somerville, E. W.: Air Arthrography as an Aid in Diagnosis of Lesions of the Meniscus of the Knee Joint. *J. Bone Surg.* 1946, 28 451.

Many methods of visualization of the knee joint have been reported in the literature. In this series of 331 arthrograms, filtered air was used following 4 hours of skin preparation. The cassette was curved and mounted on a 6 inch stand. Routine views consist of 4 tangential views (round the clock views) of the meniscus. The medial or lateral joint was outlined by holding the thigh firm and abducting or adducting the leg. McGaw and Weckesser (*J. Bone Surg.* 1945 27 432) devised a simple block frame for doing the same without subjecting the examiner to excessive irradiation.

The medial meniscus is adherent to the capsule and tibial collateral ligament, appearing in the anteroposterior film as a small triangular density surrounded by air. The size of the meniscus increases in the tangential posterior views. The lateral meniscus is long and thin, extending from the capsule into the joint and it is raised from the tibia.

In the lateral posterior tangential view the meniscus becomes more triangular in shape. It may be continuous with the capsule or slightly separated by the popliteal tendon. The latter separation is not to be misinterpreted as a tear.

The bucket handle tear is found most frequently. The displaced fragment is seen usually in the lateral condylar notch. Peripheral tears of the lateral meniscus result in undue anterior or posterior mobility of the meniscus with a defect which may be wider than 3/8 inches. (The usual popliteal cyst defect is 3/8 inch wide.) Remnants of the posterior horn, a contused meniscus, tag and discoid lesions, loose bone fragments and semimembranous tears can be visualized.

A series of 331 knee arthrograms is reported. Of this group 100 were reported as normal and 231 as positive for a meniscus lesion. In the second group 205 patients were operated upon and a lesion was found in 195. In 4 of the 10 cases misdiagnosed as lesions were found in 3 there were synovial tags and hypertrophied fat pads, in 1 there was a loose body in another torn cruciate ligaments. The incidence of error was 4.5 per cent among 334 cases of knee pathology.

Although there are no contraindications to pancreatography it is not desirable in case of fluid in the joint. Arthrography is a useful adjunct to the fluor-

dian in arriving at a correct diagnosis. Many excellent reproductions of meniscus lesions are illustrated in the text.  
MAURICE D. SACHS, M.D.

Frimann Dahl J.: On the Value of Planigraphy in Bronchial Cancer. *Acta. radiol.*, Stockh. 1946 27 99.

Fifty-six cases of bronchial cancer were examined by means of planigraphy. In all cases satisfactory films were obtained. In 46 the planigraphic findings were positive. (This material does not include a number of cases with known bronchogenic carcinoma which were not planigraphed for various reasons.)

Survey films of these cases showed likewise, a pulmonary density in 46 instances. Direct, or air bronchography was successful in 10 cases, with positive findings in 6. Oil bronchography was performed in 12 cases. In the rest of the cases this procedure was deemed unnecessary and was omitted.

The author concludes that planigraphy is of great value in showing small cavities, bronchial narrowing, bronchial obstruction, endobronchial tumors, and peribronchial infiltration. It is the best method for differentiation between tumors which do not involve the bronchi and those which surround and involve the bronchial tubes, the latter almost always representing carcinomas.

The method is superior to bronchography with iodized oil because it does not require any preparation of the patient; it is harmless and fast and it is more often conclusive than the other procedures. For accurate localization, planigrams in 2 different projections should be obtained. It is planned to arrange for planigraphy in the erect position routinely for the demonstration of fluid levels. Thus far this has been done only occasionally as the present equipment for this position was too cumbersome for convenient operation and a moving grid was lacking.

GERHART S. SCHWARTZ, M.D.

Popp W. C., and Watkins, C. H.: Roentgen Therapy for Leucemia. *Med. Clin. N. America*, 1946 30 799.

In general in acute leucemia the disease is active and death may ensue in a few days to a few weeks. In chronic leucemia, the patient may live for from 2 to 4 years. In exceptional cases the process may be controlled for much longer periods. In the subacute forms the life expectancy will usually fall between these two extremes.

Roentgen treatment is as good a therapeutic measure in cases of leucemia as is known at the present time. Although the effect is entirely palliative, yet with properly supervised treatment a patient can be maintained in a useful capacity. Much disagreement is apparent between hematologists and

radiologists as to whether or not roentgen therapy prolongs life. The authors inferred that in some instances life seems to be prolonged considerably. Even this may not be wholly true; the fact that the general health of the individual patient is usually maintained at a better level with the use of roentgen treatment is sufficient to warrant its acceptance as a therapeutic measure in the treatment of leucemia. The close co-operation of the hematologist and the radiologist is important in the successful care of leucemia.

## MISCELLANEOUS

Thorndike, A.: Rehabilitation of the Surgical Patient in Army Hospitals in World War II. *Am. J. Surg.* 1946 73 404.

During World War II the Medical Department of the Army developed an extensive reconditioning program primarily in an effort to return as many wounded men as possible directly to active duty in as short a time as possible, but also to return to limited service or useful civilian life those individuals who could not be completely salvaged. The program was planned for the surgical patient and developed in 3 aspects—physical, educational, and occupational. The success of the Army surgery plus the reconditioning program was gauged by the return of 58.8 per cent of the wounded to active duty within the overseas theaters, the best results being from the Convalescent Centers of the European theater where 84.5 per cent of the patients were returned to duty within the theater.

This article concerns itself chiefly with the physical reconditioning program. The rehabilitation plan was started early in convalescence, with classes of exercises adaptable progressively to those in bed, in the ambulant ward, and in the fully ambulant group. There were also special programs devised for special categories of the wounded such as the amputees, the thoracic cases, the paraplegic, the deaf, and the blind. It was found that even very early after injury the afebrile patient profited by exercises which used the uninjured parts and later in convalescence remedial exercises and occupations adapted to the specific injury were initiated.

The author makes no attempt to detail the whole program, but outlines the exercises designed for the bed patient since they are the most useful in civilian hospital practice. He accompanies the outline with a series of very clear figure diagrams for each exercise, and recounts the muscles used in each. It is understood that few if any bed patients are able to do all the exercises; the prescription in each case in Army practice being left to the discretion of the ward surgeon.

LILLIAN DONALDSON, M.D.

## MISCELLANEOUS

### CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

Forgas, J., Kornegay G B., and Henley T F :  
Studies on Streptomycin Assay in Body Fluids.  
*J Lab Clin M* 1946 31 514

Various methods of assaying antibiotics are mostly modifications of the cylinder-plate method

A method is described for assaying streptomycin in body fluids, particularly in the blood and in the urine. The method was developed in order to clarify absorption, excretion, and activity of the drug in human beings.

The amount of streptomycin is estimated from the width of the zone of inhibition observed on an agar plate seeded with a special strain of *Bacillus subtilis*.  
ARTHUR J LESSER, M.D.

Kornegay G B., Forgas, J., and Henley T F :  
Studies on Streptomycin. Blood Levels and Urinary Excretion in Man and Animals. *J Lab Clin M* 1946 3 523

Streptomycin was administered to mice guinea pigs rabbits, and human beings by intravenous, subcutaneous intramuscular and intraperitoneal injections and maximum blood levels appeared from 15 to 60 minutes following injection.

An intramuscular dose of 30,000 units given to human beings every 3 hours resulted in blood levels from 1 to 2.5 units per cubic centimeter. Higher levels can be obtained by increasing the dose.

No changes in red or white count were found following the administration of streptomycin. Variations of the blood levels from a given dose were observed from animal to animal and in the same experimental animal from day to day. Similar irregularities were observed in human beings. In man a considerable daily variation of urinary streptomycin excretion was observed and a prolonged urinary excretion after cessation of streptomycin therapy was considered evidence of storage somewhere in the body.

No satisfactory vehicle for oral administration was found and the absorption of streptomycin from the gastrointestinal tract was not followed by therapeutic blood level.  
ARTHUR J LESSER, M.D.

Oberrio, J M : Acroparesthesia (Acroparestesia. La artritis de hombre el plexo braquial y la acroparestesia de miembros superiores) *Rev As med argen* 1946, 60 557

There are three clinical forms of acroparesthesia namely acroparesthesia diurna acroparesthesia nocturnal and mixed acroparesthesia. Associated disturbances are vasomotor motor and trophic, and also sensory disturbances.

In all of the cases seen by the author since 1915 the acroparesthesia coexisted with an arthritis of the

shoulder while the changes of simple acroparesthesia which is a sensory disturbance, are due to brachial plexitis. The scapulohumeral arthritis originates from a neuritis of the circumflex and suprascapular nerves. In the nocturnal arthralgia form, the symptoms originate after arising from an auto-intoxication originating during sleep. At night this auto-intoxication is neutralized but on arising there is an increased basal metabolism and a decreased carbon dioxide concentration in the blood due to increased pulmonary ventilation and thus the intoxication is aggravated.

ARTHUR F CIRIELLO, M.D.

McLaren J W : Calcium Gluconate Injections in Muscle. *Brit. J Radiol.*, 1946, 19 314

It would appear that the injection of calcium gluconate carries with it some risk of damage to muscle tissue which may be of a serious nature. It is, however, difficult to ascertain the factor which causes the calcium deposition, since this happens must be of infrequent occurrence. Certain solutions of calcium gluconate may be unstable and therefore more likely to be precipitated, and it is suggested that a myositis may be set up as the crystals of the gluconate are of the sharp needle type. It is also known that calcium salts are nonlipid-soluble and are only absorbed with difficulty from a adipose tissue, so that the injection should be made only into muscle and care taken that fatty tissue is not carried to the injection site by the needle. Experimental injection of calcium gluconate into rabbits has not produced any demonstrable calcification in muscle. The case recorded by Lamm shows that serious results can be brought about by injections of calcium gluconate, and though it would appear that absorption of the calcium usually occurs there may be permanent damage which in some instances may be of an irreversible nature.

The author reports another case of calcification in muscle shown in roentgenogram.

JOHN J MALONEY, M.D.

Abbott W E., Hirschfeld J W., Williams, H H., Pilling, M A., and Meyer F L : Metabolic Alterations following Thermal Burns. The Effect of Altering the Nitrogen and Caloric Intake of Administering Testosterone Propionate on the Nitrogen Balance. *Surgery* 1946, 20 4

Previous studies indicate that both experimental animals and human beings show a characteristic metabolic response after thermal injuries. This reaction consists of a marked negative nitrogen balance temporary elevation of the blood sugar, amino acid concentrations, salt retention, increased water intake and output with actual water retention and temporary increase in urinary excretion of ketosteroids and cortin.

In this article the authors report the effect on the nitrogen balance of altering the food intake or of administering a nitrogen retaining hormone (testosterone propionate) in 45 burned patients and a group of animals with standardized experimental burns.

In moderate and severely burned patients the nitrogen deficit is more marked than in those with a smaller burn and attempts at forced feeding of patients who show the greatest loss meet with the most difficulty. Consequently a diet containing 1.6 times the basal caloric requirement (20 per cent protein) was started on the third day after the burn and was well tolerated by most patients. Such a diet kept nitrogen loss at a minimum and there was an earlier return to a positive nitrogen balance than in those patients receiving a lower caloric and protein intake. There was no evidence in a study of these patients that raising the carbohydrate content of the diet caused any significant sparing of nitrogen nor was there any substantial effect noted from the addition to the diet of dl methionine (in an amount equal to 1 per cent of the diet).

The severity of the nitrogen deficit bears a direct relation to the extent and severity of the surface area injured and is also dependent upon sex, age, nutritional state, fever, infection and type of therapy. High diets (from 3,000 to 5,000 calories containing from 100 to 300 gm. of protein) are probably deleterious during the catabolic stage following a burn and should not be given during the first week or two.

Eight burned patients were given testosterone propionate (25 mgm. daily for 10 days) without conclusive results as to the value of such therapy. This hormone reduces the loss of urinary nitrogen. It should not be used as a substitute for food, but used in an attempt to conserve and utilize better the maximum diet which the patient can tolerate. Androgenic therapy must be employed cautiously as it may produce masculine characteristics in women. It also causes water and salt retention; hence it is preferable to delay instituting therapy until the catabolic phase has subsided (from 8 to 14 days).

S. LLOYD TETTELMAN, M.D.

Cammermeyer, J. Tumor of Tactile End Organ.  
*Arch. Path.* Chic., 1946 42: 1

The author reports the case of a 50 year old man who had a congenital tumor on the mediobasal side of the two distal phalanges of the left index finger which had grown some during the 2 or 3 years preceding its removal. There had been no pain nor other disturbance except that due to the mere presence of the tumor. It was removed by excision together with an exostosis and healing was smooth.

On microscopic examination the tumor was found to consist of masses of fibrous connective tissue which surrounded conglomerates of tactile end organs.

The article is complete with photomicrograms, schematic drawings, and detailed discussions of the histologic structure of this tumor.

The author reviews the literature relating to similar structures and concludes that his case is unique in several aspects. HENRIK LAMM, M.D.

## DUCTLESS GLANDS

Jones, G. E., S. Delfs, E. and Foote, E. C.: The Effect of Thiouracil Hypothyroidism on Reproduction in the Rat. *Endocrinology* 1946 38: 337

The authors' experiments were planned in an effort to demonstrate what specific effect hypothyroidism might exert on the ability of rats to reproduce. The hypothyroidism was produced with thiouracil because of the difficulty in producing this state surgically in rats.

Fourteen male rats were given approximately 25 mgm. of thiouracil daily by placing the drug in their drinking water and then certain groups were mated after having been fed thiouracil over periods of 49, 166, 204, and 259 days. Three of the animals were obviously ill from other causes and when they were ruled out 10 of the remaining 11 sired the litters. Each rat was mated only a single time with a single female.

There was a tendency toward unsuccessful mating following the one hundred and sixty-sixth day of thiouracil administration which probably reflected the toxicity of the drug rather than any impairment of reproductive capacities.

The results of these experiments on male rats indicate that hypothyroidism as induced by thiouracil has no effect upon the reproductive system of the male rat as judged by the ability to sire normal litters.

Thiouracil was then fed in the same manner to 15 female adult rats. The dose was calculated to be 20 mgm. daily. There were 27 matings, 22 of which resulted in resorptions. The 5 litters occurred in the first group of matings made 84 days after the beginning of thiouracil administration; the remaining 4 matings of this group terminated in resorptions, as did all 18 matings made after the one hundred and twenty-sixth day of thiouracil administration. One interpretation of the findings may be that the matings of the first group reflect a state of borderline hypothyroidism perhaps comparable to the period of about 3 months described by Engle which is necessary to dissipate the effect of thyroid feeding in previously thyroidectomized monkeys. Following the time lapse which may be necessary pregnancy will occur but terminates in resorption in 100 per cent of the cases.

Experiments are now being done in which rats are given thiouracil thyroid extract in order to determine whether the hypothyroidism or the thiouracil causes this effect.

Hypothyroidism induced by thiouracil has no effect upon the reproductive system of the adult male rat as judged by the ability to sire litters. Prolonged thiouracil administration associated with hypothyroidism in the adult female rat does not cause sterility but interferes with continuation of

gestation as it leads to the resorption of embryos in 100 per cent of the cases. If the drug is given over a period of less than 100 days some rats may deliver litters which are normal in growth and development and reproduce normally.

EDMUND R. DOXOGUET, M.D.

Huggins, C., and Russell, P. S.: Quantitative Effects of Hypophysectomy on Testes and Prostate of Dogs. *Laboratory* 1946 39

Some of the chemical changes occurring after hypophysectomy in the prostate and testes of dogs are described in this paper. For several reasons, it has become important to study the involution of normal tissues, particularly since the methods which induce regression in them can sometimes be applied to produce dysfunction in neoplastic cells. The endocrine glands, as implied by definition, exert remote control of certain other tissues.

Previous investigations have been directed toward weight and cytology changes and tissue metabolism of the testis after hypophyseal extirpation. The present study deals with quantitative effects produced on the testes and prostate.

Hypophysectomy was done on 4 dogs by the method of Dandy and Reichert under intravenous sodium secenal. The testes were measured through the scrotum preoperatively with a caliper and dogs with testes of identical size on each side were selected. Hypophyseal removal was judged complete in these animals since no fragments of the sella were found at necropsy and the characteristic regressive changes were found in the adrenals. At the time of hypophysectomy one testis was removed for chemical study and the opposite one was removed when the dogs were sacrificed from 41 to 63 days postoperatively.

In 3 additional dogs, removal of the hypophysis was adjudged incomplete since minute fragments of tissue identified histologically as pituitary were found at necropsy.

In 3 normal dogs a wedge-shaped section of the left lobe of the prostate was removed for phosphate determination and the testes were then removed. The right lobe of the prostate was assayed at necropsy 1 month later.

All testes were weighed and the content of water, fat, and chloride determined. The acid and alkaline phosphatase content was determined in the hypophysectomized and castrated dogs as well as in 9 normal adult dogs and 3 immature puppies.

In conclusion the authors state that complete hypophysectomy produces slight increase in body weight.

After hypophysectomy the testicular weight increases to two-thirds the normal value and is associated with decreased water and increased chloride and fat concentration. The total fat is reduced. There is a dissociation between form and function in the Leydig cells, form and fat content being rather well retained while androgen production is greatly reduced or lost. Spermatogonia persist in the testes being found in a single layer in the tubules.

Total hypophysectomy produces profound atrophy of the prostatic epithelium which is reduced to the prepubertal state. Prostatic acid phosphatase is decreased below the castrate level to values comparable with those found in juvenile animals. Alkaline phosphatase is decreased to prepubertal level after hypophysectomy but is remarkably elevated after castration.

Subtotal hypophysectomy in dogs is associated with prostatic atrophy but with retention of normal spermatogenesis.

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In 3 normal dogs, a wedge-shaped section of the left lobe of the prostate was removed for phosphatase determination and the testes were then removed. The right lobe of the prostate was assayed at necropsy 4 months later.

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# SURGERY

## GYNECOLOGY AND OBSTETRICS

VOLUME 84

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NUMBER 3

### A NEW TECHNIQUE FOR PULMONARY SEGMENTAL RESECTION

#### Its Application in the Treatment of Bronchiectasis

RICHARD H. OVERHOLT, M.D., Boston, Massachusetts and LAZARO LANGER, M.D.,  
Cordoba, Argentina

DOCTORS are confronted with few problems that are more serious than those presented by a patient suffering from bronchiectasis. The disease process, if untreated, is irreversible, progressive, and for most patients eventually causes death. On the other hand, of all chronic pulmonary diseases, bronchiectasis is one of the most hopeful for the reason that pulmonary resection affords not only alleviation of symptoms, but also cure in a high percentage of cases.

Although the fundamental pathology of primary bronchiectasis has been known for decades, only in recent years has the characteristic distribution of the disease in bronchopulmonary segments been realized. The increasing use of bronchography and the detailed study of surgical specimens have shown that bronchiectasis is primarily a segmental disease and rarely involves an entire lobe. In addition, bronchiectasis tends to involve the bronchopulmonary segments in certain patterns. Basal segments of the lower lobes are most commonly involved. The lingula division of the left upper lobe and the bronchi of the right middle lobe are frequently found to be diseased along with the basal segments. The superior segment of the lower lobe, how-

ever, is rarely affected. Another very important pathological and clinical observation has been that the distribution of primary bronchiectasis, as far as the affected segments are concerned, has usually reached its full extent at the time of diagnosis. Any progression of pulmonary involvement from this point on will not be through involvement of other segments by the bronchiectatic process, but by associated suppurative changes in the pulmonary parenchyma itself.

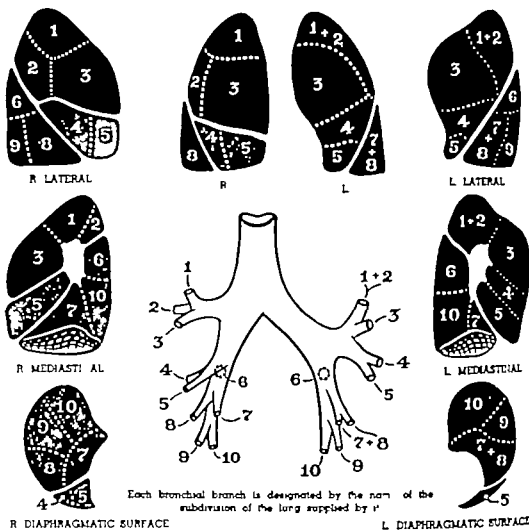
In recent years, many excellent anatomical studies (2, 3, 4, 6) along with increased surgical experience in resecting pulmonary tissue, have demonstrated that the bronchopulmonary segment is a surgical unit and lends itself to removal without undue technical difficulties or risk. As a result, segmental resection is now being used by us with increased frequency in the surgical treatment of bronchiectasis. Segmental resection not only eradicates all of the diseased segments, but it also eliminates the necessity of a sacrifice of uninvolved segments. This approach to the problem permits the accomplishment of two fundamental principles of surgery: (1) cure of the patient; (2) the preservation of as much functional tissue as possible.

During the past year we have developed a surgical technique which facilitates the removal of any bronchopulmonary segment. The use of clamps on lung tissue has been elim-

From the New England Deaconess Hospital and Tufts College Medical School, Dr. Overholt, Clinical Professor of Surgery; Dr. Langer, Fellow in Surgery, Tufts College Medical School.

# NOMENCLATURE FOR THE BRONCHI AND LUNGS

Adapted from  
CHEVALIER L. JACKSON and JOHN FRANKLIN HUBER  
Temple University School of Medicine



R. DIAPHRAGMATIC SURFACE

L. DIAPHRAGMATIC SURFACE

## RIGHT LUNG

LOBES	SEGMENTS	
Upper	{ Apical Posterior Anterior	1
		2
		3
Middle	{ Lateral Medial	4
		5
Lower	{ Superior Medial Basal Anterior Basal Lateral Basal Posterior Basal	6
		7
		8
		9
		10

## LEFT LUNG

LOBES	SEGMENTS	
Upper	{ Upper Division Lower (Lingular) Division	{ Apical-posterior Anterior
Lower	{ Superior Anterior-medial Basal Lateral Basal Posterior Basal	{ Superior Anterior Inferior

Fig

*A New Technique for Pulmonary Segmental Resection —Richard H. Orschall*

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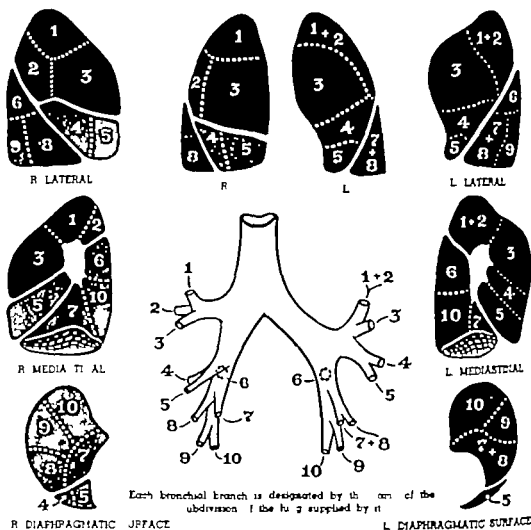
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		7+8
		9

Fig

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inated. Damage to healthy segments is avoided. The intersegmental plane is dissected so as to ensure removal of all diseased bronchi.

The purpose of this paper is to describe an original and new technique of segmental resection. We wish to refer to its application in 23 cases of bronchiectasis.<sup>1</sup>

#### IMPORTANCE OF SEGMENTAL RESECTION

Bronchiectasis is primarily a segmental disease and frequently bilateral. It usually involves certain bronchopulmonary segments within the lobe rather than an entire lobe. Unsegmental disease is found less frequently than unilateral multiple segmental disease. It is also less common than bilateral involvement. In the last one hundred consecutive cases of primary bronchiectasis studied by us 85 per cent were multiple segmental and in 30 per cent the disease was bilateral. In our series, the lower division of the left upper lobe (lingula) was involved in about 60 per cent of those patients whose principal disease was in the left basal segments. On the right side the middle lobe was found to be involved with the right basal segments in 45 per cent of our cases. A frequent bilateral pattern to be found shows involvement of the right middle, the lower divisions of the left upper (lingula) and both right and left basal segments.

Clinical observations have shown that the severity of symptoms is closely related to the amount of tissue damaged. Experience also has demonstrated that good end results parallel the surgeon's ability to eradicate all portions of lung that are diseased. If entire lobes are considered as surgical units, serious respiratory embarrassment will result if the disease is completely removed in bilateral cases; for example, the removal of the right middle lobe, both lower lobes, and lower divisions of the left upper lobe leaves the patient with one complete and one partial lobe which may not be sufficient for anything more than an invalid existence.

<sup>1</sup>Segmental resection is also being used for other localized conditions. Up to the present time this technique of segmental resection has been carried out in chronic lung abscesses (4 cases), hamartomas (1 case), metastatic melanocarcinoma (1 case), and pulmonary tuberculosis (4 cases). The individual resection of the posterior and apical segments of the upper lobe, the superior of the lower, the posterior basal of the lower and the anterior of the upper were involved.

#### BRONCHIAL NOMENCLATURE

Bronchial nomenclature is far from being standardized. Various names for the bronchopulmonary segments have been suggested. This lack of standardization has led to much confusion. Jackson and Huber<sup>2</sup> emphasized the need for terminology which will be acceptable to the bronchoscopist, the thoracic surgeon, and the radiologist and which will meet the approval of the anatomist. They have proposed a nomenclature now widely accepted which has been used herein (Fig. 1).

#### PRACTICAL CONSIDERATIONS

The conception that a bronchopulmonary segment be considered as a surgical unit is gaining greater acceptance. Nelson called attention to the pathological significance of certain segments and called the lingula the left middle lobe (counterpart of the right middle). He subdivided the lower lobe into two principal divisions, the dorsal (superior), and basal. He found that, anatomically, each segment possesses independent bronchovascular structures and is separated from the adjacent pulmonary tissue by an avascular plane. From time to time thoracic surgeons have found it necessary to remove a part of a lobe by the use of clamps and multiple sutures. Most frequently this technique was practiced in treating left lower lobe bronchiectasis with involvement of the lingula. The indurated lower tip of the upper lobe would be excised without precise dissection. Churchill and Belsey and Blades (7) have called attention to the importance of the removal of the lingula and other segments in the treatment of bronchiectasis and other diseases.<sup>3</sup>

Boyden has pointed out that from a practical standpoint, most of the segments can be considered to be surgical units, but not strictly bronchovascular units. He found some arteries mainly in the upper lobes, to be intersegmental and the veins to drain blood from adjacent segments.

<sup>2</sup>As common basis for the choice of names, they have taken the position of the segment on the lobe. Terms like apical, basal, and lingula are unanimously recognized as part of the lung; anterior and posterior, superior and inferior, and medial and lateral indicate the position of the segments within the lobe.

<sup>3</sup>Since this manuscript was submitted for publication, Church and Dretter in *Journal of Thoracic Surgery*, 1940, 5: 277-284, have discussed the importance of lingulectomy in bronchiectasis and describe technique for its removal.

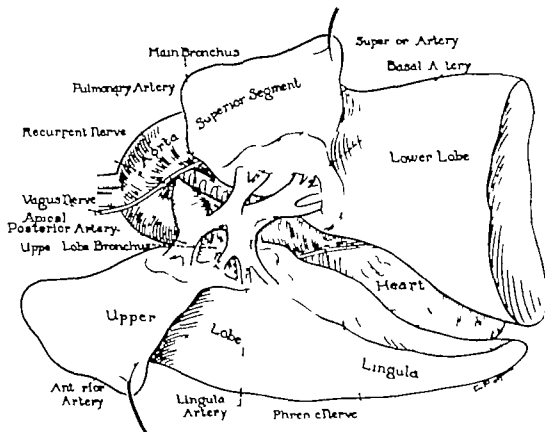


Fig. 2 Anatomical drawing of the left pulmonary artery with all of its branches as seen in the interlobar approach with both lobes retracted.

Not infrequently the presence of a rudimentary fissure or crevice will indicate the topographical boundary of a bronchopulmonary segment. Surface markings suggesting rudimentary fissures become more evident after the lung has been collapsed. The involved segments may be contracted or already completely collapsed. There may be a difference in pigmentation. The diseased segment some times fails to deflate as rapidly as the normal segments and variations in intrapulmonic pressure by inflating and deflating the lung will also aid in identification.

Accurate delineation of the bronchopulmonary segments is accomplished by (1) deflation of the lobe (2) temporary occlusion of the bronchus (3) reinflation of the lobe by means of increased positive intratracheal pressure.

#### RELATED ANATOMY OF THE SEGMENTS

A thorough knowledge of the intrahilar and related segmental anatomy of the lung is indispensable if one is to apply the surgical principles of individual treatment of anatomical

structures in partial lobectomy. The anatomical pattern may vary and an anomalous distribution of bronchovascular structures may be found. These anomalies can be recognized and do not interfere with the treatment of the segment as a surgical unit.

The pathological significance of certain segments selectively involved by bronchiectasis has already been referred to. The frequency in which bronchiectasis is found in both basal segments and in the lower division of the left upper makes these particular segments of great practical importance.<sup>1</sup>

**Basal segments—right and left side** In normal lungs each basal group constitutes approximately two thirds of the lower lobe. In bronchiectasis this proportion changes as contraction of basal segments occurs and the superior segment hypertrophies or enlarges. In longstanding disease starting in childhood the superior segment has been found to approach in size the normal lower lobe. The hilar arrangements on both sides are similar.

Related anatomy of only the most important segments involved in bronchiectasis has been given.



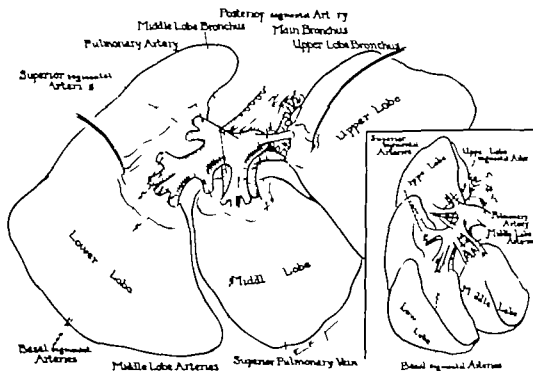


Fig. 3. Anatomical drawing of the right pulmonary artery and its branches as seen in the interlobar approach with the lobes retracted. Insert shows the pulmonary artery as seen anteriorly. The middle lobe has been retracted medially.

The inferior pulmonary vein is an anterior structure in the pulmonary root but its tributaries emerge from the lobe in a plane posterior and inferior to the bronchus. Several tributaries from the lower lobes form the inferior pulmonary vein. They frequently are found to be four. One is from the superior segment, and the remaining three are from the basal segment. The branch from the superior segment lies posterior to the basal bronchus which it crosses and should be identified and preserved when basal segmental lobectomy is performed. This vein may be as large as the combined basal veins.

The bronchus to the lower lobe has two major segmental divisions, the superior and the basal. The first division of the lower lobe bronchus is the branch to the superior segment. It arises both right and left, from the posterolateral aspect of the main bronchus. On the left side it arises below the level of the upper lobe bronchus and on the right side it arises at the beginning of the lower lobe bronchus about the level of the middle lobe bronchus. The bronchi in the basal segments are, in reality, the continuation of the main bron-

chi. Between the superior division of the bronchus and the subdivisions of the basal segmental bronchi there is a common stem from 1 to 1.5 centimeters in length which is suitable for individual ligation.

The arterial distribution of the lower lobe parallels, to a certain extent, the bronchial structures of it. The pulmonary artery on the left side (Fig. 2) during its course deep in the interlobar fissure gives off branches to supply the segments. The highest artery to the lower lobe is the superior segmental branch. Its level or origin is opposite to the branch of the lingula and sometimes higher. On the right side (Fig. 3) this branch arises from the posterolateral aspect of the interlobar portion of the pulmonary artery opposite the level or slightly above the origin of the middle lobe artery or arteries. The basal segmental arteries (four on the right and three on the left) follow their respective bronchi. Their common stem which constitutes the prolongation of the main pulmonary artery is sometimes too short to allow its ligation in mass and for this reason each branch should be disposed of separately.





Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.

*Lower division of the left upper lobe (lingula)*

The vein from the lingula division is a tributary to the superior pulmonary vein and enters it at its lowest point. It lies anterior and inferior to the bronchus and is formed by two branches the superior and the inferior, lingula veins. They are best approached from the anterior aspect of the hilum.

The lower, or lingula divisional bronchus branches from the inferior aspect of the left upper lobe bronchus and its single trunk is divided into two segmental bronchi the superior and the inferior. The inferior bronchus descends to the tongue of tissue in the antero-inferior angle of the upper lobe.

The artery to the lingula is a branch of the pulmonary artery and it takes origin from the main trunk deep in the interlobar fissure (Fig 2). Its course is posterior and lateral to the bronchus. Many variations in the lingula artery can be found. It may originate from a common trunk with the anterior segmental artery, or the two lingula branches may arise separately from the main pulmonary trunk.

## TECHNICAL CONSIDERATIONS

*Objection to clamp and suture method* In the past, segmental lobectomies or partial excision

Fig 4. 1 Left pulmonary artery 2 anterior artery 3, superior artery 4, lingula artery 5, basal artery B, superior bronchus C basal bronchus. The fissure has been developed and the left upper and lower lobes are exposed. The basal segment is alveolar and appears contracted and dark bluish in color. The superior segment is larger than average and has normal color. The pulmonary artery is situated deep in the interlobar fissure. It is anterolateral to the bronchus. The basal artery is exposed and the superior lingula and anterior segmental arteries are seen through the visceral pleura which has been partially dissected away. The first step after exposure of the pulmonary artery is the ligation of the basal branch. If the common stem of this artery is short, the various branches can be ligated separately to provide more room between proximal and distal ties. The insert shows the basal artery already divided.

Fig 5. 1 Left pulmonary artery 3, superior artery; A left main bronchus, B superior bronchus, C basal bronchus 6 inferior pulmonary vein 7 superior vein 8 basal vein. The lung has been dropped forward exposing the posterior hilum. The pulmonary ligament has been divided. The inferior pulmonary vein lies anterior to the main bronchus, but its tributaries emerge from the lobe posterior to the segmental bronchi. Before the basal veins are ligated the superior segmental vein should be identified. It can be seen posterior to the basal bronchus and crossing over it. Insert shows the basal veins ligated.

Fig 6 A Left main bronchus B superior bronchus C basal bronchus 6 inferior pulmonary vein 7 superior vein. The insert shows the basal bronchus partially divided

of pulmonary tissue have been accomplished by cutting through thick vascular pulmonary tissue between clamps and placing either a running suture ligature or individual ligatures in the lung substance held by the clamps. Distinct disadvantages of this practice should be mentioned.

1 It is impossible to place the clamps precisely in the intersegmental plane. Either too much or too little tissue is resected.

2 The application of clamps across the lung is rather crude and traumatizing. Bleeding and hematoma formation may be unavoidable.

3 Excessive suture material is necessary. This increases foreign body reaction and predisposes to secondary infection.

4 Puckering and reduction in size of remaining segments are produced. Re-expansion may tear the sutured lung surface.

*Our method* During the past year we have developed a method of segmental dissection which is fundamentally sound.

The segment is held within the lobe by four principal structures the bronchus, the pulmonary artery vein and visceral pleura. All of these structures can be identified and divided prior to the dissection of the intersegmental

and the superior vein retracted. The main drawing shows the stump of the segmental bronchus closed. Tacking for clips hold the bronchus, vein, and artery of the segment. While the bronchus is being amputated the operative field should be protected with gauze pads in order to avoid spillage of purulent material. The suction tip is constantly maintained close to the amputation line. The lobe has been inflated by oxygen under pressure. The demarcation line between the segments is now evident. The visceral pleura at this boundary is incised. After the pleura is completely free, the dissection of the intersegmental plane begins in a retrograde manner.

Fig 7 4 Left main bronchus B superior bronchus C basal bronchus 6 inferior pulmonary vein 7 superior vein. The insert shows finger method of separation. The surgeon's thumb is applied directly over the bronchi and all the branches are "peeled off." This simple procedure is very useful because the fingers find the path of least resistance which is the intersegmental plane. A few connective tissue fibers may have to be divided with a knife or scissors. In the main drawing, an intersegmental vein can be seen on the raw surface of the lobe. A few communicating vessels have been ligated. Air bubbles can be seen leaking out from the lung. They do not constitute a problem because the alveolar seal off spontaneously by the time the chest is ready to be closed. After the segmental lobectomy has been completed, all remaining bleeding points in the lung surface are sutured. If bronchial leaks are still present, they are repaired with interrupted sutures. Note the size of the remaining superior segment which represents a significant salvage.

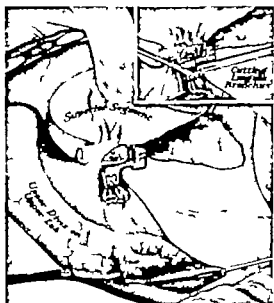


Fig. 8.



Fig. 9.

Fig. 8. 1, Pulmonary artery; 2, anterior artery; 3, superior artery; 4, lingula artery; 5, superior bronchus; 6, lingula bronchus. The remaining superior segment is retracted upward and the base of the fissure is exposed. The lingula artery has been prepared for ligation. Note that the lingula artery comes off from a slightly lower level than the artery to the superior segment. Both branches of the lingula artery have been tied distally and separately. The right angle clamp shown is used to dissect the artery. Proximally the artery is going to be tied with a main ligature of fine silk and a transfixion ligature. Insert shows the lingula artery divided. The lingula bronchus lies anteriorly to the artery. Its membranous portion can now be seen.

Fig. 9. Pulmonary artery; 1, lingula bronchus; 2, superior pulmonary vein; 3, lingula vein. The upper lobe has been freed from the pericardium and is held up. The superior pulmonary vein is exposed. The tributaries from the upper lobe pulmonary segments can be seen. Superior and posterior to the superior pulmonary vein lies the main pulmonary artery. The mediastinal pleura has been opened and the lingula veins dissected. The ligatures are placed distally on the two branches. The cartilaginous portion of the lingula bronchus can be seen superior and posterior to the corresponding vein. Insert shows the lingula vein divided and the corresponding bronchus more clearly exposed.

tal plane then the development of this plane is simplified and made possible. The bronchi do not traverse this plane. For practical purposes, this plane is avascular. The supporting framework of connective tissue is loose, slightly elastic, and yields to gentle blunt, and sharp dissection. Air leak of raw surface is negligible and self-sealing. Prompt healing of the denuded lung surface follows, as in other organs, since its blood supply has not been jeopardized, or the tissue traumatized.

The technique as applied to any segment is briefly as follows:

1. Identify and divide the segmental pulmonary artery. In all segments except the apical posterior (left) and the apical and anterior (right) the major fissure should be developed in such a manner as to find the segmental artery.

2. Identify and divide the segmental vein

3. Identify and divide the segmental bronchus.

4. Determine the line of demarcation between segments by inflation and incision of visceral pleura completely around the lobe at this line.

5. Start development of intersegmental plane at the secondary hilum. Holding forceps makes traction on the bronchus, artery and veins. Clamps on the lung tissue are not used and should be avoided as they may include ramifications of the bronchi. Dissection is done bluntly at first. Fibrous strands may be cut with scissors. Bronchi strip out between forefinger and thumb. The correct plane of cleavage is the one showing least resistance. One to six intersegmental vessels may have to be ligated. Mosquito hemostats are used. If there is a question of identifying a fine bronchus or a vessel, it is first cut and then ligated.

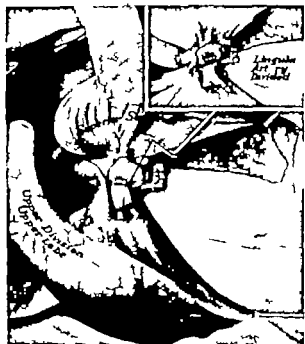


Fig 10



Fig 11

Fig. 10. 1, Pulmonary artery, 2, anterior artery, 3, superior artery; B, superior bronchus; D, lingula bronchus. The bronchus to the lingula segment can be seen closed proximally with two mattress sutures. Both of its branches have been tied distally. Note the difference in the appearance of the lingula and the remaining portion of the upper lobe. Insert shows the bronchus being cut.

Fig. 11. 1, Pulmonary artery; 2, anterior artery; C, basal bronchus; D, lingula bronchus. Insert shows the free pleural flap held in place with an Allis forceps and sutured with two wire sutures. The main drawing shows the lobes re-expanded with oxygen under positive pressure. Note the size of the superior segment which has been conserved. The lingula segment is very small and contracted and the remaining segments in the upper lobe represent about 7/10 of that lobe. The lingula is in the process of being removed in the same fashion as the basal segment.



Fig 12.



Fig. 13.

Fig. 12. Bilobar segmental bronchiectasis. Diseased segments, airless, contracted, and dark in color as drawn from an actual koda chrome photograph.

Fig. 13. Healthy segments conserved after bilobar segmental resection also from a photograph.

if it bleeds. If it happens to be a bronchus the end is picked up again and it is stripped out to its termination. Much of the dissection can be accomplished with the thumb and forefinger. It has been surprising to us to find that

the structural attachment of the segment to the remaining portion of the lobe is so frail after the four supporting structures have been released. This completes segmental separation and treatment of the raw surfaces of the re-



Fig. 14. Roentgenogram at left shows bronchiectasis in the middle lobe and anterior segment of the upper lobe on the right side and basal and lingula segments on the left

side. Roentgenogram on right, 3 months after second operation. Arrows indicate stumps of resected segmental bronchi

maining segment. No attempt is made to fold over edges or use grafts.

6. Reamputation and meticulous closure of the segmental bronchus is then carried out. We prefer to use two interrupted mattress sutures and two or three end sutures applied over a free graft of parietal pleura. Stainless steel wire (No. 35) or silk is used.

The resection technique of those segments most frequently removed for bronchiectasis is illustrated. The same principles may be applied to other segments (see Figs. 4 to 11). The patient is in the face-down position<sup>1</sup> and the head of the table is to the left. In all color drawings the artery is shown in red and the vein in blue.

During the past year and one-half we have adopted the face-down position with the diseased side dependent for pulmonary resection (5). The conventional side position places the diseased lung above the healthy lung and favors spillage of secretions and debris via the intercommunicating bronchi during the operation. The face-down position minimizes this danger. It also permits wider range of respiratory movement. Patients tolerate an open pneumothorax better and positive pressure is rarely required.

After completion of the operation the pleural cavity is thoroughly washed out with saline warmed to body temperature. The thoracic cage is reconstructed by two pericostal chromic catgut No. 2 sutures placed subperiosteally. The intercostal nerves should be carefully avoided. Postoperative pain is greatly diminished by these precautions. The intercostal muscles are loosely sutured with interrupted sutures. The muscles are closed in two layers with interrupted sutures. The superficial fascia is closed separately and the skin is sutured with a multiple needle technique. Silk (No. 9) is used throughout. Before the chest is closed a rubber catheter (No. 26) with lateral openings is placed in the pleural space and carried out through the lower end of the incision. Gentle suction is used for 24 to 48 hours.

#### POSTOPERATIVE ATTENTION

In the care of patients following segmental resection the same measures should be used



Fig. 15. Photograph of the patient, L. B. Front and back view a months follow ing second operation

that have been found to be of value after routine lobectomy. The two primary concerns are maintenance of airways and complete re-expansion of the remaining segments. Oxygen therapy is rarely needed. Deeper breathing is more apt to occur if the patients are in a normal atmosphere. Patients should be stimulated to cough and raise. Undue postoperative pain seriously interferes with expectoration. Early changes in position are encouraged. The lower half of the chest should be temporarily immobilized by exerting pressure with the hands on the side operated upon because it allows cough and expectoration with less discomfort. Bilateral bronchiectasis presents a particular problem after the operation on the first side because of the presence of secretions originating in the contralateral lung. Any accumulation of secretion should be avoided. Tracheal aspirations after insertion of a catheter via the nose will frequently suffice. The temporary catheter drainage is removed in 24 to 48 hours. Further evidence of fluid and air in the pleural cavity calls for aspiration by needle. Regular examination under the fluoroscope helps greatly in keeping track of the progress of re-expansion.

#### SUMMARY OF CASES

Twenty three segmental resections have been performed upon 21 patients for primary bronchiectasis. No deaths have occurred in this series and all of the patients have benefited greatly from the surgical intervention. All of the unilateral cases are free of symptoms. The age of the patients ranged from 7 to 56 years. Most of the patients were in the second or third decades. The duration of the disease was from 4 months to 27 years. The amount of sputum varied from 1 ounce to 20 ounces daily. The outstanding clinical features in the order of severity were as follows: repeated colds, bouts of pneumonitis, hemoptysis, cough and expectoration of purulent secretions. Foul sputum was present in 40 per cent of the cases. Bilateral lesions were present in 11 cases (52.4 per cent) with the following segmental distributions. In 10 cases the middle lobe, right basal and lingula and left basal segments were involved. 1 patient had the middle lobe, the anterior segment of the right upper and the lingula and left basal diseased. In the unilateral group 5 patients showed involvement of two segments. The lingula and left basal were involved in 3 cases, and the



TABLE I.—SUMMARY OF 21 CASES (23 OPERATIONS) AS TO AGE, DURATION OF DISEASE, AMOUNT OF EXPECTORATION SEGMENTS INVOLVED, SEGMENTS REMOVED, POSTOPERATIVE COMPLICATIONS AND PRESENT CLINICAL STATUS.

Case No. Name Age	Duration of Illness	Segments involved	Amount of expectoration (ounces)	Segments removed	Date of operation	Complications	Present clinical status
L. B. 9	5 yrs	Middle lobe anterior seg- ment, upper lobe, lingula and basal left	5 ozs	Middle lobe and anterior segment, upper lobe, lingula and basal left	3-14-45 3-20-45	Atelectasis 4th P. O. day	Well
M. M. 7	3 yrs	Middle lobe and basal right lingula and basal left	3 ozs	Middle and basal right lobes, lingula, and basal left	4-27-45 5-22-45	—	Well
R. D. 17 yrs	27 yrs	Middle lobe and basal right lingula and basal left	8 ozs	Lingula and basal left	7-10-45	Fistula and empyema drained 2nd P. O. day	Cough and expecto- ration, some draining very little
E. D. 17 yrs	3 yrs	Lingula and basal left	3 ozs	Lingula and basal left	8-28-45	Atelectasis 1st P. O. day	Well
M. U. 5	20 yrs	Basal left	0 ozs	Basal segment	9-5-45	—	Well
M. R. 7	1 mo	Basal right	0 ozs	Basal segment	9-7-45	—	Well
B. M. 7	3 yrs	Lingula and basal left	0 ozs	Lingula and basal left	9-4-45	Atelectasis and P. O. day	Well
J. H. 8	3 yrs	Middle lobe and right basal lingula and basal left	0 ozs	Lingula and basal left	9-9-45	—	Still draining slight amount of thick sputum
O. F. J. 9	3 yrs	Middle and right basal lingula and basal left	0 ozs	Lingula and basal left	9-9-45	Empyema—cured 1st procedure	Well
C. B. 8	3 yr	Lingula and basal left	0 ozs	Lingula and basal left	9-24-45	—	Well
M. H. 3	7 yrs	Lingula and basal left middle lobe and basal right	0 ozs	Lingula and basal left	1-2-45	Atelectasis, broncho- pleural fistula and empyema—drained 1st P. O. day	Well draining very little Fistula closed Slight expectoration
A. M. 3	3 yrs	Basal right	0 ozs	Basal right	30-45	—	Well
L. W. 8	3 yr	Middle lobe and right basal lingula and basal left	0 ozs	Lingula and basal left	3-40	Empyema drained 1st P. O. day	Still draining very little. No sputum
N. R. 20	3 yrs	Middle lobe and basal right lingula and basal left	0 ozs	Lingula and basal left	3-3-45	Bronchopleural fistula repaired	Expecto- ration about amount of sputum
J. C. 16	5 yrs	Middle lobe and basal right lingula and basal left	5 ozs	Lingula and basal left	3-7-45	—	Well
W. M. C. 18	5 yrs	Superior segment left	0 ozs	Superior segment left	3-20-45	—	Well
V. G. 16	15	Middle and right basal lingula and left basal	0 ozs	Middle lobe and right basal	4-9-45	—	Expecto- ration temporary of amount of sputum
R. M. C. 16	5 yrs	Middle and right basal	0 ozs	Middle and right basal	4-18-45	—	Well
R. H. 16	3 yrs	Basal left	0 ozs	Basal left	5-18-45	—	Well
M. P. 20	3 yrs	Lingula middle and right basal	0 ozs	Lingulectomy	6-22-45	—	Too recent to evaluate
J. M. 20	3 yrs	Middle and right basal lingula and left basal	0 ozs	Lingula and left basal	6-24-45	—	Too recent to evaluate

middle lobe and right basal segment were involved in the other 2 patients. The remaining 5 patients had their disease localized to only one segment as follows. Two were in the right basal 2 in the left basal 1 had the superior segment of the left lower lobe involved.

Bilateral bisegmental operations were performed in 2 cases 1 in a 7 year old girl. During the first stage the middle and right basal segments were removed. Four months later the lingula and left basal segments were resected. The other patient was a 19 year old female who had a history of 15 years of cough and purulent sputum. During the first operation the middle and the anterior segment of the right upper were resected. Nine months later the lingula and left basal segments were operated upon. Both patients made an uneventful recovery following the operation and are free of symptoms.

#### COMPLICATIONS

In 4 cases bronchoscopy was necessary to aid in re-expansion. In each instance watery secretions were found but no definite bronchial plug. Bronchoscopy also revealed submucosal edema of the orifice of the segment adjacent to the amputated one. We believe that this pathological finding explains the obstructive atelectasis in the absence of a bronchial plug. In times past when all diseased segments were not removed thick tenacious sputum was a frequent postoperative finding. Following bronchoscopy all of the patients conditions improved and re-expansion was obtained. Empyema developed in 4 cases. One was treated locally with pleural aspiration and penicillin and cleared up entirely. The remaining 3 were drained. Bronchopleural fistula was demonstrated in 2. In 1 of them a tension pneumothorax developed requiring an exploratory thoracotomy. This was performed 20 days after the segmental resection and revealed a pinpoint opening in the basal bronchial stump. This defect was repaired with interrupted sutures. Continuous negative suction was applied and re-expansion was obtained.

The incidence of complications in this series of segmental resections is greater than that which attended routine lobectomy for the in-

cidence of empyema has been brought down to approximately 5 per cent. This segmental series however is an original group and there is reason to believe that a reduction in complications will follow. It should be pointed out that at the present time the conservation of uninvolved pulmonary tissue far offsets any effects of a temporary pleural infection which may occur. Functional studies have not been done in this group of cases. In the future when these studies can be undertaken we are confident that comparative studies will re-emphasize the importance of selective segmental resection for bronchiectasis.

#### CASE REPORT

L. B. student nurse 19 years of age. Patient had a chronic cough dating as long as she could remember. Recently the cough was productive of thick yellowish sputum daily. She had been having frequent cold episodes of pneumonia and dyspnea. She was forced to give up work. Bronchographic studies (Fig. 14 a) revealed cylindrical bronchiectasis in the middle lobe and anterior segment of right upper lobe and in the lingula and basal segments of the left lower lobe. On March 14 1945 a middle lobectomy and resection of the anterior segment of the right upper lobe was performed. On December 10 1945 the lingula and basal segments on the left were removed. Bronchogram (Fig. 14 b) taken 2 months after second operation showed the remaining segments to be well re-expanded and free of bronchiectatic changes. The four segmental stumps can be seen. The superior segment of the left lower lobe now occupies the lower lung field.

#### CONCLUSIONS

1. A new method of removing a pulmonary segment applicable to any segment has been described. This method does away with the use of clamps or suture of the lung surface. The development of the intersegmental plane is precise relatively avascular and not traumatizing.

2. The importance of considering the bronchopulmonary segment as a surgical unit in the management of bronchiectasis has been discussed. The frequency of bilateral and multiple segmental involvement has been pointed out.

3. Conservation of all healthy pulmonary tissue is desirable in all cases and obligatory in bilateral disease. It is vitally important that the surgeon limit the resection to diseased seg-

ments rather than remove entire lobes, segments of which are healthy and capable of respiratory function

## REFERENCES

1. BLADES, B. *Ann Surg.* 1943, 8 353-365.
2. BLADES, B. and KENT E. M. *J Thor Surg* 940, 0 84-98.
3. *Ibid* 942, 8-30.
4. *Idem* *Ann. Surg* 1942 6 78-794.
5. BOYDEN, E. H. *Surgery* 945 18 706-731.
6. CHURCHILL, F. D. and BELSEN R. *Ann Surg* 1944, 09 48 499.
7. JACKSON, C. L. and HUBER, J. I. *Correlated Applied Anatomy of the Bronchial Tree and Lungs with System of Nomenclature. Diseases of the Chest* 1943 9 18.
8. NELSON, H. P. *Brit M J* 934, 2 25.
9. OVERHOLT, R. H., LANGER, LUDWIG STROCKM, JR. T. and WILSON, NORMAN J. *Pulmonary resection in the treatment of tuberculosis—present-day technique and results. J Thor Surg.* (in press)

# CLINICAL EXPERIENCES WITH THE USE OF PENICILLIN TREATMENT OF INFECTIONS INVOLVING BONES AND JOINTS

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A CLINICAL investigation of the efficacy of penicillin in the treatment of infections involving the bones was begun on the University of California surgical services in April 1944 and continued until March 1945 after which the study was limited to bone grafting in infected areas and to the treatment of infections of the central nervous system and skull. During this period 87 patients with infections involving the bones and joints were studied. There were 58 cases with established infections of the large bones and joints (20 acute and 38 chronic) 4 cases with infections of the mandible and 25 cases with infections involving the bones of the skull (the latter with infections of the central nervous system will be reported elsewhere). Frequent bacterial cultures, blood penicillin levels and penicillin sensitivity tests accompanied the study of all cases (Table I).

## ACUTE INFECTIONS INVOLVING BONES AND JOINTS

There were 20 patients with acute infections involving the large bones and joints. 7 had postoperative infections, in 4 infections followed injuries and 9 had acute hematogenous osteomyelitis.

1. *The acute hematogenous infections* included 7 cases of acute osteomyelitis (2 tibiae, 1 femur, 1 clavicle, 1 clavicle and sternum, 1 humerus, and 1 ilium) and 2 cases of acute septic arthritis (knee and hip joints). Five of the 9 patients had fulminating infections of 1 to 5 days duration with temperatures of 104 to 105 degrees F. and with blood cultures pos-

itive for hemolytic *Staphylococcus aureus* in 4 cases and beta hemolytic streptococcus, 1 case. The other 4 patients had been acutely ill for 2 to 8 weeks with temperatures 101 to 103 degrees F. with hemolytic *Staphylococcus aureus* infections but their blood cultures were sterile. The organisms were penicillin susceptible in all cases. In 5 cases a period of sulfonamide therapy given prior to penicillin treatment had failed to control the infection. Systemic penicillin was given by the intramuscular route at 3 hour intervals in all cases.

The initial dosage varied from 100,000 to 200,000 units per day. This was increased to 200,000 or 300,000 units per day within 24 to 48 hours if response to treatment appeared slow. The patients with fulminating infections usually became less toxic and the blood cultures became sterile within 48 to 72 hours after systemic penicillin therapy was started, but the temperatures declined rather slowly over a period of several days. The patients with less severe infections showed more rapid diminution of temperature and toxicity. The small abscesses and all infected joints were aspirated and penicillin solution was instilled into them. Usually concentrations of 5,000 units of penicillin per cubic centimeter were used in the abscesses and 1,000 units per cubic centimeter in joints. Infected joints and small abscesses usually became sterile after 48 hours of local penicillin therapy but aspirations and instillations were continued as long as fluid could be obtained. Large abscesses necessitated surgical incision for drainage in 4 of the 9 cases. Two of these were in the group of 5 patients with the fulminating infections, and 2 were in the group of 4 patients with less severe infections. Transfusions of blood were required in only 2 cases. All patients were kept in bed during the height of the infection and

From the Division of Surgery of the University of California Medical School. The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of California.

## INFECTIONS OF THE MANDIBLE

Four patients with serious infections involving the mandible were treated with penicillin. Two had chronic infections with penicillin susceptible hemolytic *Staphylococcus aureus*. One of these had an extensive chronic osteomyelitis and the other an infected fracture of the mandible with nonunion. Two patients had acute infections of the mandible: one had an acute osteomyelitis arising from a carious tooth with a large abscess involving bone and soft tissues and containing anaerobic staphylococcus, streptococcus, actinomyces and bacteroides; the other an osteomyelitis apparently from a carious tooth resulting in a fulminating bacteremia with beta hemolytic streptococcus.

The first patient had an operation for drainage and removal of sequestra, and received 1 800 000 units of systemic penicillin therapy over a period of 18 days. The wound was left open and healed promptly with an excellent result. The patient with an infected fracture had an open reduction including a sliding bone graft, done in conjunction with 3 700 000 units of penicillin given systemically over a period of 23 days. The wound healed without infection; the bone graft was successful and gave a satisfactory functional result.

Two patients had acute infections involving the mandible. Both apparently originated from infected teeth. One had a large abscess containing anaerobic streptococcus, staphylococcus, actinomyces and bacteroides. It was aspirated daily for 6 days, and 50 000 units of penicillin were injected daily for the first days and 25 000 units on each of three

## CHRONIC INFECTIONS OF BONES AND JOINTS

In this group of 38 patients there were 12 with chronic infections resulting from hematogenous osteomyelitis, 18 with infected fractures, 5 with postoperative infections of the bone in a chronic phase, and 3 patients with tuberculosis of the bones, associated with chronic secondary pyogenic infections. Systemic penicillin therapy was given by the intramuscular route at 3 hour intervals. The improvement in appetite and nutrition of this group of patients within a few days after beginning systemic treatment with penicillin was striking. The drainage from the infected sinuses often became clear or opalescent, and a few cases ceased entirely after a few days of penicillin therapy.

1. The chronic bone infections resulting from hematogenous osteomyelitis included 2 cases of osteomyelitis of the humerus, 2 of the tibia and 8 of the femur, in 1 of which the hip joint was involved. The bacterial flora in these patients were hemolytic and nonhemolytic *Staphylococcus aureus* (occurring alone and together), hemolytic and nonhemolytic *Staphylococcus* (combined) and mixtures of hemolytic *Staphylococcus aureus* with *Escherichia coli*, *Aerobacter aerogenes*, hemolytic *Staphylococcus albus*, alpha hemolytic streptococcus, beta hemolytic streptococcus and *Proteus vulgaris*. The organisms were penicillin-susceptible except the *Escherichia coli*, *Proteus vulgaris* and the alpha hemolytic streptococcus.

*Aerobacter aerogenes* and the alpha hemolytic streptococcus were very susceptible to penicillin. The alpha hemolytic streptococcus was very susceptible to penicillin.

penicillin therapy. All 10 of these patients had a course of preoperative penicillin therapy of 3 to 15 days duration averaging 8 days. The preoperative penicillin dosage varied from 100 000 to 200 000 units per day. Postoperatively systemic penicillin was continued for not less than 3 weeks and usually at least 6 to 8 weeks. The total amounts of systemic penicillin used in treatment in each case varied between 1 900 000 and 17 800 000 units averaging 4,499 000 units. The operations consisted of excision of all infected scars, granulations, sinus tracts, and sequestra, and excision of infected bone as far as was practical. The soft tissue wounds were closed at once in 6 of the 10 cases and 4 of these healed promptly without infection; one wound disrupted on the 5th postoperative day but subsequently healed slowly and satisfactorily, and the other wound became grossly infected (hemolytic *Staphylococcus aureus* and *Aerobacter aerogenes*) on the 7th postoperative day but subsequently healed and has remained healed. Three of the patients had secondary closures performed on the 14th, 16th, and 17th postoperative days, and all of these soft tissue wounds healed promptly and remained healed. The wound of 1 patient was left open and healed slowly but completely by granulation. Four patients (2 with primary closures and 2 with secondary closures) had local penicillin therapy given postoperatively through rubber tubes that were placed in the wounds at the time of operation and healing was rapid and complete in all 4 patients.

At the time this report was prepared there was no sign of activity of osteomyelitis in any of the 10 patients treated with operation in conjunction with penicillin therapy, and the soft tissue wounds in all were completely healed. The 2 patients who were treated with penicillin therapy alone had excellent temporary results but both had a recurrence of infection after having remained healed for a year.

2. *Chronically infected fractures.* In the group of 18 patients with chronically infected fractures, the tibia was involved in 13 cases, the femur in 3 cases, and the humerus in 2 cases, 1 including the elbow joint. The organisms cultured from the wounds of these pa-

tients were hemolytic *Staphylococcus aureus* (occurring alone and with *Bacillus pyocyaneus*, *Escherichia coli*, beta hemolytic streptococcus and alpha hemolytic streptococcus), nonhemolytic *Staphylococcus aureus* (separately and mixed with *Streptococcus fecalis* plus *Clostridium welchii* and with gamma streptococcus), hemolytic *Staphylococcus albus* and a mixture of beta hemolytic streptococcus, *Streptococcus fecalis* and *staphylococcus*.

All of these patients required operation. They usually received a few days of preoperative penicillin therapy, and in 3 cases several weeks of penicillin therapy preceded operations on infected fractures. Operation usually consisted of excision of infected scar, sinuses and granulations, and removal of infected and nonviable bone so that only well vascularized soft tissues and bone remained. At the same time open reduction of the fractures was performed. In 6 of these patients internal fixation with large metal plates was used, and bone grafting was done in 13 of the patients. Position of the fragments was maintained with appropriate orthopedic methods of fixation. Multiple operations were required in some cases: 4 patients had 2 operations, 4 patients had 4 operations, and 1 patient had 5 operations. The additional procedures consisted of skin grafting, secondary closures, removal of metal plates, and regrafting fractured bone grafts. Each operation was done in conjunction with a preoperative and postoperative course of penicillin therapy. There was no indication of dissemination of infection following any of the surgical procedures. The wounds were closed by primary suture in 16 of the 18 cases. Eight of these healed *per primam*; 3 had some necrosis of the soft tissue wounds due to closure under tension, 2 developed trivial superficial infections, and 3 wounds broke down with gross infection. The wounds of two of the 18 patients were left open, and a trivial infection developed in 1 of these.

All patients received their systemic penicillin by intramuscular injection at 3 hour intervals. The daily dosage usually was 100 000 to 200 000 units. The total amounts of penicillin used in each case varied from 1 800 000 to 20 000 000 units, averaging 7,600 000 units.

per patient. An effort was made to maintain systemic penicillin therapy until all of the contaminated fracture area and overlying soft parts were vascularized completely and until bony repair was well begun. In some cases in which tension necrosis or superficial infection produced open wounds local bacteriostasis was maintained with penicillin ointment dressings. Four of the patients had postoperative local instillations of penicillin solution through catheters placed in the wounds at operation. In 3 of these healing was prompt and complete; in one the introduction of pyocyaneus delayed healing of the soft tissues but the final result was good. These tubes for local penicillin therapy were removed between the 10th and 14th postoperative days. Apparently firm union occurred at the fracture site in 13 of the 18 cases, 1 patient has fibrous union with poor function and 4 patients still have non union. At present the soft tissue wounds of 13 patients are completely closed, 2 have small superficial granulating areas and 3 have open infected draining wounds.

3. *Chronic postoperative bone infections*. Five patients had chronic infections of the bones resulting from previous operations. These included patients with the following conditions: an infected osteotomy of the tibia (poliomyelitis deformity), an infected revision of an amputation stump in the lower leg, an infected spinal fusion (performed for a fracture of the odontoid process), an infected hip joint arthrodesis (performed for traumatic arthritis) and an infection involving bones of the pelvis following an attempted lumbosacral fusion operation. The predominating organism found in this group was hemolytic *Staphylococcus aureus*, which occurred alone and with hemolytic *Staphylococcus albus*, beta hemolytic streptococcus, and in 1 case was mixed with nonhemolytic *Staphylococcus aureus*, gamma streptococcus and anaerobic non hemolytic streptococcus. All organisms were penicillin-susceptible *in vitro*. Each patient received a course of systemic penicillin consisting of 100,000 units daily for 3 to 11 days (average 8 days). In this group all 5 patients had operations for removal of infected and nonviable bone, scar granulations, and sinuses. The wounds of all patients were closed

by primary suture without drainage. Tubes were placed for postoperative local penicillin therapy in 2 cases. Postoperative systemic penicillin therapy was maintained for 14, 20, 43, 68 and 137 days respectively and the total penicillin dosage in these 5 cases was 1,400,000 units, 2,000,000 units, 4,095,000 units, 5,150,000 units, and 16,500,000 units.

The soft tissue wounds healed without infection in 3 of the 5 patients. In 2 patients *Proteus vulgaris* infections occurred postoperatively and produced serious acute infections followed by prolonged suppuration of the soft tissues but after several weeks both of these wounds healed completely. (One of the proteus infections occurred in a patient receiving local penicillin therapy through a rubber catheter; the other occurred in a patient who did not receive local penicillin therapy). Subsequently these 5 patients have exhibited excellent results; all wounds remaining healed.

4. *Tuberculosis of the bone and joints with secondary pyogenic infection*. The 3 patients in this group were treated with penicillin. One patient had tuberculosis of the spine (with thoracic to second lumbar) with multiple sinus tracts and secondary infection with a penicillin sensitive strain of hemolytic *Staphylococcus aureus*. He was given three separate courses of systemic penicillin therapy consisting of 100,000 units per day for 18 days, 14 days and 37 days, respectively. The secondary infection (hemolytic *Staphylococcus aureus*) responded slowly but apparently was controlled temporarily by penicillin therapy. However infection with the same organism recurred within a few weeks after each course of penicillin treatment. He received a total of 7,380,000 units of penicillin.

The second patient had tuberculosis involving the bones about the shoulder joint. The secondary infection in this case was a penicillin resistant hemolytic *Staphylococcus albus*. He received 2,100,000 units of systemic penicillin therapy over a period of 23 days without benefit. Suppuration from the draining sinuses was unchanged and the bacterial cultures remained positive for hemolytic *Staphylococcus albus*.

The third patient had long standing chronic tuberculosis of the knee joint with extensive

omyelitis of the femur and tibia. Cultures of his wounds grew a strain of hemolytic *Staphylococcus aureus* that was penicillin susceptible. Systemic penicillin was given preoperatively for 7 days (150 000 units per day). At operation the sinus tracts granulations were debrided and infected bone was excised thoroughly. Cancellous bone grafts from the ilium were placed in the large resulting defect and a cast was placed for postoperative local penicillin therapy. The wound was closed without drainage and the extremity was fixed with steel plates in a plaster-of-paris cast. Postoperative local penicillin therapy consisted of 10 000 units per day for 10 days after which the tubes were removed. Systemic penicillin therapy was continued for 46 days. A total of 6 750 000 units of penicillin was given to this patient and the wound healed *per primam*. The bone grafts became vascularized and incorporated, giving a repair that produced complete arthrosis. One year later this patient was seen and had excellent function of the extremity. Systemic penicillin therapy proved to be a valuable adjunct to the surgical treatment of chronic infections involving bones. Complete surgical removal of all infected tissues and unviable bone appears to be of primary importance in the successful penicillin treatment of most patients with chronic bone infections. Incomplete surgical removal of infected tissues is the most important cause for failure with penicillin therapy. In some cases it was impossible to remove all of the infected sclerosed bone, e.g. in a patient with osteomyelitis involving an entire long bone or large segment of the spine and in such cases recurrence of infection is inevitable. Internal fixation with metal plates almost invariably produced complications in the form of necrosis of the overlying soft tissues or delayed recurrence of the bone infection and it appears desirable that such plates when indispensable be removed at the earliest suitable time. Tension of the overlying soft tissues consistently resulted in

necrosis and infection with penicillin resistant organisms. Bone infections associated with very large open soft tissue defects were difficult to control because of reinfection through the open wound. Bone grafting in contaminated and infected areas was accomplished successfully in conjunction with penicillin treatment and several bone grafts in wounds that became infected postoperatively were saved by administration of penicillin.

Preoperative systemic penicillin for a period of several days appeared to be desirable and postoperatively it was found necessary to maintain systemic penicillin therapy until the soft tissues were healed and the bone defects were revascularized and had started their repair. This generally required at least 3 weeks and often several months depending on the size of the soft tissue and bony areas to be revascularized and on the vascularity of the tissues adjacent to the site of healing. Doses of 100 000 to 200 000 units daily were used but in most serious chronic infections it appears desirable to give at least 200 000 units per day. Inadequate dosage, i.e. small doses given infrequently or adequate doses given for too brief periods is ineffective. Whenever the infected area was accessible to local penicillin therapy the control of infection and healing seemed to take place more rapidly than with systemic penicillin therapy alone. Local penicillin treatment was particularly useful in controlling infection in large defects, and in areas contaminated with organisms that were somewhat resistant to penicillin levels obtainable in the blood but susceptible to higher concentrations of penicillin. It proved to be desirable to remove the tubes used for local therapy by the 14th postoperative day and it was necessary to avoid contamination with penicillin resistant organisms. Such contamination usually produces only prolonged suppuration of soft tissues but will permit reinfection of the bone unless penicillin therapy is maintained until healing takes place.



# CARCINOMA OF THE PROSTATE

Review of 130 Cases Treated between 1940 and 1946

CHARLES PIERRE MATHE, M.D., F.A.C.S., and CARLOS E. ARDILA,  
San Francisco, California

**P**HYSICIANS who deal with carcinoma of the prostate are appalled at the consistently fatal outcome of this disease

In addition it carries a high operative mortality (approximately 20 per cent for radical removal and in our hands 11 per cent for lesser operative interventions). Careful rectal palpation may provide an early diagnosis however when carcinoma is occult and when it originates in the median or lateral lobes, this method fails. The hard nodule which is usually situated in the posterior lobe can be confused with localized inflammatory lesions and calculi. It is only at this stage that radical perineal prostatectomy can be carried out with any hope of cure and even then the disease may already have extended beyond the prostate via the lymphatics. The great majority of patients consult the urologist after cancer has extended well beyond the confines of the prostatic capsule, often associated with extensive metastases, uremia and cachexia. These cases present the immediate problem of affording relief of urinary obstruction and ameliorating toxic symptoms of the disease, thereby prolonging life.

Radical perineal prostatectomy is the method of choice for treatment of early carcinoma of the prostate. In advanced cases until recently the obstructing portion of the gland was removed suprapubically or perineally. These procedures have been gradually supplanted by transurethral resection as it provides a satisfactory channel and is a far more benign intervention. Two to three decades ago operative relief of obstruction was supplemented by radiation therapy either deep x ray or radium implantation. Recently increasing favor has accrued to the application of bilateral orchec-

tomy and oral administration of diethylstilbestrol. Deep x ray therapy is still used in a few cases in which pain persists in the metastatic manifestations of the disease. In advanced cases, transurethral resection, orchectomy and hormone therapy are followed by lower operative mortality, greater longevity and more marked relief of symptoms.

This communication consists of a report of 130 patients treated at St. Mary's Hospital and Southern Pacific General Hospital between January 1940 and January 1946. They, we add our observations to the experiences of others recorded in the excellent articles already published on this subject.

## INCIDENCE

It has been repeatedly stated that approximately 20 per cent of the pathological specimens removed by prostatectomy reveal the presence of carcinoma. Out of 337 specimens removed by suprapubic or perineal prostatectomy at our two hospitals during the past 5 years, 8.4 per cent showed carcinomatous involvement. In a certain number of these, the presence of malignancy was suspected because of the hard consistency of the gland to rectal palpation in many clinical evidence was negative for cancer. According to Kahler in 51 per cent of autopsied cases in which a clinical or pathological diagnosis of prostatic cancer had been made, metastases were encountered. These may appear in any part or tissue of the body but have a predilection for the bony pelvis, spine, vertebrae, long bones, and lungs. They may also involve the testes and epididymes by retrograde lymph transport.

The current concept of carcinoma of the prostate is that it may coexist with simple hypertrophy and inflammation and does not represent carcinomatous degeneration of an adenoma. In this series, malignancy was re-

From the Department of Urology of St. Mary Hospital and Southern Pacific General Hospital. Read before the Second Mexican Cancer Congress, Guadalajara, Mexico, February 6, 1946.

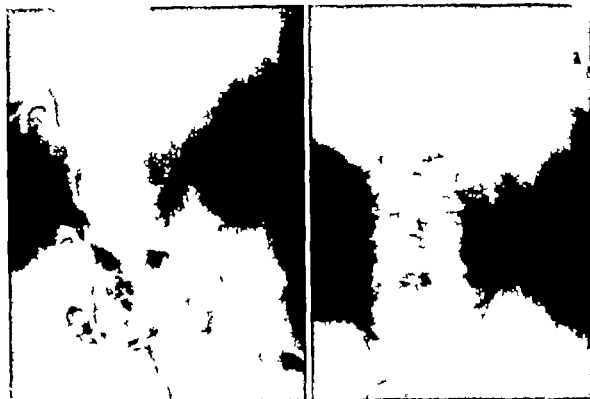


Fig. 1 a left, Retrograde cystogram showing nodular filling defect in base of bladder due to obstructing prostatic cancer. Note unusual course of catheter in lower right ureter due to pressure of invading prostate. Left ureter could not be catheterized. b Roentgenogram of lumbar spine demonstrating osteoplastic invasion of fifth lumbar vertebra and sacrum.

countered in 77 of the 533 patients on whom transurethral resection was performed for benign hyperplasia and the smaller bladder neck obstructions. In the great majority of these 77 cases, carcinoma of the prostate was diagnosed prior to operation. A certain number showed the typical clinical picture of carcinoma as the gland was of stony hard consistency yet pathological study of the sections removed by transurethral resection failed to demonstrate this lesion. Two such cases are of interest. In the first castration was not carried out and resection was repeated because of recurrent obstructive symptoms. At the time of the second intervention pathological study revealed carcinoma. The second case presented a stony hard area in the region of the apex of the prostate and x ray evidence of metastasis in the spine. Sections removed were negative for carcinoma. The striking clinical improvement manifested by this patient after resection orchiectomy and diethylstilbestrol therapy left little doubt as to the true diagnosis. In all other cases carcinoma was found in a varying percentage of the

sections removed by transurethral resection. Age incidence ranged between 45 and 87 years.

#### DIAGNOSIS

The onset of carcinoma of the prostate is insidious and urinary disturbances occur late in the course of the disease. Careful palpation of the gland per rectum is of prime diagnostic importance. The plea for more frequent rectal examination of the prostate in all men over 50 has well been made by the numerous urologists who have written on the subject of prostatic carcinoma. In recent years an increasing number of internists have referred patients in whom this neoplasm was suspected by reason of the hard consistency of the gland discovered on routine examination by this method. The significance of hard nodules situated in the posterior lobe is accepted by every physician. Unfortunately similar hard areas located in the lateral and median lobes are inaccessible to digital palpation. Patients who had no reason to consult a urologist presented pain in the back due to bony metastasis in the pelvis and spine. Metastasis from prostatic car-

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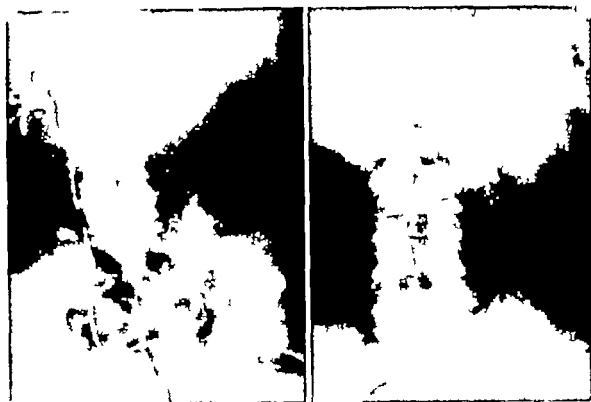


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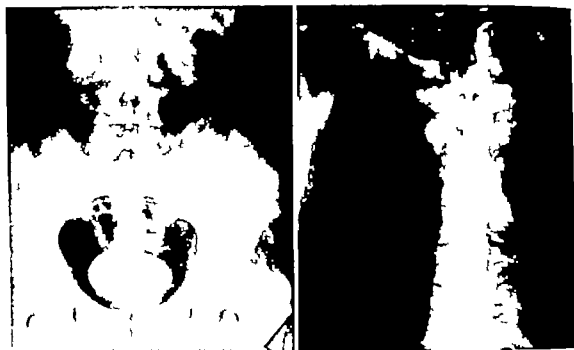


Fig. 1. a, left, Intravenous urogram showing filling defect at base of bladder due to obstructing cancer of prostate. b, Roentgenogram of dorsal spine demonstrating osteoplastic and osteolytic lesions of fifth and sixth vertebrae. Patient referred by neurologist because first symptoms appeared in spine.

cinoma was visualized on x-ray examination by the attending orthopedist or neurologist to whom the patient had been referred. In these cases, rectal examination determined the original site of the tumor and patients were sent to the urologist for treatment. In moderately and fairly well advanced cases, cystoscopy reveals nodular encroachment into the vesical neck and prostatic urethra. The hard consistency of the gland is more noticeable on rectal palpation when cystoscope shaft is in place.

Retrograde or intravenous cystography shows nodular filling defects in the base of the bladder quite different from the picture seen in benign hypertrophy. We routinely carry out intravenous urography as it affords the opportunity of determining back pressure changes and concomitant lesions in the kidney as well as characteristic filling defects in the base of the bladder. In every instance of suspected carcinoma of the prostate roentgenograms are made of the long bones, bony pelvis, spine, and lungs in an effort to determine the presence of metastasis. Its appearance is often confused with that of hypertrophic arthritis and other forms of osseous hyperplasia par-

ticularly Paget's disease. I recall a patient treated by a competent internist for hypertrophic arthritis. Complete retention of urine brought this patient to our service and examination revealed advanced carcinoma of the prostate with metastasis to the spine. The reaction of bone to metastatic carcinomatous invasion is osteoplastic. Normal cancellous structure is replaced by the blurred outlines of new bone formation. Following orchiectomy the bone usually becomes denser its outlines smoother and clearer as healing takes place (1).

Determination of the acid and alkaline phosphatase levels, as originally proposed by Scott and Huggins, offered promise in the diagnosis of carcinoma of the prostate with metastasis. However Huggins' subsequent study of 47 men with advanced prostatic carcinoma showed 50 per cent elevation of phosphatases and 50 per cent normal (4). We have made phosphatase studies in a number of patients presenting this disease and find it unreliable. In fact, in the majority of cases reported in our series in which blood acid phosphatase tests were carried out, the concentration was found to be within normal limits.



Fig. 3 a, left, Roentgenogram of pelvis showing advanced osteoplastic and osteolytic involvement of bones making up pelvic girdle. Transurethral resection, bilateral orchectomy and stilbestrol therapy prolonged this patient's life. b, Roentgenogram of chest demonstrating late metastasis in lung and ribs.

When it is elevated this finding aids in confirming the diagnosis already made by other clinical observations. In addition it assures the rationale of orchectomy.

Direct biopsy of prostatic tissue has been used; we do not employ it as a routine because the piece removed may be free of disease in an otherwise carcinomatous gland; more over this intervention may serve to hasten dissemination of cancer cells.

#### SYMPTOMATOLOGY

Unfortunately the patient presents no symptoms in the early stages of the disease at which time carcinoma is usually localized in the posterior lobe. Loss of weight, anemia, cachexia, and pain often precede urinary disturbances. It is at this time that the astute attending physician may detect the elusive disease by carrying out skillful rectal examination. Later invasion of the vesical neck and posterior urethra takes place, causing frequent difficult, and painful urination. In cases in which carcinoma occurs concomitantly with benign hypertrophy the well known obstruc-

tive symptoms of prostatism are present. Occasionally prostatic cancer metastasizes early and pain resulting from extension to the spine, pelvis, long bones, and lungs are the only manifestations present. Cases have been reported in which the first symptoms were due to metastases occurring in the brain, thyroid, liver, testes, and epididymes. Not infrequently the internist, orthopedist, and neurologist are consulted because pain in the osseous system predominates. These specialists are rapidly becoming familiar with the characteristic roentgen appearance of bony metastasis of cancer of the prostate and refer more patients to the urologist for present day treatment.

#### TREATMENT

Radical perineal prostatectomy as proposed by Young and modified by Colston and by Belt is the treatment of choice for eradication of early carcinoma of the prostate. The entire gland including its capsule, the adjacent vesical neck, prostatic urethra, and seminal vesicles are removed *en bloc*. Unfortunately this operation is of no value in occult carcinoma.

nor does it provide for removal of the regional lymphatics which become involved early (51 per cent according to Kahler). As the disease progresses encroachment into the prostatic urethra and bladder neck takes place and the problem becomes primarily and often urgently one of relieving urinary obstruction. At this stage, the disease has advanced to a point far beyond the reach of radical intervention. Until about 1932 removal of obstructing cancerous tissue was accomplished suprapubically or perineally. Since that time the perfected operation of transurethral resection has proved to be the more benign procedure even if it must be repeated. By providing an adequate channel for urinary outflow back pressure on the kidneys is relieved early death from uremia prevented and life prolonged. At best life expectancy in these elderly men is short surgical risk is poor and the comfort of the patient is the primary motive. Our good results added to those reported by many other authors, are a testimonial to the efficacy of this operation. It offers the additional advantage of detecting and relieving concomitant lesions of the bladder e.g. papillomas and small calculi.

The splendid work of Huggins and his associates on orchiectomy (6) added an effective weapon to combat this incurable disease. Their observations concerning regression of the cancerous process in the gland itself as well as in its metastatic manifestations in the skeletal system and soft tissues following orchiectomy were readily accepted and corroborated by numerous surgeons. Some prefer to employ radiation therapy to the testicles rather than orchiectomy the results of the two procedures are of equal value. Orchiectomy has given us very good results however we prefer to relieve urinary obstruction by transurethral resection as without this auxiliary intervention the patient may succumb from uremia before sufficient regression of the obstructing cancerous gland has taken place. A case in point is that of Dr. H. aged 70 years, who entered the hospital with advanced cancer of the prostate. He presented considerable retention of urine and elevated acid phosphatase. Orchiectomy was performed transurethral resection was refused and the patient died from uremia 3 weeks later. One should not de-

pend on orchiectomy and stilbestrol therapy alone. Opinion is divided regarding the best time to perform orchiectomy (8). Some employ it only after metastasis has taken place and is advanced others contend that it should be carried out as soon as the diagnosis is made. In the presence of metastases we always advise it, and in active cases associated with pain we recommend its early application.

Further studies of Huggins (5) revealed that in the majority of cases ingestion of stilbestrol caused regression of cancer of the prostate and of its metastatic manifestations throughout the body. This female hormone exerts an antagonistic effect on androgens which are normal in the prostate and excess in the presence of cancer of that gland. Hormone therapy (oral diethylstilbestrol) should be instituted as soon as the diagnosis is made. There are certain cases of advanced cancer with extensive metastases in the bony structures and lymph and vascular systems in which pain due to pressure on adjacent nerve is not relieved by orchiectomy or hormone therapy. In these deep irradiation may be utilized for relief of intractable pain.

#### ANALYSIS OF CASES

In reviewing our 130 cases on which operation was carried out for carcinoma of the prostate, 12 (10.8 per cent) failed to reveal the presence of cancer in the sections removed by transurethral resection. In many of these the gland presented stony hard consistency to rectal palpation there was loss of weight, uremia, cachexia etc. and x ray evidence of metastasis in the bony structures and lungs. In some patients, all sections removed demonstrated active carcinoma in others, it was found in only 1 out of 8 or more sections. When clinical evidence pointed to prostatic cancer and the pathological specimens were negative for cancer the acid phosphatase test was of little value to us in clarifying the diagnosis as has already been pointed out by Huggins and many others. In some cases, a second resection became necessary for relief of recurrent urinary obstruction later histological examination revealed the elusive carcinoma.

It must be realized that in carrying out transurethral resection one is concerned with

removal of the obstructing tissue alone and that the cancerous process which was so well detected by rectal palpation may not have involved the intraurethral tissues. Our observations clearly show that in 10 per cent of cases carcinoma of the prostate was absent in tissue removed by resection. Yet in these the clinical picture was typical of advanced carcinoma. Therefore in attacking the problem one must be guided by the clinical diagnosis, although one must always strive to secure laboratory substantiation. This was obtained in 90 per cent of our cases in the 10 per cent in which it was lacking we felt justified in proceeding with present day methods of relief.

Carcinoma of the prostate was encountered in 28 glands removed by suprapubic enucleation. In the great majority of these, it was not suspected prior to operation. In 8 the gland was fairly hard to rectal palpation and carcinoma was believed to be present. When early carcinoma of the prostate was suspected we elected radical perineal prostatectomy in the very early case and transurethral resection in all others. Transurethral resection was carried out in 77 patients. It was necessary to perform secondary resection for recurring obstructive symptoms in 4. Radical perineal prostatectomy was performed in 3 (2.3 per cent). These are living and well 3, 4 and 5 years after operation. Subsequent orchiectomy and stilbestrol therapy was carried out in 2 of these. The fact that so few cases of early carcinoma came to us at a time at which it was possible to carry out radical operation substantiates the opinion of other urologists, that earlier diagnosis should be made by the attending physician. Orchiectomy was carried out in 94 patients. When the favorable results obtained by this beneficial operation were explained to the patient we had little difficulty in securing his consent. Nine presented no urinary obstructive symptoms, and were treated by orchiectomy alone. We prefer to carry out transurethral resection in cases in which retention is present, and not to rely on orchiectomy to bring about regression of the growth thereby permitting free urination. It affords the additional advantage of corroborating the diagnosis by histological examination. In certain cases in which we counted on orchiectomy

alone death from uremia ensued. Among those who refused orchiectomy were two physicians.

Thirteen patients were not treated by prostatectomy or transurethral resection. Some of these were in the advanced stages, and died shortly after cystotomy for urinary retention due to impassable obstruction. x ray therapy for metastasis and medical care alone. Of the 108 patients on whom operation was carried out, 12 (11 per cent) died within 6 weeks. We wish to comment on the greater mortality following removal of the prostate for cancer (11 per cent) than for benign hypertrophy (3.5 per cent). Two patients succumbed after suprapubic prostatectomy for benign hypertrophy in which carcinoma was encountered and 10 after transurethral resection for known carcinoma. Causes of death were pulmonary embolism, pneumonia, cardiac collapse and other complications or intercurrent disease. An important number died of carcinomatosis and there was no noticeable abatement of the disease process. It is interesting to observe that 7 out of 13 cases in which no operation on the prostate was carried out promptly expired, 5 after medical care alone (45 per cent), 2 after cystotomy for complete retention due to impassable obstruction (100 per cent) and 1 after orchiectomy alone (11 per cent). The mortality following operative intervention for carcinoma of the prostate is high because we are dealing with patients in the advanced stages of cancer, debilitated by toxemia and varying degrees of uremia. Except in the occasional early case treatment consisting of transurethral resection, orchiectomy and hormone therapy is merely palliative. However the relief of symptoms and prolongation of life which it offers makes the risk worth while—11 per cent mortality as shown by the review of this series of cases.

Out of 108 cases in which surgical intervention was carried out for carcinoma of the prostate we were able to follow 50. In these orchiectomy and stilbestrol therapy supplemented transurethral resection, radical perineal prostatectomy, and suprapubic enucleation. Eighty per cent were definitely improved, 20 per cent showed little if any amelioration and these rapidly succumbed to the disease.



Since 1942 when orchiectomy and stilbestrol therapy were proposed as an additional means of combating this disease, 9 survived three years, 14 two years, 10 one year and 17 less than one year. Of unusual interest is the case of Mr. A. aged 76 years, who was completely disabled because of difficult urination and intense pain due to metastasis. He had been abandoned to morphine therapy. Transurethral resection, orchiectomy and stilbestrol therapy were carried out 1 year ago. Relief was so great that he returned as a shipyard worker within 6 weeks and has been active ever since. A number of similar cases in this series bear evidence to the efficacy of this treatment. Of particular interest is the case of Mr. D. colored, aged 65 years. On December 1, 1944, transurethral resection and bilateral orchiectomy were carried out. The removed sections showed active carcinoma. Recheck examination was made on September 21, 1945, at which time digital and cystoscopic investigation revealed clinical absence of carcinoma. A number of patients who refused orchiectomy at the time of transurethral resection accepted it 1 to 2 years later on account of increasing pain due to bony metastasis which persisted in spite of stilbestrol therapy. Of equal interest is the case of Mr. J. K. aged 58 years, on whom suprapubic prostatectomy was carried out in March, 1942. Carcinoma was encountered within the adenoma and bony metastases developed 1 year later. He refused orchiectomy, was placed on diethylstilbestrol therapy and is still enjoying good health.

#### SUMMARY

One hundred thirty cases of carcinoma of the prostate treated between 1940 and 1946 are reviewed. Operative intervention was employed in 108: transurethral resection in 77, radical perineal prostatectomy in 3, and suprapubic enucleation in 28. Eleven advanced cases received medical care or x-ray therapy only. In 2, cystotomy for relief of retention due to impassable obstruction, in 9, orchiectomy and stilbestrol therapy alone were carried out.

Twenty-eight of the 337 specimens of prostate removed for benign hypertrophy in which carcinoma was not suspected revealed carcinoma (8.4 per cent).

Mortality for operative interventions for cancer of the prostate is 11 per cent in 108 cases, as compared with 3.5 per cent in 337 prostatectomies for benign adenoma during the past 5 years.

Rectal palpation is still the sole criterion of early diagnosis. Only 3 in our series were detected early enough to justify radical perineal prostatectomy. Cystoscopy, cystography and x-ray examination of the skeletal system and lungs corroborated the presence of varying stages of cancer with or without metastasis. Elevation of blood acid phosphatase, although of great aid when present, was of no value in elusive disease.

In 11 per cent of our 77 patients treated by transurethral resection which presented positive clinical evidence of carcinoma, histological examination of the pathological specimens failed to reveal the presence of cancer. The favorable subsequent clinical course warrants our contention that one should proceed with transurethral resection, orchiectomy and stilbestrol therapy in such cases.

Radical perineal prostatectomy is the treatment of choice in early carcinoma. Unfortunately, it is of no value in occult cancer and does not provide for removal of regional lymphatics. Transurethral resection, supplemented by stilbestrol therapy, orchiectomy and deep irradiation for intractable metastatic pain resulted in definite improvement and increased longevity in 80 per cent of our patients.

Although we are dealing with a progressively fatal disease, the present day palliative measures at our command are justified as they relieve urinary obstruction and ameliorate toxic symptoms, thereby prolonging life.

#### REFERENCES

1. ALVIA, E. P. and HENDERSON, A. F. *J. Urol.*, Balt., 1942, 48: 675-681.
2. BILT, E. *J. Urol.*, Balt., 1942, 48: 367-397.
3. COLETON, J. A. C. *J. Am. M. Ass.*, 1945, 127: 69-72.
4. HODGINS, C. T. West. Sect., *Am. Urol. Ass.* 1941, 943, 1: 132-136.
5. *Idem*, *Physiol. Rev.* 1945, 25: 28-295.
6. HODGINS, C., STEVENS, R. E., and HODGINS, C. V. *Arch. Surg.*, 94, 43: 209-223.
7. KATLIN, J. E. Carcinoma of prostate: pathologic study. Thesis, Univ. Minnesota Grad. School, 1947.
8. MEEDE, A. M. *J. Urol.*, Balt., 1945, 53, 4: 5-10.
9. SCOTT, W. W. and HODGINS, C. *Endocrinology* 1944, 30: 107, 1: 2.
10. YOUNG, H. H. *Bull. Johns Hopkins Hosp.* 1905, 16: 3-321.

## STUDIES ON ANURIA

### Effect of Infusion Fluids and Diuretics on the Anuria Resulting from Severe Burns

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IF an anuria is not relieved by physiological processes or by therapy death invariably ensues. Many types of diuretic agents and infusion fluids have been employed with varying degrees of success to relieve anuria or oliguria following hemoglobinemia. This study attempts to evaluate the agents and fluids which have been used on human beings. We have found that some agents were far more effective than others and that the accepted therapeutic practice was not always the most effective. Although the agent found to be most effective in our study has been infrequently employed it was successful when used in a limited number of human cases. We believe therefore that our results can be applied in the treatment of patients with anurias following severe burns, transfusion reactions, crush syndrome and in toxic hemolytic anurias, and we therefore submit our experiences and our results to the medical profession.

In an earlier study of anuria in experimental shock we differentiated three distinct types which we designated the 'burn', 'crush', and 'hemorrhage' (reduced blood volume) anurias (17). The 'burn' anuria was selected for the more extensive studies because it is acute and develops rapidly and therefore may be studied more easily in the experimental animal. Severe thermal trauma produces a severe hemoglobinemia consequently if the kidney is able to excrete urine, hemoglobinuria follows. In patients burned in the Coconut Grove disaster Shen and co-workers described hemoglobinemia and hemoglobinuria. We believe that a review of the literature (5, 10, 19, 20) together with our data indicates

that the damaged renal function produced by burns is similar to that following hemolysis from incompatible blood transfusion (transfusion kidney), blackwater fever, and other hemolytic diseases. Some features are also similar to the renal impairment in the crush syndrome. The common factor in all of these cases is an intravascular hemolysis due to the sudden and rapid destruction of erythrocytes or muscle cells. This destruction liberates large amounts of hemoglobin or myoglobin and fragments of destroyed cells into the systemic circulation. In addition the factor of damage to renal tubular epithelial cells by anoxia and toxins plays a rôle. Ross states that the mortality rate is high in most diseases associated with hemoglobinuria.

In our studies of anurias which followed experimental procedures leading to shock we felt the need for determining the relative effectiveness of present methods of relieving these anurias. A number of workers in England have observed and treated impairment of renal function due to crush or compression of limbs (crush kidney syndrome). Bywaters in 1944 has suggested the following therapy for the crush kidney: administration of fluids and alkali, concentrated serum, mercurial diuretics and in established renal failure decapsulation. Matland in 1941 (12) recommended the use of isotonic sodium sulfate for the treatment of the crush kidney and later reported good results (13). Shepherd in 1942 used a slow intravenous drip of isotonic sodium sulfate solution and in view of the tubular renal lesions was against giving any drastic diuretics such as mercurials. He feels that 'blood transfusion is contraindicated as the inevitable degree of hemolysis will throw additional strain on secretion'.

We felt that conclusions as to the most effective treatment are difficult to establish

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the intravenous infusions of saline. In Experiment 2 (not shown on Chart 1) a small amount of urine, 14 drops per 15 minutes, was excreted after the infusion of saline. However the free hemoglobin was only 580 milligrams per cent. We have found that saline has very little beneficial effect on the anuria when the free hemoglobin in the plasma is above 1200 milligrams per cent. In Experiment 6 (Chart 1) 6 per cent gelatin had a slight diuretic effect when the free hemoglobin was 1100 milligrams per cent. In Experiment 8 2 per cent urea in 6 per cent gelatin had a slightly better effect than gelatin alone although the plasma hemoglobin was higher. In Experiment 9, 2 per cent urea in saline had an even more marked diuretic effect when the free hemoglobin was as high as 1850 milligrams per cent. The addition of urea made saline solution an efficient diuretic. This is shown in Experiment 4 in which no urine was excreted although the levels of free hemoglobin were similar in Experiments 4 and 9. In Experiment 10 we found that Ringer's lactate solution was superior to saline or gelatin. It had some beneficial effect on urinary flow even though the plasma hemoglobin was as high as 1540 milligrams per cent. The therapeutic value of saline was improved by addition of caffeine. In Experiment 12, a distinct diuretic action was shown by this combination when the free hemoglobin in the plasma was 1710 milligrams per cent. A combination of 2 per cent urea, 5 per cent dextrose and caffeine in 1/12 molar lactate solution was somewhat toxic, and we discontinued further attempts with this "shot gun" type of therapy. In Experiment 15 we found that 2 per cent urea in 1/6 molar sodium lactate solution had no effect on the anuria produced when the animal was severely damaged (free Hb was 2700 mgm. %).

At this stage of our study we concluded that certain infusion fluids were more effective than others in overcoming the anuria of burns but that a limit could be reached in effectiveness when such severe burns were produced that the plasma hemoglobin was extremely high. In Experiment 19 on Chart 2 heparinized plasma produced a distinct excretion of urine when the free hemoglobin in the plasma was only 1195 milligrams per cent. But when the

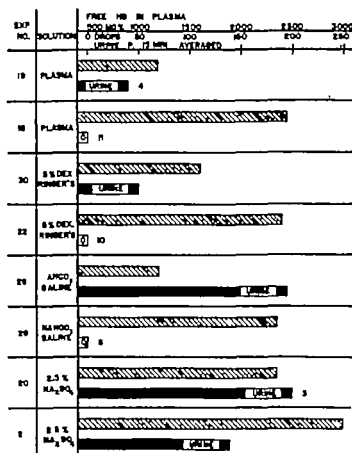


Chart 1. The shaded columns represent the amount of free hemoglobin in the plasma, in milligrams per cent. The black columns represent the average drops of urine per 15 minute intervals, excreted after the last infusion.

kidneys were more severely damaged as in Experiment 18 in which the free hemoglobin was 2450 milligrams per cent, no urine was excreted after three infusions of plasma. Five per cent dextrose in Ringer's solution was more effective in Experiment 30 than saline alone in Experiment 4, but when the animal was more severely damaged, as in Experiment 22, dextrose Ringer's had no effect. The next type of fluid tried was a combination of 0.87 per cent sodium bicarbonate in saline. When free hemoglobin was low following the burn this mixture had a marked diuretic action as shown in Experiment 28 (plasma hemoglobin was 1170 milligrams per cent, and urine flow 195 drops per 15 minutes). However, when the free hemoglobin was 2300 milligrams per cent as in Experiment 29 bicarbonate and saline had no effect on the burn anuria. We finally tried isotonic sodium sulfate solution as suggested by Maitland for the treatment of the crush kidney syndrome (12). Experiment

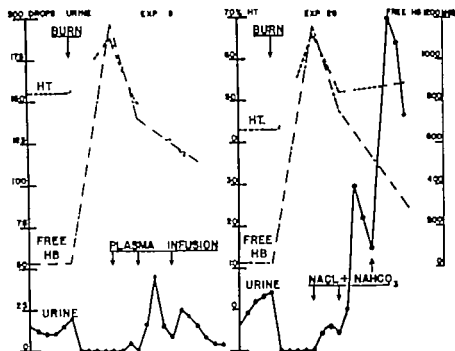


Chart 3. Urine from both kidneys is recorded as the average number of drops per 5 minutes. Plasma hemoglobin (free Hb) is recorded in milligrams per cent, and the hematocrit (Ht) as per cent.

32 showed that this fluid could produce a marked diuresis, even when the amount of free hemoglobin was as high as 2250 milligrams per cent. In Experiment 20 isotonic sodium sulfate solution was used free hemoglobin was 2350 milligrams per cent, and urine was excreted at the rate of 200 drops per 15 minutes. In Experiment 21 free hemoglobin was 2080 milligrams per cent yet the kidneys excreted 140 drops per 15 minutes after three infusions of sodium sulfate. To date this fluid has been the only agent that will, in all cases, stimulate the kidneys to excrete after a severe burn. It is the only fluid that has been found to have a marked beneficial effect on the burn anuria when the free hemoglobin in the plasma is above 2000 milligrams per cent, and no failure of response to sodium sulfate infusion was encountered in any of our experiments.

A closer comparison of certain experiments is enlightening when they are selected on the basis of similar concentrations of plasma hemoglobin after the burn. Chart 3 illustrates the effect on the burn anuria of plasma in Experiment 19 and the effect of saline plus an alkali ( $\text{Na HCO}_3$ ) in Experiment 28.

The control values in Experiment 19 (left) are as follows: urine 14 drops per 15 minutes, hematocrit, 52 per cent, free hemoglobin, 10 to 20 milligrams per cent. One hour after the burn the hematocrit had risen to 65 per cent, free hemoglobin was 1175 milligrams per cent and urine excretion stopped. The first plasma infusion caused only a slight excretion of urine, less than 1 cubic centimeter; the second infusion was followed by an average of 19 drops per 15 minutes, but after the third infusion urine secretion fell to 12 drops per 15 minutes. The total urine excreted after a total plasma infusion of 750 cubic centimeters was only 19 cubic centimeters over a period of 3½ hours. There was however a marked decrease in both plasma hemoglobin and hematocrit. This was probably due to the diluting effect of the plasma only. The control values in Experiment 28 were urine 20 drops per 15 minutes, hematocrit 43.5 per cent, free hemoglobin 15 to 20 milligrams per cent. One hour after the burn the hematocrit had risen to 66 per cent, the free hemoglobin to 1170 milligrams per cent (similar to the concentrations in the plasma experiment) and urine excre-

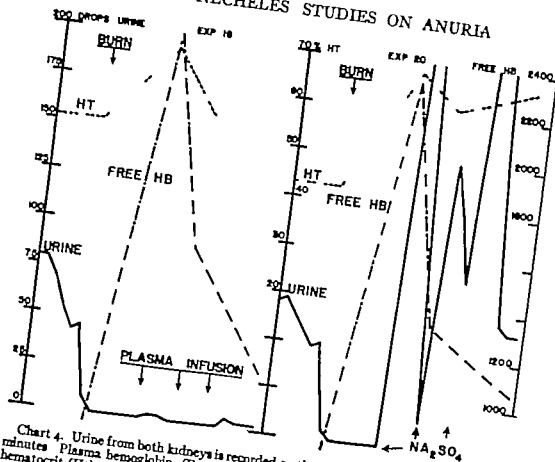


Chart 4. Urine from both kidneys is recorded as the average number of drops per 15 minutes. Plasma hemoglobin (Free Hb) is recorded in milligrams per cent, and the hematocrit (Ht) as per cent.

tion had dropped to zero. The first infusion of the sodium bicarbonate plus sodium chloride solution produced only a small amount of urine averaging 13 drops per 15 minutes and a total volume of 6 cubic centimeters. The second infusion produced considerably more urine, 67 drops per 15 minutes and a total volume of 32 cubic centimeters and the third infusion an average of 195 drops per 15 minutes and a total volume of 92 cubic centimeters of urine. Altogether 130 cubic centimeters of urine was excreted in response to 708 cubic centimeters of infusion fluid. The drop in free hemoglobin is greater in this experiment than in the previous one in which plasma was used. There was a 75 per cent decrease in the free hemoglobin and a 120 per cent decrease in the hematocrit. In Experiment 19 a 60 per cent decrease in free hemoglobin but a 31 per cent decrease in hematocrit occurred.

Chart 4 compares the results of infusions of plasma and isotonic sodium sulfate (Experiments 18 and 20). Both animals were given more severe burns than those in Chart 3. The values for free hemoglobin after the burn were

2450 and 2350 milligrams per cent, respectively. The three plasma infusions in Experiment 18, totaling 795 cubic centimeters produced less than 1 cubic centimeter of urine. The three sodium sulfate infusions in Experiment 20 totaling 570 cubic centimeters produced 266 cubic centimeters of urine and an immediate diuretic effect was obtained with the first infusion. In the experiment in which plasma was used the decrease of the hematocrit was 25 per cent, and the decrease in plasma hemoglobin was 59 per cent. On the other hand when sodium sulfate was used the decrease in hematocrit was only 5 per cent although free hemoglobin decreased 49 per cent. This seems to indicate that more free hemoglobin was removed from the blood following sodium sulfate infusion than after plasma infusion and that the action of the plasma was largely that of a diluent of the blood.

Table I is a summary of all experiments reported in this paper grouped according to the therapeutic agent employed. The experiments which have been discussed in detail

TABLE I.—SUMMARY OF ALL EXPERIMENTS ON EFFECT OF DIURETICS ON THE BURN ANURIA

Exp. No.	Fluid or substance injected	No. of subjects	Free H <sub>2</sub> O in plasma	Per cent increase in osmotic	Drops of urine <sup>a</sup> p. 1 ml.
1	Plasma	3	1430	6	5
19	Plasma	3	75	13	5
22	1% glucose saline	3	1400		
23	Saline		7	3	
5	Saline		140	10	3
4	Saline		879		4
3	Saline		130	18	6
	Saline		180	7	10
	Saline	Control (a)	3080	10	
27	1% hypertonic saline	3	1490		31
18	Ricarb. saline	3	70	13	300
29	Ricarb. saline	3	3.5	44	
7	Sodium lactate		183	3	3
16	Sodium lactate		1875	0	3
10	Ringer's lactate		540	5	0
	Urea, glucose, lactate		130	7	10
13	Calcium, urea, glucose lactate		7.5	8	303
4	Vitamin, lactate		140	5	6
5	Urea, vitamin, lactate		1730	5	
	Calcium-saline		1720		3
13	Calcium-lactate		7.5	12	6
5	Calcium-lactate		1730	5	
	Mercuric-saline		710	13	34
18	Mercuric-plasma		1430	18	
18	Aminophyllin-plasma		1430	16	3
30	Sodium sulfate	3	159	95	303
	Sodium sulfate		1080	13	13
31	Sodium sulfate	3	50	30	181
33	Sodium sulfate control	3			30
34	Sodium sulfate		1173	5	194
35	Sodium sulfate		1630		483
36	Sodium sulfate		130	17	173
37	Sodium sulfate		303		403
38	Sodium sulfate		3030	13	833
39	Sodium sulfate		108	13	780
40	Sodium sulfate		1993		936
41	Sodium sulfate		3033	16	978
43	Sodium sulfate		1333	14	473
43	Sodium sulfate		4006		130
6	Gelatin		104	11	18

TABLE I.—SUMMARY OF ALL EXPERIMENTS ON EFFECT OF DIURETICS ON THE BURN ANURIA—Continued

Exp. No.	Fluid or substance injected	No. of subjects	Free H <sub>2</sub> O in plasma	Per cent increase in osmotic	Drops of urine <sup>a</sup> p. 1 ml.
7	Urea-gelatin		183	13	11
8	Urea-gelatin		163	13	9
9	Urea-saline		1330	9	10
3	Urea-lactate		1730	5	
	Lactate-vitamin C, B <sub>1</sub> , B <sub>2</sub> , B <sub>6</sub> , nicotinic acid		140	13.5	6
5	Lactate, vitamin C, B <sub>1</sub>		1730	15	
17	Lactate, vitamin B <sub>1</sub> , B <sub>2</sub> , nicotinic acid		1875	19	
16	Tyrosine	3	999	19	18
30	1% Glucose-Ringer	3	1630	16	14

## Averages

were selected from this group on the basis that they demonstrated the pertinent findings of our study while the remaining experiments are confirmatory. Attention should be drawn to the agent employed, to the amount of free hemoglobin in the plasma after the burn, and to the amount of urine excreted. It will be noted that other diuretic agents had little or no effect when the damage to the kidneys was great. These agents were mercuric, aminophylline, thiamine chloride, ascorbic acid, niacin, and vitamin B<sub>1</sub> and B<sub>2</sub>.

Kidney function tests were performed in the sodium sulfate treated animal only because that diuretic agent was the only one capable of stimulating sufficient urine excretion for these tests, even in the severest type of burn. Table II gives the significant experimental data obtained, when glomerular filtration rate was studied before and after the thermal trauma and subsequent infusion of sodium sulfate. In the control Experiment G F 1 there was a decrease in filtration rate of 12 per cent although no trauma was inflicted upon the animal, except that of the anesthesia and the operative procedures. In Experiment G F 2 an 82 per cent decrease in rate occurred but in G F 3 with a slightly higher plasma hemoglobin, the decrease was only 44 per cent. It should be noted that while the decreases quoted above were decreases from the control values, the differ

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TABLE II.—EFFECT OF BURN AND SUBSEQUENT INFUSION OF ISOTONIC SODIUM SULFATE SOLUTION ON GLOMERULAR FILTRATION RATE (G F)

Exp't No.	Procedure	Free Hb in plasma	Per cent change of G F	Drops of urine in 5 min. periods
G F 1	Control + Na <sub>2</sub> SO <sub>4</sub>		-1	
F 2	Burn + Na <sub>2</sub> SO <sub>4</sub>	75	-8	50
F 3	Burn + Na <sub>2</sub> SO <sub>4</sub>	1650	-44	594
F 4	Burn + Na <sub>2</sub> SO <sub>4</sub> + Plasma	550	-45	56
F 5	Burn + Na <sub>2</sub> SO <sub>4</sub> + Plasma	803	-8	7
				40

TABLE III.—EFFECT OF BURN AND SUBSEQUENT INFUSION OF ISOTONIC SODIUM SULFATE SOLUTION ON COMBINED KIDNEY TESTS

Experiment N	Free Hb in plasma	Control filtration fraction	After burn + Na <sub>2</sub> SO <sub>4</sub> filtration fraction	Per cent change in filtration fraction	Per cent change in G. F.
PAH 1	950	803	63	+57	-44
PAH 2	1103	86	433	+51	-74
PAH 3	1993	301	803	+30	-35
PAH 4	803	850	443	+71	-34
PAH 5	235	873	100	-27	-3

ences from 100 per cent represent absolute increases from the anuria previous to infusion with sodium sulfate. A combination of sodium sulfate and plasma did not improve the filtration rates over those obtained with sodium sulfate alone as shown in Experiments G F 4 and 5. In all experiments with sodium sulfate the volumes of urine excreted were excellent as compared with the control volumes.

Table III summarizes the data obtained when both glomerular filtration and effective renal plasma flow were studied before and after the burn and subsequent treatment with isotonic sodium sulfate solution. The first four experiments showed similar results: a greater decrease in renal plasma flow than in glomerular filtration rate while in Experiment PAH 5 the opposite occurred. The greater change in renal plasma flow in Experiments PAH 1 to 4 was demonstrated by a marked increase in filtration fraction as shown in the table. Two factors which may cause an elevated filtration fraction are, first a vasoconstriction of the renal arteries and second a marked damage to the renal tubules. Both are probably responsible for our results because the renal tubules are damaged and may be blocked in renal insufficiency associated with hemoglobinuria (15) and vasoconstriction occurs after injections of hemoglobin (14).

## DISCUSSION

In the present studies, we were able to produce an acute anuria in dogs which was

treated effectively in every instance with isotonic sodium sulfate while alkali solutions were distinctly inferior. This was surprising because many authorities recommend the use of alkaline solutions and these are widely used at present in an effort to alkalinize urine in patients with hemoglobinuria from transfusion reaction (4) blackwater fever (19) and crush syndrome (3). In a recent article Lund recommends the use of alkalis (sodium bicarbonate or sodium lactate) for the treatment of hemoglobinemia and hemoglobinuria in occasional cases of very extensive deep burns (10). We will not deny that in many cases alkali treatment is sufficient; our experiments show that alkaline solutions are effective when the free hemoglobin in the plasma is below 1500 milligrams per cent. Above this level however isotonic sodium sulfate infusion is necessary to start the excretion of urine.

Recently Macgrath and Havard warned strongly against the use of intensive alkali treatment in black water fever. They claim that the mortality of blackwater fever has not diminished since intensive alkali treatment was introduced. They also state "The persistence of the high mortality in blackwater fever shows that any benefit that intensive alkali treatment may have for individual patients is counterbalanced by the deleterious effects it has on others. The danger lies in the production of an alkalosis and this condition may be sufficient to kill the patient."

A careful review of the literature as to the dangers of alkalosis to kidney function reveals



that many observers were cognizant of this fact. Kirsner and Palmer described a number of patients with peptic ulcer who had normal renal function before treatment with calcium carbonate developing markedly depressed renal function during alkalosis. The Army Malaria Research Unit at Oxford (1) recently described the effects of large doses of alkali in normal men and found that all subjects had disturbances of renal functions. Their conclusion was that large doses of alkali should not be administered in a condition in which renal failure may supervene.

Considerable disagreement is present as to the mechanism of impaired renal function in the presence of hemoglobinemia and hemoglobinuria (19). The most persistent theory first introduced by Baker and Dodds (2) is that acidosis occurs in many cases of hemoglobinemia and that the hemoglobin damages the kidney only if the urine is acid due to the precipitation of acid hematin in the renal tubules with subsequent mechanical blockage of urine flow. This is the basis of the alkali therapy. Wakeman and co-workers in 1932 were first to question this theory in conjunction with blackwater fever. They state: "No support has been found for the theory that acidosis occurs in blackwater fever to offer an indication for alkaline therapy. The administration of bicarbonate in the cases described led to the development of alkalosis. Another very important piece of work frequently overlooked is that of Foy and Kondi who described cases of anuria frequently developing in patients who had slight hemolysis and passed alkaline urines and other patients who failed to develop anuria, although they had marked hemolysis with acid urine (6). In 1943 these men carefully examined the alkalization hypothesis and concluded that there was insufficient evidence to warrant any statement as to the efficiency of alkali solutions in either preventing or relieving the oliguria and anuria in blackwater fever incompatible transfusions and crush injuries (5)."

What are the dangers of the use of isotonic sodium sulfate? This solution has consistently been nontoxic in all of our experiments. Peters states in a recent review: "Because of the efficiency with which sulfate is excreted

and its comparative physiological inactivity, its salts have a strong diuretic effect. The sulfate ions, when being excreted, promote the chloride ion, while many other diuretics cause a depletion of chloride ion. Therefore, in cases where there is a possible diminution of chloride concentration as in burns (5), sodium sulfate is the diuretic agent of choice, due to its mechanism of conserving chloride ion."

Relatively large amounts of isotonic sodium sulfate have been effective in preventing the anuria in the crush syndrome. Marshall originally suggested the use of sodium sulfate up to a maximum of 3 liters per day in men with crush injuries, given by constant drip intravenously (12). In several cases a total amount of 8 liters was given during the first 11 days with complete recovery (13). We believe that it might be possible to give an initial injection of sodium sulfate to start the urine flow and then follow this by other diuretic agents. In Experiment 43 we obtained the highest level of plasma hemoglobin, 4096 milligrams per cent. The first injection of sodium sulfate caused a slight excretion of urine. The plasma hemoglobin was lowered to 3,300 milligrams per cent,  $\frac{1}{2}$  hour after the injection. After this an injection of 8 per cent gelatin solution was able to stimulate some urine formation. This agent was one of the poorer types of diuretics, yet it was able to cause urine excretion when the plasma hemoglobin was above 3000 milligrams per cent, because of the priming effect of the sodium sulfate.

Ross concludes his excellent review with several important statements which we feel should be stressed. "Hemoglobin must remain in its normal intra-erythrocytic position if health and normal body function are to be maintained. Although capable of transporting oxygen and of sustaining life when in solution in the plasma, the escape of large quantities of hemoglobin from erythrocytes into the plasma is almost invariably followed by adverse symptoms and frequently by death. Red or black urine, the danger signal indicating extensive intravascular hemolysis, must always be taken seriously; its cause determined and appropriate therapeutic measures imme-

diately instituted' Our study indicates that isotonic sodium sulfate is a very valuable therapeutic agent in anurias resulting from the hemoglobinemia of severe burns.

# SUMMARY AND CONCLUSIONS

1 With the type of burn employed an acute anuria was produced in which the extent of renal dysfunction could be correlated with the amount of free hemoglobin in the plasma

2 Plasma and saline were the least effective infusion fluids for combating the anuria. The following solutions in increasing order of effectiveness were superior, sodium lactate 5 per cent dextrose in Ringer's solution 2 per cent urea in saline and 0.9 per cent saline with 0.87 per cent sodium bicarbonate. They were effective in instances in which kidney damage was not great

3 Isotonic sodium sulfate was the most effective agent in combating the burn anuria. It has overcome anuria in all cases in which it was tried. The most severe anuria was one in which the free plasma hemoglobin was over 4000 milligrams per cent.

4 The concentration of free hemoglobin in the plasma was most effectively decreased by the use of sodium sulfate. Infusions of plasma globulin but this was demonstrated to be associated with the more prolonged diluting effect of the plasma.

5 The following substances had very little diuretic effect when kidney impairment was great: mercupurine, aminophylline, thiamine, chloride, ascorbic acid, nicotinic acid, vitamin B<sub>2</sub> and vitamin B<sub>6</sub>.

6 In complete anurias, glomerular filtration rate and effective renal plasma flow were partially restored following the infusion of sodium sulfate. The greatest improvement occurred in the filtration rates.

7 The use of isotonic solutions of sodium sulfate is recommended in the treatment of the anuria of burns and of related anurias.

# REFERENCES

1. Army Malaria Research Unit Oxford. *Lancet*, Lond., 1945 2 701-704.
2. BAKER, S. L. and DODD, E. C. *Brit. J. Exp. Path.* 1935 6 247
3. BYWATERS, E. G. L. *J. Am. M. Ass.* 1944, 124 1103
4. DE GORTIN, E. L., OSTERHAGEN, H. F. and ANDERSON, M. *Arch. Int. M.* 1937 59 437-444.
5. FOY H., ALTMANN, A., BARNES, H. D., and KOND, A. *Tr. R. Soc. Trop. M. Hyg.* 1943 36 197-237.
6. FOY H. and KOND, A. *Tr. R. Soc. Trop. M. Hyg.* Lond., 1943, 34 343.
7. GOLDBERG, W. and CHARLES, H. *Hypertension and Cardiovascular Disease*. Page 195 New York: Com. Health Fund, 1944.
8. HARKINS, H. N. *Treatment of Burns*. Page 50. Springfield: Charles C. Thomas, 1942.
9. KIRKNER, J. B. and PALMER, W. L. *J. Am. M. Ass.* 1941 116 384-390.
10. LUND C. C. *New England J. M.* 1943, 229 868.
11. MARGRAFT, B. G. and HAVARD R. E. *Lancet*, Lond. 1944, 2 338.
12. MATTILAND A. I. L. *Brit. M. J.* 1941 1 570.
13. Idem. *Lancet*, Lond. 1941 2 446.
14. MAROV, J. B., and MANN F. C. *Am. J. Physiol.* 1931 98 181-185.
15. MORISON J. E. *Brit. M. J.* 1942 2 736.
16. OLSON W. H. and NECHELES, H. *J. Lab. Clin. M.* 1942 27 802.
17. OLSON W. H., WALKER, L. and NECHELES H. *Proc. Soc. Exp. Biol.*, N. Y., 1944, 56 64-67.
18. PETER, JOHN P. *Physiol. Rev.* 1944, 24 491-531.
19. ROSS, JOSEPH F. *New England J. M.* 1945 233 691.
20. SHEN S. C., and HAM, T. H. *New England J. M.* 1943, 229 701-713.
21. SHEPHERD, J. A. *J. R. Naval M. Service*, 1942, 28 314-335.
22. WAKEMAN A. M., MORRALL, C. A. EMMAN A. J., SPRUNT D. L., and PETERS, J. P. *Am. J. Trop. M.* 1932 12 407-438.

# DIVERTICULA OF THE STOMACH AND DUODENUM

## Treatment by Invagination and Suture

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ALTHOUGH improved roentgenographic technique and an impressive accumulation of medical literature have established the clinical significance of diverticula of the gastrointestinal tract, those of the stomach and duodenum remain relatively rare surgical entities. However in a period of 1½ years in a Naval Hospital, 5 such cases have been encountered: 2 in the cardiac portion of the stomach and 3 in the third portion of the duodenum. All were diagnosed preoperatively and all patients have been treated surgically. It is our purpose in presenting these cases to summarize briefly the literature, to state our opinion that the symptoms of diverticula can be entirely relieved by the operation of inversion of the sac without excision—a procedure which has proved successful in our hands and which appeals to us as the safest of all surgical methods, and to consider in some detail several technical features which we have found helpful in its employment.

### INCIDENCE

The incidence of diverticula of the alimentary tract cannot be determined, for most of them remain asymptomatic throughout life (15). However Babcock states that duodenal diverticula are found in 2 per cent of bodies, while Finney gives the frequency as between 1 and 1½ per cent of adults. Lockwood found them in 1.7 per cent of routine gastrointestinal roentgenologic examinations. An incidence of 2.2 per cent was disclosed by Nagel in over 900 autopsies. Warren and Emery report an incidence of 2.3 per cent of patients showing roentgen evidence of gastrointestinal disease. That these figures may be too conservative is suggested by the work of Ackerman who by packing the duodena of cadavers with plaster of paris, demonstrated diverticula in 11 of 50

subjects. However Edwards (11) emphasizes that experiments on the dead intestine are entirely without value pointing out that the strength of the bowel depends upon the strength of its muscular coat and that the strength of muscle lies in its power to contract.

The stomach is infrequently the site of diverticula. Bockus states that over 150 cases have been reported, although in some of these the diagnosis was not established beyond question. Four gastric diverticula were encountered in 3,662 routine autopsies, as reported by Rivers, Stevens, and Kirklin. Shiffert stated they were observed in 0.65 per cent of 194 routine roentgenologic examinations of the stomach. Ten diverticula were removed in 11,234 exploratory operations on the stomach at the Mayo Clinic, according to Schmidt and Walters. Cunha encountered 15 cases of diverticula in the upper end of the stomach in 1 year, a fact indicating that their occurrence may not be too rare.

### AGE AND SEX

Most patients having known diverticula are between 50 and 70 years of age. The youngest of Finney's patients was 47; the oldest 78; the average for the group was 63.7 years. Edwards (11) gives 51.9 years as the average age of 25 patients studied by him. In Warren and Emery's series of 103 patients the average age was 58 years, ranging from 30 to 84 years. The literature indicates a slight predilection for the male sex.

### ETIOLOGY

Attempts to classify gastrointestinal diverticula have led to the designations true and false, congenital and acquired, primary and secondary, and pulsion and traction. True diverticula are composed of all mural elements, while one or more layers are absent in

the false variety. Congenital types result, by definition from anomalies of development and, according to Keith in many diverticula of the stomach. The age at which most diverticula become manifest favors their classification as acquired although it cannot be denied that an inherent weakness may be the underlying factor in such cases. Edwards (8) has identified this inherent weakness with the amuscular intervals in the bowel wall through which blood vessels pass. Intraluminal tension (pulsion) is of undoubted importance in the development of acquired diverticula and chronic cough constipation vomiting and labor are said to be factors in the genesis of lesions of this type. The so-called traction diverticulum results from adhesions secondary to ulcers and other inflammatory reactions of which the commoner examples are found in the stomach i.e. between stomach and gall bladder or stomach and pancreas and in the

commonly in or close to the mesenteric border. Edwards (8 9) on the basis of studies on specimens removed at autopsies and operations emphasized the constancy with which diverticula are associated with blood vessels. According to him the mesenteric arterioles bifurcate as they approach the bowel, the branches piercing both muscular coats a short distance from the mesenteric line. The amuscular interval through which the vessels pass has been designated by Edwards as a *locus minoris resistentiae*. These areas of lesser resistance form the anatomical basis for outpouching or herniation of the mucosa. The precise rôle of intraluminal tension in the genesis of diverticula remains speculative.

Three duodenal diverticula operated on by us originated in the posterior wall, a position corresponding to the mesenteric line. The 2 diverticula of the stomach were found on the posterior wall of the cardia near the lesser curvature. The sacs in each case were retro-pentoneal and were devoid of muscular fibers the mucosa forming a delicate translucent wall. The diameter of the smallest was 18 millimeters while the largest measured 45 millimeters. Definite muscular rings were identified in the necks in all cases. In each instance a single prominent blood vessel was found crossing over the pouch. However exploration of this vessel disclosed the constant finding that, as the neck of the diverticulum was approached it diverged from the sac wall. The small interval thus formed between the blood vessel and the neck proper contained areolar tissue. We believe this anatomical feature to be an important consideration in the surgical management of diverticulum and reference to it will be made under 'Treatment'.

#### ANATOMY

The frequency of occurrence of diverticula throughout the alimentary tract is said by Van Noort to be in the following order (1) colon (2) Meckel's (3) duodenum (4) pharynx and esophagus (5) stomach (6) jejunum and (7) ileum. Of those arising in the duodenum three fourths are found in the second portion (12). In 85 duodenal diverticula recorded by Edwards (9) none originated in the first portion 65 were in the second portion and 20 sprang from the third portion. Fletcher and Castleden stated that diverticula never occur in the first portion of the duodenum, although Weintraub and Tuggle found them there in 17 per cent of their cases and Lust described 3 in that location in 1 patient. Warren and Emery's 103 duodenal diverticula were located as follows in the first portion 7 per cent second portion 65 per cent third portion 15.5 per cent multiple 6.8 per cent.

Although Rankin and Martin claimed that their experience intestinal diverticula are found most frequently opposite the border of mesentery or in the lateral wall most authors are in agreement that they occur most

#### SYMPTOMS

It is probable that most diverticula remain symptomless, an opinion supported by the frequency with which they are found incidentally at autopsy. Of 57 cases of duodenal diverticula studied by Whipple not more than half gave symptoms. It is widely held that symptoms due to diverticula are vague and inconstant, and that they do not present a syndrome clear enough to be of aid in diagnosis (10 12 14 18 23 28). Lahey cited accu-

mulation of food within the sac and ulceration as the factors determining the symptoms of duodenal diverticulum.

Of the cases treated by us 3 described their distress as sensations of pressure, tension or fullness. Another complained of moderately sharp pain. The site of distress or pain bore no specific relation to the site of the lesion. Thus, discomfort in the 3 duodenal cases was in the left epigastrium, the midepigastrium and the right umbilical region. One patient with diverticulum of the stomach complained of pain in the midepigastric area. In 2 discomfort usually followed ingestion of a large meal while 1 denied any relation between food and distress. One patient (Case 3) was able to obtain relief by eating or by taking baking soda. The only feature common to all of our patients was the intermittent character of their discomfort. It appears that the symptoms caused by diverticula of the proximal gastrointestinal tract are not specific, that they share features of other and more frequent pathologic states and that they are of value only insofar as they call for further diagnostic efforts.

#### DIAGNOSIS

The only reliable method of establishing the presence of a diverticulum of the gastrointestinal tract lies in x-ray examination. Photo-fluoroscopic and roentgenographic demonstration of a paraluminal sacculus following the administration of barium affords the diagnosis. Pendergrass advised taking a plain film of the abdomen prior to the ingestion of barium in order to differentiate fecaliths and calcified nodes. The diagnostic observations of Costello with reference to lesions of the duodenum include (1) roundness and smoothness in outline of the diverticulum (2) a connection between diverticulum and lumen demonstrated by emptying the sac by manipulation (palpation) and (3) retention of barium in the sac for periods up to several days. Barium filled pockets in relation to the duodenum which *per se* show peristalsis which empty with the duodenum and which are shallow and wide mouthed, are apt to be secondary to primary ulcer the so-called ulcer diverticulum (11). Examination should be made with the patient

in the upright, prone, lateral, and oblique positions. Efforts to fill sacs in which drainage is dependent may call for the Trendelenburg position or modification thereof. Guthrie and Brown suggested distending the duodenum with barium by blocking the duodenojejunal juncture with pressure by one hand, while the other hand manipulates the barium through the pylorus. The use of a duodenal tube in injecting barium, as recommended by Biedstein, does not appear to be general.

#### TREATMENT

While there is some disagreement as to the management of gastric and duodenal diverticula, the weight of opinion favors surgical treatment when symptoms persist or when the sac is large (3, 6, 10, 14, 19). Rankin and Martin prefer medical treatment, but state that surgical intervention seems warranted occasionally. Finney considered that duodenal diverticula should not alter life expectancy and concluded therefore, that very few of them were of surgical significance.

When abdominal symptoms are present in a patient with a demonstrable diverticulum and when no evidence of other disease of the digestive system can be found it is our practice to assume the existence of a relationship between symptoms and diverticulum and to advise operation. This is especially true if the sac is large and barium retention is noted by x-ray examination. Several procedures are available for the obliteration of diverticular sacs, invagination (inversion) of the pouch and simple closure of the mural muscular ring have the advantage of simplicity. Resection of the sac and neck or resection of the sac with inversion of the neck is frequently employed. In the face of contraindications to manipulation of the sac itself gastroenterostomy has occasionally been employed for relief of duodenal diverticulitis and segmental resection for lesions distal to the duodenum. Multiple diverticula may also demand bowel resection.

We prefer to rely on simple inversion of the sac for diverticula of the stomach and duodenum. This procedure is simple, a fact of first importance in attacking lesions of limited accessibility. The advantage of its aseptically obvious. The hazard of obstruction following

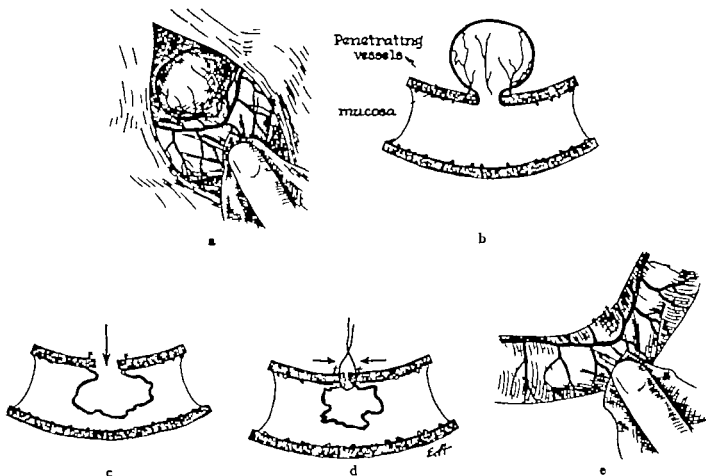


Fig. 1 Diagrammatic view of operation for treatment of diverticulum by invagination. a, Exposure of the diverticulum on the upper surface of the third portion of the duodenum b diagrammatic cross section showing the

penetrating vessels as they appear on the diverticulum c, view of the diverticulum after ligation of the penetrating vessels d, closure of the muscular ring e, view showing complete suture.

invagination especially of the larger sacs is regarded as more academic than practical, an opinion supported by our experience.

#### OPERATIVE TECHNIQUE

On the evening before operation or early in the morning of operation a glass of bismuth mixture is given by mouth. This gives the diverticulum a white lining and aids materially in its identification at operation.

The incision for both gastric and duodenal diverticula is made in the midline, and the peritoneum is divided at the site indicated by the roentgen plate. Thus the retroperitoneal space is entered where the white wall of the diverticulum can be identified by pushing aside the loose fatty tissue. Most diverticula which show retention will be found to protrude through a small muscular ring which may be clearly identified by gentle dissection. Usually one or two small vessels are found to

pass from the outside of the muscle layer to the rising surface of the diverticulum. After they have been divided between fine silk ligatures the sac can be completely inverted with in the lumen of the gut and the muscular ring closed with fine silk sutures. The operation is completed by approximating the divided peritoneal layer (Fig. 1).

In the postoperative care food and fluids by mouth are withheld for 3 to 4 days to permit the effects of the operative trauma to subside.

CASE 1 F B M a 43 year old boatswain in the United States Navy was admitted to the hospital on April 4, 1944 complaining of intermittent abdominal pain. Upper abdominal distress described as a feeling of tension often amounting to pain, had begun in 1934. The symptoms were referred to a point just to the right of the umbilicus, they developed shortly after meals particularly those consisting of fried or highly seasoned foods and fats. Vomiting was infrequent. The bowels had always been normal. A diagnosis of chronic cholecystitis had been made originally and gall bladder drainage had

been employed many times. Later, the patient was told that he had an ulcer. Recently when duty in Africa had made it impossible for him to adhere to his restricted diet the abdominal symptoms had become aggravated. X-ray studies of the gastrointestinal tract were said to have shown an intestinal diverticulum. The past history was not noteworthy. The patient's father had died of cancer. Physical examination showed the patient to be a robust looking, white male in early middle life. Findings at general examination were not remarkable except in the abdomen. There was no distension or free fluid. The liver and spleen were not felt. There was no palpable mass. A circumscribed area of moderate tenderness to deep pressure was present, centering at a point 3 centimeters to the right of the umbilicus. Rebound tenderness was not present nor was the right hypochondrium tender. Laboratory findings were normal. Repeated examinations of the stools for occult blood and bile were negative. A gastrointestinal x-ray series disclosed no abnormality in the esophagus, stomach or duodenal cap. However a large diverticulum was present, arising from the duodenum near the duodenojejunal juncture (Fig. 2). Films made 2 and 4 hours after the ingestion of barium showed considerable retention of the medium in the diverticulum. The 24 hour film showed none. On May 2, 1944, laparotomy was performed through an upper abdominal midline incision under continuous spinal metyrcaine anesthesia. Omental adhesions to the anterior parietal peritoneum were separated. The ligament of Treitz was divided and the incision was carried somewhat to the right opening thereby the posterior parietal peritoneum and exposing the terminal duodenum. The diverticulum measuring 3.5 by 3 by 1.5 centimeters was found arising from the upper mesial and posterior surface of the duodenum, 4 centimeters proximal to the duodenojejunal fold. The neck was small and communicated with the lumen of the gut through a muscular ring 2 millimeters in diameter. It was inverted into the duodenum, and the hiatus in the muscularis was closed over it with interrupted sutures of chromic catgut No. 0. The posterior peritoneum was sutured over the duodenum, and Treitz' ligament was reconstructed. The wound was closed in layers, following the instillation of 25 cubic centimeters of a 20 per cent suspension of microcrystalline sulfathiazole into the retroperitoneal pocket. Healing was complicated by the formation of a subcutaneous hematoma, evacuated on the seventh postoperative day and by a small disruption of the wound on the tenth day permitting evisceration of a walnut-sized mass of omentum. This was repaired at once. The serum protein on this day was 6.8 milligrams per cent. Infection of the abdominal wound (*Bacillus coli*) developed 12 days following the secondary closure and was quickly controlled by 460,000 units of penicillin. This series of complications forced the intermittent use of gastric (Wangenstein) suction and parenteral fluids until the 22nd postoperative day when the tube was removed and soft diet permitted. Full diet was given

after the 27th day. Gastrointestinal x-ray series June 11, 1944, disclosed no abnormality in the duodenum (Fig. 3). The patient remained free from gastrointestinal symptoms following the operation. He was discharged from the hospital on July 6, 1944.

**CASE 2:** J. A. C., a 43 year old specialist, in class in the United States Naval Reserve, was admitted to the hospital May 29, 1944. His complaint of pain in the left upper abdomen was of 2 years' duration. The pain was intermittent, being most troublesome after heavy meals, and was described as feeling as though "a pocket of gas was pressing the heart." It had never been severe, was well localized in the left epigastrium and had no relationship to the type of food eaten. The sensation of pressure was accompanied by mild shortness of breath. There had been no nausea or vomiting. One year previously, the patient had had a similar single attack, lasting a few days and abating without treatment. His appetite had continued good and he had not lost weight. The bowels were somewhat "irregular." Appendectomy had been performed in 1932. The family history was not relevant. Physical examination showed no abnormal findings, except in the abdomen. An oblique, healed scar was present in the right lower quadrant. No distension or fluid was noted. Deep palpation elicited mild tenderness centering at a point 3 centimeters below the costal border on the left parasternal line. Rebound tenderness was not present. Laboratory findings were normal. Examination of the stools disclosed no occult blood, parasites, or occult blood. Gastrointestinal x-ray series revealed a large diverticulum arising from the upper surface of the transverse duodenum in its distal third (Fig. 3). The diverticulum remained filled with barium at the end of 4 hours, but there was otherwise normal progression of the motor mass. Barium enema disclosed several bud-like diverticula in the transverse, descending, and sigmoid colon. Laparotomy under continuous spinal metyrcaine anesthesia, was performed on June 23, 1944. The abdomen was opened through an upper midline incision. A diverticulum 5 centimeters in diameter was found springing from the duodenum at the ligament of Treitz. The pouch was isolated and amputated through a narrow hiatus in the duodenal muscularis. The muscle opening was closed with a continuous seromuscular suture of chromic catgut No. 0, reinforced with nylon. Five grams of microcrystalline sulfathiazole suspension were placed in the peritoneal cavity. The abdomen was closed in layers with steel alloy wire. Continuous Wangenstein drainage was employed for 48 hours postoperatively during which time the patient was supported with parenteral fluids. On the second postoperative day liquids were given by mouth. Soft diet was ordered on the fourth day and a full diet was permitted after the ninth day. There were no complaints referable to the alimentary tract following the operation. Healing was normal. The patient was allowed out of bed on the sixth postoperative day and was discharged to duty 1 month after operation. Gastro-



Fig. 2 a, left, Preoperative x ray film of Case 1, b postoperative x ray film 6 weeks after invagination of the diverticulum (official U S Naval photograph)



Fig. 3 a, left, Preoperative x-ray film showing diverticulum of the third portion of the duodenum b postoperative x ray film about 15 days following invagination of the diverticulum (official U S Naval photograph)

intestinal x ray examination on July 6 1944 showed no evidence of diverticulum in the duodenum (Fig 3) The progression time of the barium was found to be normal

CASE 3 W A S aged 38 years a seaman first class in the United States Naval Reserve was admitted to the hospital on April 18 1945 with the complaint of upper abdominal pain of 1 year's duration For 6 or 7 years the patient had had frequent attacks of indigestion the features of which were a feeling of fullness in the stomach heartburn and belching One year previously an especially severe attack had been experienced during which the patient suffered pain in the upper abdomen felt nauseated and vomited Similar and even more aggravated episodes had followed at shortening intervals These were not associated with the ingestion of food

rather they were somewhat relieved by eating and taking soda The midepigastrium was indicated as the site of discomfort The bowels were sluggish moving every 2 or 3 days There had been no weight loss The patient smoked 20 cigarettes per day and drank whiskey moderately His previous medical history was not significant in any particular His father had had stomach trouble for years Physical examination showed a normally developed middle aged white male who presented no abnormality in any particular except in the abdomen Moderate tenderness to deep pressure was present in the epigastrium and was greatest at a point halfway between the umbilicus and the ensiform process The iliac colon was also slightly tender No organs or masses were palpable The laboratory findings were normal Repeated stool specimens contained no oc



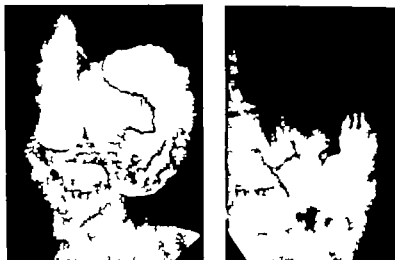


Fig. 4. a, left, Preoperative x-ray film showing diverticulum of the third portion of the duodenum. b, postoperative x-ray film 3 weeks after invagination of the dilated diverticulum (official U. S. N. val photograph)

cult blood. Gastric analysis disclosed normal values for acid and contained no blood. Lactic acid Roentgenograms of the gastrointestinal tract showed no defect in the esophagus or stomach. At the juncture of the second and third portions of the duodenum there was a large diverticulum measuring 5 centimeters in its widest diameter (Fig. 4). At the end of 4 hours the stomach was empty but a small residue was seen in the diverticulum, the neck of which appeared directed caudad. Laparotomy through an upper abdominal midline incision under continuous spinal pontocaine anesthesia was performed on May 6, 1945. The stomach and gall bladder were normal. The distal duodenum was visualized by incising the posterior peritoneum, and a large diverticulum was exposed arising from the superior border of the duodenum. Ligation of a single large vessel which coursed over the sac permitted dissection and mobilization of the entire pouch. This was found to communicate with the lumen of the bowel through a well demarcated muscular ring in the bowel wall. The diverticular sac was inverted into the gut through this muscular ring which was closed by means of interrupted nylon sutures. The posterior peritoneum was reconstructed and the abdominal parietal wound was closed in layers with steel alloy wire. Liquid diet was permitted sparingly immediately after operation. Soft food was begun on the fourth day and a full diet on the seventh postoperative day. The patient was allowed out of bed on the fourth postoperative day. The wound healed perfectly. There were no complaints referable to the gastrointestinal tract following the operation. Gastrointestinal x-ray series on June 7, 1945, revealed no evidence of the previously noted diverticulum (Fig. 4). At the end of 4 hours the stomach was empty and the head of the barium meal was in the cecum. The patient was discharged from the hospital on duty 4 weeks after operation.

CASE 4. F. J. D., a 27-year-old veteran, was admitted to the hospital October 16, 1944, with the complaint of pain in the upper abdomen. The pain, of 2 years duration, was dull radiated to the upper right quadrant and was intermittent. For many months, it had awakened him each morning. It had no relationship to meals or to the type of food eaten, and was not relieved by alkalies. Vomiting was not a complaint. The patient had lost 90 pounds during the previous 30 months, although his appetite remained good. Bowels were normal. He smoked 20 cigarettes per day but did not use alcohol in any form. The patient had received a medical discharge from the Army in October 1943 because of the diagnosis of diverticulitis. Appendectomy was performed in May 1944. The family history was not pertinent. Physical examination showed the patient to be a tall, spare young adult male, not appearing ill. His weight was 150 pounds. The particulars of the examination were essentially normal with the exception of the abdomen. No distention or fluid was present. The liver and spleen were not felt and no masses were palpated. Moderate tenderness resulted from deep pressure in the epigastrium, the point of greatest discomfort being just to the right of the midline 3.5 centimeters below the costal arch. Laboratory findings were normal. Repeated examinations of the stools were negative for ova, parasites, and occult blood. Gastric analysis disclosed normal values for free and total acid. Gall bladder visualization studies showed normal filling and emptying with no evidence of calculus. Gastrointestinal x-ray series revealed a diverticulum measuring 2 by 1.5 by 1 centimeter arising from the posterior wall of the stomach near the lesser curvature just below the esophageal hiatus and connected to the stomach by a narrow neck (Fig. 5). The barium remained in the diverticulum for 24 hours (Fig. 5). On November 15, 1944, laparotomy was performed under continuous

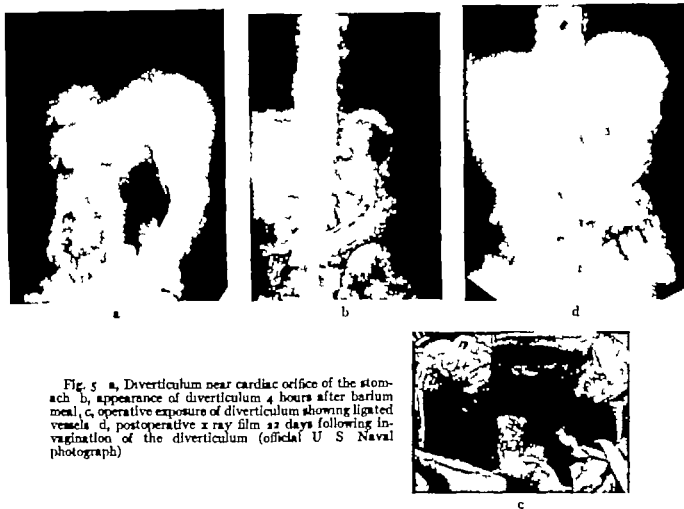


Fig. 5 a, Diverticulum near cardiac orifice of the stomach b, appearance of diverticulum 4 hours after barium meal c, operative exposure of diverticulum showing ligated vessels d, postoperative x ray film 32 days following invagination of the diverticulum (official U S Naval photograph)

spinal pontocaine anesthesia employing an upper midline incision. The lesser bursa was entered through the gastrohepatic omentum and the posterior gastric wall was mobilized. The diverticulum, about the size of a maraschino cherry was identified on the posteromesial wall of the stomach directly beneath the cardiac orifice. The neck was 8 millimeters in diameter. A single artery was seen coursing over the pouch (Fig. 5). The sac was inverted through the neck i.e. through the defect in the gastric musculature, and the muscular ring closed by means of a continuous Lembert suture of chromic catgut No. 0. Five grams of microcrystalline sulfathiazole suspension were placed in the lesser cavity and the gastrohepatic ligament was closed. The abdominal incision was closed in layers with steel alloy wire. Nothing was given by mouth until the third postoperative day when liquid diet was permitted. Soft food was ordered on the fifth day and full diet on the seventh. The patient was ambulatory following the sixth postoperative day. Healing of the wound was uncomplicated and the patient was discharged from the hospital without complaints 26 days after operation. Gastrointestinal x ray series on December 5, 1944 disclosed no defect at the diverticulum site.

CASE 5 C S W a 25 year old seaman was admitted to the hospital on May 10, 1945 complaining of epigastric pain and frequency of bowel move-

ments. The epigastric pain appeared after eating and was not relieved by soda or food. The bowel movements numbered 3 to 5 daily and were often liquid and associated with crampy abdominal pain that appeared to be distinct from the epigastric distress. The patient had lost 18 pounds in the preceding 2 months aboard ship. Physical examination showed a thin young male with definite local tenderness on deep pressure in the upper epigastrium and some tenderness over the sigmoid area. Gastric analysis was normal. There was a slight anemia. An x ray examination showed a gastric diverticulum arising near the esophagogastric junction which seemed to project posteriorly and to the left. The diverticulum was still visible at the end of 4 hours. A barium enema showed the loss of haustrations typical of a colitis. Operation on May 21, 1945 under serial spinal anesthesia revealed the diverticulum as shown by x ray examination. It was treated by invagination and closure of the muscular ring with interrupted silk sutures. The patient made an uneventful recovery from operation and an x ray examination showed no evidence of the previously present diverticulum. He was relieved of his epigastric distress but his symptoms of colitis persisted.

These 5 patients with gastric and duodenal diverticula presented vague upper abdominal

symptoms which had persisted for some time in spite of treatment. Usually the treatment had been given for one of the more common upper abdominal lesions, ulcer or gall bladder disease. A finding common to the group was the retention of radiopaque material in the diverticulum. This condition was shown to be due to a sac with a very small neck and it is probable that the symptoms arose from recurring distension of the sac. Repair of the diverticulum by invagination of the thin sac of mucosa produced a relief of symptoms. The invaginated mucosa apparently atrophies or shrinks up to resume a normal position as shown by the normal appearance of the post-operative roentgenograms.

#### SUMMARY

1. A brief review of the incidence, etiology, symptoms, and diagnosis of diverticula of the upper stomach and duodenum is given.

2. A technique of treatment by invagination of the diverticulum and suture of the muscular ring is described.

3. Five cases are presented in which the patients were treated by this method with relief of symptoms due to the diverticula in all cases.

#### REFERENCES

ACKERMAN, Ann Surg, 943, 7 403-4 2.

BAMCOCK, W. Textbook of Surgery, P 983 Phila-  
delphia W B Saunders Co 935

3. BARNES, FRANK L. Am. J Surg 915, 20, 38-48
4. BOCKUS, H. L. Gastroenterology 945, 1, 120
5. BUCKSTEIN, J. Am. J Surg, 1937, 3 340-347
6. COSTELLO, C. D. Brit. J Radiology 911, 6 577-584
7. CUMRA, FELIX. Am J Surg 1935, 27 252-264
8. EDWARDS, H. C. Ann. Surg., 1936, 23 230-244
9. Idem. Diverticula and Diverticulitis of the Intestine. Bristol John Wright & Sons, Ltd., 1939
10. Idem. Lancet, Lond., 934, 1 69-174
11. Idem. Surg. Gyn. Obst., 1935, 60 946-965
12. FINNEY, J. M. T., JR. South. Surg. 942, 1 50-52
13. FLETCHER, H. N. and CASTLEMAN, L. I. M. Am J Surg, 1936, 23 776-786.
14. GUTHRIE, D. and BROWN, MERRILL J. Am. J Surg 194, 40 8-30.
15. HARE, H. F. and CATTILL, R. B. Surg. Clin. N. America, 944, 24 635-639.
16. KEEFE, A. A. Brit. M. J. 9 376-380
17. LAHEY, F. H. Labey Clin. Bull., 1930, 1 23-26
18. LEWIS, D. Practice of Surgery Hagerston W F Prior Co 1927
19. LOCKWOOD, A. L. J. Am. M. Ass 1934, 96 961-964
20. LUST, F. J. Radiology, 937 28 620-621.
21. NADEL, G. W. Arch. Surg 1935, 349-350
22. PICKERINGS, R. C. Am. J Surg., 1935, 5, 49-57
23. RANKIN, FRED W. and MARTIN, WILLIAM J. Ann. Surg 1934, 60 3-1135.
24. RIVERS, A. B., STEVEN, G. A. and KIRKLAND, E. R. Surg. Gyn. Obst. 935, 60 66-71
25. SCHMIDT, H. W. and WALTERS, W. Am J Surg 194 52 315-318.
26. SHIFFLETT, E. L. Am. J Roentg 937 35 26-28
27. VAN NOORD, D. W. Ned. tische geneesk., 935, 7 5 3 5 36
28. WARREN, H. A., and EMERY, E. S. JR. Gastroenterology 943, 1 1085-1092
29. WEINTRAUB, SYDNEY and TOOLE, A. Radiology, 194 36 270-301
30. WHIFFLE, ALLEN O. In Textbook of Surgery by Frederick Christopher 3rd ed., p 137 Phila-  
delphia W B Saunders, 942. Quoted by Keesee and Emery

# GROWTH OF HUMAN TROPHOBLAST IN EYE OF RABBIT ITS RELATIONSHIP TO THE ORIGIN OF CANCER

## A Preliminary Report

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**A** RELATIONSHIP between the pregnancy trophoblast and cancer has long been suspected (10 14 81 94)

It was particularly well explored by John Beard (10 11, 12, 13) on the basis of extensive embryological and zoological studies (5 6 7 8 9) It was further implied in the later experimental work of Loeb (55, 56 57) Brachet, Maximov Blumenthal and Auler and Kido It is the purpose of this communication further to clarify this relationship particularly in the light of vertebrate metagenesis.

Experiments to be described are the first of a series of transplantations of human placental material in the anterior chamber of the eye of the rabbit. They constitute confirmation of similar experiments performed by Kido and serve to illustrate *in vivo* the results obtained by Maximov with growth of rabbit conceptus in tissue culture

Our results indicate that heterologous trophoblast grows easily and promptly in the anterior chamber in a manner analogous to malignant tumors

### EXPERIMENTAL MATERIAL AND PROCEDURE

Tissue explants obtained from normal human placentae aged 2 5 7 months and at term were placed in the eyes of 8 rabbits including two serial transfers A total of 27 implants were made in 16 eyes through incisions performed at the corneal scleral margin under local anesthesia produced by instillation with 5 per cent cocaine hydrochloride. Explants were obtained after dissecting off the maternal portion from within and just below the spongy layer of the placenta. A section of the 5 months' placenta is shown in Figure 1 Of

the 8 rabbits which were all less than 4 months old and obtained from widely separate sources 6 were virgin albino females 1 was a young albino male and 1 a black young male The females were kept in two large cages the males each in a separate cage and all were kept in a quiet dark room The use of different placentae in animals of unlike strains insured against the probability that results might be due to virus infection Corneal incisions were well healed after several days A latent period of from 2 to 4 days preceded evidence of growth All implants were examined every few days with a binocular magnifier ( $\times 10$ )

*Rabbit 1* Small albino virgin female (circa 1 5 kgm.) inoculated with 5 months placental tissue

Right eye—1 implant 1 by 1 millimeter placed 4 millimeters below corneal scleral junction. Left eye—1 implant 1 by 1 millimeter close to junction

7 days Right eye—Implant 2 by 2 millimeters Eye hyperemic around edges Incision site slightly raised Implant pale yellow and translucent. Left eye—Implant not well demarcated. Zone of diffuse growth 2 by 3 millimeters. Cornea vascularized between implant and sclera

26 days Right eye—Implant 2 by 3 millimeters Appears to have moved closer to sclera Left eye—Implant 4 by 4 millimeters and round Well demarcated yellowish, no diffuse zone Upper border of vascularized implant attached at corneal-scleral junction.

80 days Right eye—Implant has all but disappeared. Very small mass remaining at corneal scleral margin. Left eye—Implant almost circular yellowish with a more diffuse but well demarcated crescentic area extending beyond the denser yellowish mass Appears to be growing within or attached to the cornea and is well vascularized Eye slightly opalescent with granular area below entire implant but otherwise normal in appearance Little change in size.

*Rabbit 2* Medium size (circa 2 kgm.) albino virgin female inoculated with 5 months placental tissue

Right eye—Three implants measuring about 1 by 1 millimeter were placed 2 to 3 millimeters from

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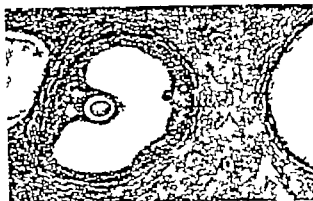


Fig. 1. Ripening follicle in left ovary of Rabbit 2. It is seen in the middle of the same ovary shown in Figure 2.  $\times 65$

junction at 2, 6 and 8 o'clock. Left eye—One implant 2 by 1 millimeter at junction and at 11 o'clock second implant 1 by 1 millimeter at 3 o'clock 2 millimeters away from junction.

7 days. Right eye—Densely clouded and glaucomatous but implants visible. Only 12 o'clock implant growing and is now 2.5 by 2 millimeters. Situated 2 millimeters below junction it appears very close to the iris. Left eye—11 o'clock implant pale yellow and lobulated. No diffuse zone in glaucoma size 1.5 by 2 millimeters. Three o'clock implant 2 by 1 millimeter pale pink not attached.

18 days. Right eye—No further growth of 12 o'clock implant no change in appearance. When this growth was sectioned it was found to constitute a very thickened portion of the iris outside of which no discrete mass was found. Since this implant was seen from the beginning at a point near the iris and appeared later to have grown very close to the iris invasion of the iris may have occurred during observations. Histological section of the remaining right eye implant (Figs. 5, 7, 8 and 9) shows the presence of giant cells and syncytial masses strongly

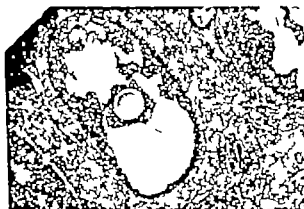


Fig. 3. Ripening follicle in ovary of Friedman doe injected with urine obtained from black male Rabbit 3.  $\times 65$



Fig. 2. Left ovary of Rabbit 2 showing cystic development of follicles.  $\times 10$ .

suggestive of chorionic villi. The other two nipples had apparently been absorbed. Left eye—11 o'clock implant 2 by 3 millimeters fixed to cornea and was herniated at site of growth and appeared like a small boil (Fig. 4a). Three o'clock growth unchanged (Fig. 4b). Eye glaucomatous but clear.

This animal was killed after the eyes were moved under general anesthesia. When the herniated implant of the left eye was accidentally touched with forceps it broke open at one point. The intraocular pressure produced a fine stream of aqueous humor 18 inches high.

When the abdomen was opened the uterus was found definitely hyperemic. The ovaries showed no gross changes. The eyes, uterus, and ovaries were removed and fixed in Bouin's fluid, sectioned, and stained. The stained section of the uterus shows proliferation of the labyrinthine glands brought about by steroid hormones, while the ovaries show follicle ripening and a beginning of the formation of follicular cysts (Figs. 1 and 2).

The stained section of the 11 o'clock implant of the left eye is shown in Figure 4a. There is much distortion of the iris and bridges connecting the iris with a hypertrophied ciliary body. The herniation was followed also by marked distortion of the iris, with

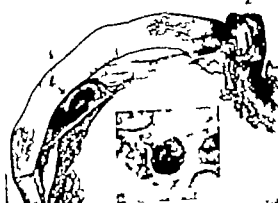


Fig. 4. Section of anterior chamber of Rabbit 2. Left of herniation at site of degenerating implant 2 may indicate that extrusion of iris is in part due to erosion by growth of trophoblast whose morphology may be obscured by osmotic response of iris and ciliary body. Left eye.  $\times 100$ .

Fig. 5. Inset. Giant cell in Figure 7 photomicrograph through a dark green filter. The nuclei arranged at the periphery give this cell the appearance of chorionic villi.  $\times 200$ .



Fig 6. Section of normal 5 months placenta. Compare syncytium with that to be seen in both Figures 8 and 9.  $\times 300$ .

was pushed up against the cornea. Part *b* in Figure 4 shows the second implant to be degenerating.

**Rabbit 3.** Medium size black young male (circa 2 kgm.) inoculated with 5 months placental tissue.

**Right eye**—Implant 2 by 1 millimeter near corneal scleral margin. **Left eye**—Two implants one near margin 2 by 2 millimeters the other 2 by 2 millimeters was pushed to the bottom of the anterior chamber.

**7 days.** **Right eye**—3 by 1.5 millimeters pale yellow and well demarcated. Surrounded by clear zone less than 1 millimeter wide. Beyond zone a dense white outer margin was seen about 1 millimeter wide. Very small knob on lower margin of implant. Slightly diffuse zone extending to 3 millimeters around growth. Incision site elevated. Sclera hyperemic for a distance of 8 millimeters on each side. Implant appears attached near incision site. **Left eye**—Implant near junction 3 by 3 millimeters. Bottom implant 2 by 5 millimeters. Chamber slightly cloudy and



Fig 7. Section of ins from right eye of Rabbit 2. Giant cells, whorls, and syncytial masses suggest chorionic villi.  $\times 300$ . Photographed with light green filter.

glaucomatous. Sclera markedly hyperemic near first implant close to incision site. This implant has a small knob protruding from lower border. It is well demarcated and yellowish. Lower implant has ragged edges and is rectangular with well defined but diffuse brush like extensions from each end. They have the appearance of strands characteristic of sarcomas cultured *in vitro*. The ragged edges of the growth examined through the cornea with a Greenough type binocular microscope ( $\times 40$ ) showed growing sheets of tissue which appeared like a surface of wave like crests finely granular with a beautiful opalescent sheen showing well against the black background. In contrast to the brush like extensions on the ends of the growth the sheet-like proliferation from the same implant is reminiscent of carcinoma.

**26 days.** **Right eye**—Implant 3 by 6 millimeters. Oval in shape and yellowish with well demarcated crescentic diffuse extension on the left side toward



Fig 8. Higher magnification of part B outlined in Figure 7. Photographed with dark green filter. The rows of nuclei in the syncytial strands and whorls can be readily seen.  $\times 300$ .



Fig 9. Higher magnification of part C outlined in Figure 7. Photographed with dark green filter. The giant cell mass in the center appears to be arising out of a chorionic villus.  $\times 300$ .

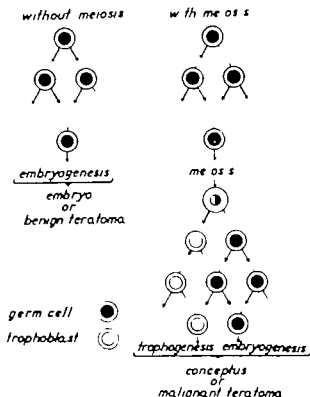
Germ cell evocation

Fig. 1. Diagrammatic chart of germ cell development. Normal evocation on the left. Evocation culminating in cancer is shown on the right. The dotted lines indicate phases of simple mitotic multiplication and only one of the resulting cells is figured to indicate subsequent development which represents the fate of that single cell.

Inner canthus. Left eye—Top implant 3 by 5 millimeters. Bottom implant circa 2 by 5 millimeters. Top implant appears attached to the cornea and sclera. No cloudiness. Growth vascularized and spreading down in the direction of the inner canthus where a diffuse zone is visible about 3 by 3 millimeters. Bottom implant also yellow and vascularized. Brush end have now almost disappeared but implant is slightly larger.



Fig. 1, left. Right eye of Rabbit 4 showing vascularized implant.



Fig. 2, center. Right eye of Rabbit 4a bearing

30 days. Right eye—Implant 4 by 6 millimeters vascularized. Nictitating membrane appears large, normal in color. Left eye—Upper implant 4 by 1 millimeters vascularized. Bottom implant 3 by 1 millimeters, crescent shaped. Eye slightly jaundiced and clear. The urine from this male rabbit was collected on the twenty first day and injected into a Friedman doe. At the end of 48 hours the reaction was positive for the presence of chorionic gonadotropin although as a pregnancy test it could have been rated as doubtful since there were no blood points observed instead of frankly hemolytic follicles. However we are here dealing with the use of a male rabbit rather than that of a pregnant woman. The ovaries were removed and prepared for histologic examination. A section is shown in Figure 3.

Rabbit 4. Large albino male (circa 3 kgm) inoculated with 5 months placental tissue.

Right eye—One implant 1 by 1 millimeter at corneal-scleral junction. Left eye—Three implants, all 1 by 1 millimeter. One near junction at 10 o'clock, two implants at 4 o'clock placed between pupil and junction.

7 days. Right eye—Implant now 2 by 2 millimeters. No glaucoma. No inflammation. Eye clear. Left eye—Very cloudy containing an irregular broken ring of yellowish implants in and below pupil. Glaucomatous. No apparent inflammation.

26 days. Right eye—Well vascularized implant 5 by 4 millimeters. Eye glaucomatous and clear. Left eye—Cloudy difficult to observe. Animal in apparent distress. Very restless and inclining head to one side. Occasionally squeals as if in pain. Implant appears as large irregular broken mass situated mostly near bottom of chamber. No apparent inflammation.

50 days. Right eye photographed (Fig. 1). Left eye too cloudy. Not photographed. Right eye implant 6 by 4 millimeters. On the fifty-first day animal anesthetized with sodium pentobarbital and left eye was removed, fixed in Bouin's fluid, sectioned and stained. Implant in right eye was firmly attached to the cornea of which a piece 7 by 5 millimeters was excised. Two fragments were cut from this piece and transplanted along with the attached cornea from which implant could not be separated.



Fig. 3, right. Left eye of Rabbit 4a bearing serial transplant obtained from right eye of Rabbit 4.

into a small, young albino female virgin rabbit (Rabbit 4a). The testes from the host rabbit were removed, fixed, sectioned and stained. There was indication of some inhibition of spermiogenesis. A histological section of the left eye shows the iris and ciliary bodies to have hypertrophied markedly and grown entirely across the anterior chamber. Both iris and ciliary bodies are connected by many long bridges. Although the normal rabbit eye may show a remarkably large ciliary body and outgrowths of loose vascular tissue from the iris the eye of Rabbit 4 represented a very marked departure from the normal and after 60 days there were no signs of inflammation.

**Rabbit 4a.** Young albino virgin female (circa 1.5 kgm.) implanted with corneal fragments obtained from Rabbit 4.

**Right eye—**Implant 2 by 2 millimeters including cornea. **Left eye—**Implant 1 by 3 millimeters including cornea. Within 24 hours growth was apparent. Within 3 days right eye transplant measured 3 by 4 millimeters. Left eye implant 2 by 3 millimeters. Right eye markedly inflamed (Fig. 12). Left eye normal (Fig. 13).

**30 days** Right eye—Implant growing attached to the cornea. Size 2 by 8 millimeters, vascularized. **Left eye—**Implant now 2 by 5 millimeters. At first irregular it now appears more like the right eye implant.

**Rabbit 5.** Small albino virgin female (circa 1.5 kgm.) inoculated with tissue from a 7 months' placenta.

**Right and left eye—**One implant in each 2 by 1 millimeter near corneal-scleral junction. Grew slowly after about 4 days.

**30 days** Both implants now 2 by 2 millimeters.

**68 days** Both implants 1 by 1 millimeter. Definite regression has occurred after a very slow initial growth.

**Rabbit 6.** Medium size albino virgin female (circa 2 kgm.) inoculated with tissue from a term placenta. Organ was soft, spongy and very bloody.

**Right eye—**Two implants 2 by 2 millimeters. One in area of pupil the other at the corneal-scleral junction. There was a latent period of growth of about 12 days. **Left eye—**Three implants all near pupil around the edge. Size 2 by 2 millimeters.

**27 days** Right eye—Pupil implant almost entirely absorbed. Implant at junction well demarcated, yellow. Size 2 by 5 millimeters. Left eye—All 3 implants absorbed.

**32 days** Right eye—Implant 3 by 5 millimeters. Slightly vascularized.<sup>1</sup>

**Rabbit 7.** Small albino virgin female (circa 1.5 kgm.) inoculated with 2 months' placental tissue.

**Right eye—**Two implants 2 by 2 millimeters placed at 4 millimeters below corneal-scleral junction. **Left eye—**Two extremely small implants placed 4 millimeters below junction at 12 o'clock.

<sup>1</sup>The presence of syncytial steroids was verified in the implants of this animal by histochemical methods. Private communication from G. B. Wislocki.

All 4 implants grew only slightly. After 38 days 2 implants were left measuring about 1 by 1 millimeter. They appeared not to be growing.

The experiments herein described indicate that normal human pregnancy trophoblast, when grown in the anterior chamber of the eyes of rabbits, behaves like a malignant tumor grown in a similar medium. This raises the question of how closely related these two tissues are. Our experiments, as well as a great many other data, suggest that all malignant tumors regardless of their protean character, are fundamentally trophoblastic. Admittedly if this is true there are many things to be explained and in the case of most tumors the relationship between pregnancy and cancer trophoblast can only be a subtle one. We know that trophoblast *per se* can be violently malignant, indeed its malignancy can be of a degree not exceeded by any known tumor. That trophoblast, like other tissues may be capable of undergoing malignant degeneration cannot be seriously considered here because no one knows what malignant degeneration is. Moreover, it is particularly because of the need to explain 'malignant degeneration' that the relationship between trophoblast and cancer is being examined. Also if we keep in mind that growth of the implanted heterologous trophoblast in the anterior chamber was observable grossly only a few days after inoculation it is very doubtful if it can be said to have undergone 'malignant degeneration'.

The analogous behavior of trophoblast and malignant tumor implants is consistent with the generally accepted observation that chorionepithelioma appears as a simple overgrowth of normal trophoblast cells (22).

If cancer is fundamentally trophoblastic it can only be germinal in origin. It is well to point out the semantic limitation of the term cancer as applied to a complex structure whose malignant properties are attributable to one component only, for if cancer is trophoblastic it is, like the chorion a dual tissue unless it happens to be anaplastic. In this case it might qualify as a polymorphic manifestation of chorionepithelioma. The nontrophoblastic component of the chorion is embryonic where as the nontrophoblastic component of cancer



is somatic. In either case the embryonic or somatic components tend to limit the relative growth of the trophoblast. Indeed the growth of the former would appear to be stimulated by trophoblast. This is particularly suggested by the marked growth of embryonic mesenchyme pushing the pregnancy trophoblast at first relatively smooth into the multibranched chorion frondosum eventually. Thus the relative development of each tissue gives the combination its own particular architecture.

Because of its antagonism to somatic tissues (embryonic as well as adult) trophoblast can not be described as embryonic. To the contrary trophoblast precedes the embryo in development and represents the asexual or pre-embryonic generation. Better known in the invertebrates the asexual generation is generally recognizable as the trochophore or some modification of it, the morphology of which is practically identical through six different phyla.

Both the asexual (trophoblast) and the embryonic (sexual) generations stem from a single origin—a diploid totipotent cell (germ cell). Germ cells are totipotent because they can give rise to complete embryos. If a diploid totipotent cell undergoes meiosis a gamete-like cell is formed. If the diploid totipotent cell proliferates as such (without meiosis) more germ cells are formed—one or more of which may eventually proceed through differentiation to definitive embryogenesis.

Diploid totipotent cells have three possible fates. They may (1) proliferate through simple mitosis and produce more totipotent cells or (2) proliferate through meiosis and produce gamete-like cells or (3) proliferate through differentiation and produce embryos.

During the early cleavage of activated gamete-like cells some of the daughter cells are trophoblast and the remainder are totipotent cells. Thus in 1 all resulting cells are totipotent. As a result of 2 and after activation only some of the cells are totipotent. In 3 all resulting cells lose their totipotency but all cells do not totally lose their potencies.

A gamete-like cell, after activation or fertilization divides to produce trophoblast cells (asexual generation) and embryo-forming cells. The latter represent totipotent cells, one or more of which differentiates in the process of

definitive embryogenesis while the remaining diploid totipotent cells, the total potency of which is reserved from early cleavage, comprise the germinal stream. During gestation the embryo is formed by the direct differentiation (without meiosis) of a totipotent or (germ cell) segregated from the trophoblast during very early cleavage. In mammalian eggs, as in the eggs of a number of lower forms the segregation most likely occurs at the very first cell division (75). So far as totipotency is concerned the germ cell *per se* can give rise to the sexual generation only. After meiosis, however, a resulting gamete-like cell can give rise during cleavage both to the trophoblast (asexual generation) and to embryo-forming diploid totipotent or germ cells (Fig. 10).

The two generations develop in autonomy of each other as reflected in their eventual mutual antagonism. The relationship between the asexual and sexual generations is the basis for metagenesis.

Metagenesis, sometimes referred to as alternations of generations, implies a discontinuity in the life-cycle whereby in animals the definitive sexual generation may be said to be preceded by a nonembryonic asexual generation. There may be overlapping and the discontinuity is not absolute. Hitherto regarded in the higher animals as a more or less academic concept, metagenesis assumes a fundamental importance with regard to the etiology of cancer.

Like other developmental phenomena cancer is the result of organizer action upon competent cells—specifically totipotent or totipotent cells (59-89). The conclusion that cancer cannot develop from cells of lower potency is based upon accepted morphogenetic principles (89-66). Organizer stimuli upon totipotent cells, as well as cells of lower potency possessing fewer competences, may be mediated by hormones, hydrocarbons or viruses. The diploid totipotent cells of higher animals are normally dispersed throughout the soma (sexual generation) (4, 11, 21, 61, 72, 74-84). This dispersion has substantial phylogenetic roots, since these cells are responsible for complete regeneration in lower forms (17). Their early separation from the trophoblast of the conceptus is apparent at the four-cell stage

in a number of mammals (49-85). From then on the trophoblast cells and the totipotent (embryo-forming) cells go their separate way, the one can never become the other" (85).

The somatically dispersed totipotent cells, in contrast to embryonic somatic cells of lesser potency do not take part in repair processes and indeed are normally functionless in the higher chordates (45, 94). Their total potency or competence is reserved since early cleavage (78) and is not acquired from somatic cells (92) whose lower order potency or competence cannot give rise to cells of higher potency (2, 18, 32, 67). This principle of the irreversibility of potency has been well expressed in connection with evolution and is known as Dollo's dictum. It states that so far as animal structure is concerned evolution is irreversible, but regarding adaptation to a new environment simulating conditions which obtained in the past in another environment, evolution is reversible. In this case new organs may be developed from reserved *anlage* the new organs serving functions analogous to old organs which have disappeared never to return (29). This generalization applies with equal force to cellular development. Phylogenetically and ontogenetically cellular potencies once lost or expended can never be regained. This is not to be confused with the various possible fates of pluripotent cells which have a number of prospective potencies. For example undifferentiated mesenchymal cells may differentiate into hemocytoblasts, macrophages, primitive fibroblasts, osteoblasts, chondroblasts or several other forms. Some of these products of mesenchymal differentiation may likewise have a number of prospective potencies. Existing confusion in terminology may make it appear that certain differentiated cells may give rise to more primitive cells. But it was eventually verified that there is no going back on the scale of potencies (2). It is as impossible for totipotent cells, for example to arise from somatic cells as it would be for a neuron to form primitive ectoderm or for an erythroblast to form primitive mesenchyme. As for mutations, so far as they may be said to have any bearing on potency they can only be followed by an overall decrease rather than an increase as it is apparent on the evolution scale (18).

With respect to ontogenesis the concept of gene-mutations as they are known to occur would appear to be quite irrelevant.

From the number of somatically dispersed totipotent cells counted in 4-5 millimeter embryos (45) and in a number of elasmobranch embryos of various ages (7-8-9) it can be calculated that there are at least  $3 \times 10^4$  totipotent cells—possibly more—dispersed in adult man an average of 2 for every cubic millimeter of tissue. This is after making allowance for 50 per cent degeneration and assuming that these cells continue to proliferate at the same rate as their surrounding cells, as they are known to do in embryos (8). These cells possess a competence for either trophogenesis or somatogenesis (embryogenesis) (Fig. 10). The latter occurs only by differentiation (without meiosis) of a germ cell and possibly only within a trophoblastic medium (decidua). Trophogenesis, on the other hand, can occur only after a germ cell or totipotent cell has undergone meiosis (heterotypic mitosis) resulting in a gamete or gamete-like cell which, now obliged to divide or perish possesses an obligative competence for trophogenesis. The occurrence of teratomas in practically every part of the organism, as well as the occurrence of extragenital chorionepitheliomas in both sexes, is further evidence for the existence of somatically dispersed totipotent cells which although they usually remain functionless may unfortunately be stimulated to attempt a new life-cycle. Moreover considerable evidence exists for the occurrence of ectopic meiosis (heterotypic mitosis) (4, 35, 74, 89, 90, 94).

Direct evocation of more than one embryopotent or diploid totipotent cell within a single trophoblastic blastocyst results in twinning (polyembryony) to which metagenesis is a necessary corollary (51, 68, 76, 83). Benign teratomas (ectopic sexual generation) in the young are most likely identical twins evoked at the same time as their host (72). Identical twins are examples of polyembryony in man. Malignant teratomas (malignant ectopic conceptions) consist of more or less distorted or enmeshed embryonic tissue of a genetic composition different from that of their host (change in genetic composition produced by

meiosis) (61) occurring in a trophoblastic matrix or apposed to it, which matrix has arisen through the activation of a gamete-like cell developed through meiosis from a diploid totipotent cell.

The malignant character of trophoblast has been demonstrated by *in vitro* culture of definitive rabbit embryonic tissue in the presence of its own trophoblast unavoidably introduced with the embryonic tissue (63). In culture the cytrophoblast infiltrates, erodes, and completely destroys the embryonic tissue (63). Recognized in these experiments as due to release of the trophoblast from the somatic restraint exerted by the entire embryo and mother these results constitute confirmation of previous observations (23). The occasional striking resemblance of phenomena observed in these experiments to chorionepithelioma (63) indicates that trophoblast can exhibit its violently malignant properties with or without assuming the appearance of chorionepithelioma. Because it consists of almost pure trophoblast (cytrophoblast and syncytium) chorionepithelioma is one of the most malignant forms of cancer. Normally the trophoblast is prevented from overgrowing as chorionepithelioma by a humorally mediated factor produced by the embryo and mother. The question of its identity will be discussed elsewhere.

The occurrence of chorionepithelioma in males, primary in the liver (65), primary in the brain (84), primary in the mediastinum (46, 47, 52), metastasizing as adenocarcinoma or sarcoma (1, 62), and grading by extension into carcinoma or sarcoma (35, 82) likewise constitutes evidence not only for the malignant character of trophoblast in the relative absence of its physiological inhibitor normally produced by an embryo and mother (20, 63) or male host but at the same time for the existence of somatically dispersed totipotent cells and for somatic response which endows trophoblast with the appearance of carcinoma or sarcoma.

In those malignant teratomas in which the trophoblast is clearly separate from the remainder of the teratoma, it is the trophoblast alone which is responsible for any metastases (37). Destruction of embryonic tissue by

trophoblast has been observed in ovaries, testis, and atomas in guinea pigs (55) and confirmed repeatedly (3, 24, 27, 56, 57, 58). Significant testicular chorionepithelioma or primary chorionepithelioma in the mediastinum or in the brain is identical with primary uterine chorionepithelioma. Since the testes contain a high concentration of totipotent cells normally analyzed it is not surprising that occasionally (following meiosis) one becomes activated before spermiogenesis occurs, to form ectopic trophoblast, exhibited in some cases as chorionepithelioma, in others as carcinoma or sarcoma. It is also significant that even the primary carcinomas and sarcomas occurring in testes are known to produce chorionic gonadotropin.

If the trophoblast cell and the cancer are one, the normal trophoblast of pregnancy should be indistinguishable from cancer in some cases at least. By the fresh tissue technique (38) the trophoblast is found to be the only cell indistinguishable from cancer. Moreover in the trophoblastic portion of the cultured rabbit conceptus, the presence is noted of practically all cell types known to be malignant (63). The observation, in a long series of autopsies of pregnant women, that metastases or dispersion of normal pregnancy trophoblast may be found in over 80 per cent of the cases is further confirmation of the malignant character of trophoblast (50, 75, 76). Furthermore when not a part of the normal conceptus of pregnancy trophoblast cells have never been observed except as cancer (1).

Heterologous malignant tumors may be successfully transplanted into the anterior chamber of the eye of animals (40, 41, 42, 43) whereas attempts to grow heterologous late embryonic and adult somatic tissues have failed. Yet heterologous late trophoblast (from placenta) will grow (53). Therefore heterologous transplantability as a criterion of malignancy is fulfilled by trophoblast.

The human placenta has a somewhat higher rate of aerobic glycolysis than nonplacental tissues. This is not in itself very significant, but when the cytrophoblast and syncytium are peeled from the placenta the ablated trophoblast (chorion) exhibits a high aerobic glycolytic index whereas the residual placenta now

shows the same value as normal somatic tissues (16)

As shown previously the pregnancy trophoblast is the only "normal" tissue known regularly to metastasize (50-79, 87). Finally the trophoblast of pregnancy has been observed without any embryo at all, the latter being destroyed at an early stage. In such cases the trophoblast often continues to erode and infiltrate the host. The distinction between such cases and chorionepithelioma is arbitrary (20, 9, 95).

Morphological multiplicity of malignant tumors is in part a function of the type of tissue in which the ectopic trophoblast develops and of the degree of somatic reactivity or host response manifested by the surrounding cellular elements. This response is fundamentally the same as that which is responsible during gestation for chorion formation and placentation. The combination and relative concentration of trophoblastic and somatic cells determine the architecture and malignancy of each type of malignant tumor. Thus the higher the concentration of trophoblast the higher the malignancy. An anaplastic tumor is one in which the concentration of trophoblast approaches 100 per cent because the relative lack of host response has resulted in little or no investment of the trophoblast by the somatic elements in the vicinity. At the same time the somatic architecture has not been impressed upon the trophoblast. Whereas in pregnancy the chorion is formed following the somatic tissue response of the embryo and mother to the trophoblast, cancer is formed by the tissue response of the postembryonic soma to an ectopic trophoblast.

Somatic response or tissue reactivity forms an extremely complex chapter of morphogenesis and is related to growth stimuli, differentiation and variations in cell form. Variations in cell form in cancer are well known and have been previously described for trophoblast (63). The anaplasia and polymorphism characteristic of Jensen sarcoma when grown *in vitro* are greatly modified in the presence of somatic tissue when the tumor is transplanted *in vivo* (28). A Flexner Jobling tumor transplanted into the rat endometrium produced a decidual reaction (64) resulting in a malignant decidu-

oma paralleling placentation. When rabbit tumors are transplanted into the eyes of alien species variations in parenchymal stromal relations may occur (40). The heterologous transplantation of human carcinomas under similar conditions may be followed by marked histological changes (41). A rabbit squamous cell carcinoma varied histologically according to the tissue into which it was transplanted (43). Chorionepithelioma may grade into sarcoma or carcinoma (34, 81) or metastasize into either (1, 62). Moreover the reverse process may take place. Trophoblast syncytium has been observed in cancer of the tongue carcinoma of the breast, sarcoma of the ovary and of course in testicular as well as in uterine chorionepithelioma and in other carcinoma sections (15). It has also been observed that liver metastases from such diverse tumors as mammary cancer hypernephroma and chorionepithelioma may be indistinguishable (33). Somatic response is entirely consistent with the observation that the more nearly a malignant tumor approaches the morphology of the tissue in which it grows the less malignant it is.

Somatic tissue response is well illustrated in cancer of the endocrine glands in which hormone production is associated with the malignant tumor. Cancer of the thyroid for example unless anaplastic, is composed of trophoblast as well as the hormone-secreting cells. These somatic cells are responsible for reproduction in a metastatic lesion of the architecture of the primary growth. Insofar as metastases, or transplants, still contain somatic glandular thyroid tissue, to this extent will such a secondary growth continue to produce thyroid hormone. Metastases or transplants from a primary growth which contains a relatively high concentration of trophoblast cells may be anaplastic thus giving no clue to the primary site. In general, cancer of glandular tissues will not go through many transplants and still produce their characteristic secretions. Cancer of the adrenals ovaries and testes are exceptions. These tumors can be transplanted quite a number of times and still produce hormones. Eventually hormone production may cease owing to the destruction of the somatic secreting cells by the cancer cells. The transport or metastasis of somatic tis-

sue *per se* is well known although rare. It has been reported for benign hyperplasias. Such metastases are simple autotransplants or autogenous grafts. That they may be transported along with trophoblast is to be expected.

When somatic response or the lack of it results in the rare extragenital chorionepitheliomas or in other highly cellular cancers a strongly positive Aschheim-Zondek reaction may result. Since only the cytotrophoblast produces gonadotropic hormone (96) growths containing a high concentration of cytotrophoblast will produce a pregnancy reaction. Syncytial trophoblast, an adaptation through differentiation of cytotrophoblast to somatic tissue produces no gonadotropin (96) but sterols instead which are similar to the sex hormones (27 77 96). Syncytial adaptation probably accounts in most cancers for an absence of the pregnancy reaction when performed in the usual manner. However if urine extracts, from persons suffering from cancer are injected parenterally in immature white rats, growth of the endometrium or enlargement of the prostate has been reported to take place after 24 hours (27 77). The urine of nonpregnant cows suffering from carcinoma of the eyes without involvement of the genital organs produces follicle ripening in infantile rabbits (88). This occurs in spite of the fact that pregnant cows give negative Friedman reactions (88). In testicular chorionepithelioma, in addition to very high prolactin titers, gynecomastia, lactation, morning sickness and pregnancy changes in the hypophysis have been reported (26 39 48). In fact practically all testicular cancers produce prolactin the titer of which is proportional to the histologic similarity of the tumor to chorionepithelioma (36).

It has been reported that the vitamin uniformity of malignant tumors, regardless of tissue origins, manner of induction, sites and animal species, is such as to indicate that cancer forms in effect a common tissue type (73). It has also been pointed out that the metabolic quotients of a wide variety of tumors are nearly the same that the lactic acid and sugar contents of sarcoma and carcinoma are approximately the same that enzyme uniformity among tumors is greater than among the same organs in different animals of the same

species that cytochrome-oxidase activity of a number of tumors is very similar: that is general tumors resemble each other metabolically more than they do normal tissues, or the normal tissues resemble each other (44). It is to be expected that pregnancy trophoblast shares this uniformity with malignant tumors particularly if they are anaplastic.

The life cycle of antithetic metagenesis is indispensable to an understanding of cancer. Metagenesis explains why trophoblast cannot be embryonic. It explains cancer as a synthesis between two fundamental types of tissues occurring normally in every life cycle: trophoblastic (asexual generation) and somatic (sexual generation) (10 12). Moreover if cancer is trophoblastic it is clear that it cannot arise from any of the primary germ layers of the embryo (71).

In arthropods and vertebrates where the asexual and sexual generations remain long in intimate contact metagenesis is distinctly antithetic. In most other forms the definitive two generations develop on the whole without retaining or developing the same close intimacy. As a result pronounced antithesis is generally not observed. It is to be expected, therefore, that cancer will occur most frequently in arthropods and vertebrates (94 93).

In Sauropsida and Ichthyosada, the analogue of the trophoblast is the extraembryonic blastoderm (60 80). With failure of cleavage of an embryopotent cell in Sauropsida the extraembryonic blastoderm proliferates to form a mass of undifferentiated cells called an anidion (60 66 85) a result most likely due to the absence of the primary organizer (66). The cancerous quality of this curious growth has been recognized (85). It is reminiscent of the human trophoblast growing without an embryo (20). In animals, as the sexual generation (embryo) gains ascendancy over the asexual generation (trophoblast) after the critical period during gestation (or incubation) the trophoblast normally degenerates (6). In other words each individual in the course of its life cycle normally destroys the counterpart of cancer.

The development of an ectopic (normally dispersed) totipotent cell into trophoblast rep-

resents an escape from an individuation field in the host through meiotic mitosis. This is the result of the organizer effect of endogenous (54) or exogenous carcinogens raised usually through the localizing effect of a persistent inflammatory process (30) which may be limited to an exceedingly small area to a level of concentration required for the gradual escape of a totipotent cell from the individuation field. The resulting ectopic meiosis, cleavage and formation of trophoblast constitute carcinogenesis. An unsuccessful repetition of the metagenetic life cycle results (10, 11). Almost invariably, no adequate embryogenesis follows ectopic trophogenesis and the antithesis of the host alone being insufficient, probably through a lack of an internally secreted inhibitor of trophoblast, the latter maintains its escape from the individuation field. The soma unable to destroy the ectopic trophoblast invests it if possible, thus producing a characteristic more or less malignant tumor.

#### SUMMARY OF EXPERIMENTS

1. Normal human trophoblast grows readily in the anterior chamber of the eye of the rabbit and is serially transplantable.

It produces chorionic gonadotropin as demonstrated by action on the ovaries of the host and those of a Friedman doe by urine obtained from a transplant bearing male animal.

3. It also produces syncytial sterol hormones as demonstrated upon the uterus of the host and by some degree of inhibition of spermiogenesis in a male host after 60 days.

4. In addition to inflammatory infiltration the presence of giant cells, whirls and strands of syncytium in the iris are suggestive of chorionic invasion.

5. Growth and hormone production of transplanted heterologous trophoblast is now shown in male as well as female animals.

6. This work is being continued.

#### SUMMARY OF DISCUSSION

Cancer appears to be trophoblastic and develops according to the following sequence:

1. Persistent inflammation associated with high blood titer of carcinogens.

2. Localization and concentration of carcinogenic substances at inflammation site.

3. Meiosis of an ectopic diploid totipotent cell.

4. Formation of a gamete like cell.

5. Activation and cleavage of the gamete like cell is followed with formation of trophoblast.

6. Characteristic malignant neoplasm produced by the somatic response of the tissue where trophogenesis has taken place.

7. Maintenance and growth of tumor because of the lack of a humorally mediated inhibitor of trophoblast.

8. In primary uterine chorionepithelioma factors 1 to 5 are absent or modified by the presence of the trophoblast of the pregnancy conceptus.

9. The affinity of viruses for specific tissues brings about their own localization without a necessary previous inflammation which in fact may characterize the first stages of their invasion.

#### REFERENCES

1. AHLSTRÖM, C. G. *Acta path. microbiol. Scand.* 1931, 8: 213-257.
2. ARREY, L. H. *Developmental Anatomy: a Textbook and Laboratory Manual of Embryology*, 3rd ed., p. 9. Philadelphia and London: W. B. Saunders Co. 1943.
3. ARTHUR, M. *Arch. d'Anat. microsc.* 1929, 25: 415-425.
4. BARRATT, J. O. W. *Proc. Roy. Soc., Lond.*, 1909, 9: 372-377.
5. BEARD, J. *Zool. Jahrb.* 1867, 9: 319-326.
6. Idem. *The Span of Gestation and the Cause of Birth*, pp. 22-24. Jena: C. Fischer, 1897.
7. Idem. *Anat. Anz.*, 1900, 18: 465-485.
8. Idem. *Zool. Jahrb.* 1902, 16: 615-698.
9. Idem. *Anat. Anz.*, 1902, 21: 50-51.
10. Idem. *Lancet, Lond.*, 1902, 1: 1758-1761.
11. Idem. *Anat. Anz.*, 1903, 23: 486-494.
12. Idem. *Lancet, Lond.*, 1904, 2: 1200-1201.
13. Idem. *Dublin J. M. Sc.*, 1910, 147, 21: 225.
14. BELL, W. B. *J. Obst. Gyn., Brit. Empire* 1928, 35: 233-246.
15. Idem. *P.* 18-22. New York: William Wood & Co. 1930.
16. BIRN, W. H., BROOKS, J. and JOWETT, M. *J. Cancer Res.*, 1925, 12: 369-391.
17. BRIDGILL, N. *J. Physiol. Rev.*, 1941, 23: 101-123.
18. BURN, H. F. *Am. Nat.*, 1935, 69: 354-359.
19. BURKHART, F., and ALLEN, H. *Zentralblatt für Gyn.*, 1932, 35: 253-254.
20. BOWEN, J. *J. Obst. Gyn. Brit. Empire* 1913, 10: 217-218.
21. BOWEN, J. *A Textbook of Pathology*, 4th ed., p. 10. Philadelphia: Lea & Febiger, 1915.
22. Idem. *p.* 673.
23. BROWN, T. A. *Arch. Biol. Litterat. Eur.* 1913, 1914, 2: 447-503.
24. BRUCE, A. *Arch. Biol.* 1925, 35: 325-447.
25. CANN, J. *J. Soc. Med. L.*, 1911, 61: 122-131.

26. CARATALLA, A. T. *Bol. Inst. med. exp. B. Aires*, 1944, 21: 183-214.
27. COURRIER, R., and OBERLING, C. *Bull. Soc. Anat. Paris* 1923, 20: 724-730.
28. CRACIUN, E. C. *C. rend. Soc. biol.*, 1931: 108: 309-3.
29. DOLLO, L. *Bull. Acad. roy. de méd. de Belgique*, 1903, 8: 799-80.
30. DURAN-REYNAL, F. *Proc. Soc. Exp. Biol., N. Y.* 1937: 56: 369.
31. ENGEL, C. S. *Zachr. Krebsforsch.* 1930, 32: 531-543.
32. EVERETT, N. B. *J. Exp. Zool.* 1943, 92: 49-91.
33. EWDON, J. *Neoplastic Diseases. A Treatise on Tumors*, 4th ed., p. 88. Philadelphia and London: W. B. Saunders Co., 1940.
34. *Ibid.*, pp. 863-863.
35. FARMER, J. B. MOORE, J. E. S., and WALKER, C. E. *Proc. R. Soc., Lond.*, 1903, 7: 499-504.
36. FERGUSON, R. B. *J. Am. M. Ass.*, 1933, 10: 1933-937.
37. *Idem.* *Teratoma Testis, Pathogenesis of the Malignant Tumors of the Testis (preliminary note) The Cancer Problem*. Pp. 86-9. New York: The Science Press, 1937.
38. FIDLER, H. K. *Am. J. Cancer* 1935, 25: 773-779.
39. FRIEDLANDER, E., and MOSES, E. *Wien klin. Woch.* 1936: 49: 684-687.
40. GREENE, H. S. N. *J. Exp. M.*, 194: 73: 461-474.
41. *Ibid.* 475-486.
42. *Idem.* *Cancer Res.*, 1943, 3: 649-654.
43. GREENE, H. S. N. and BROWN, W. H. *Cancer Res.*, 1943, 3: 53-64.
44. GREENSTEIN, J. P. *Ann. Rev. Biochem.* 1946, 4: 643-664.
45. HAMILT, G. W. D. *Anat. Rec.*, 1935, 6: 273-279.
46. HAMMARBY, B. *Acta radiol. Stockh.*, 1934, 15: 3-24.
47. HEAVY, H. G. *Am. J. Cancer* 1933, 9: 2-30.
48. HERBERT, M. *Bull. Am. Cancer*, 1937, 26: 2: 133.
49. HERRER, C. H. and STRICKER, G. L. *Contr. Embryol. Carnegie Inst.*, 1930, 20: 1-28.
50. HITZEMANN, F. *Zachr. Geburtsh. Gyn.*, 1904, 33: 14-35.
51. JHERING, H. VON. *Biol. Zbl.*, 1886, 6: 532-539.
52. KANTROWITZ, A. R. *Am. J. Path.* 1934, 53: 53-544.
53. KIDO, I. *Zbl. Gyn.*, 1937, 6: 1531-1555.
54. KLEINBERG, H. E., NEUFACH, S. A., and SHABAD, L. *M. Cancer Res.*, 194: 1: 853-859.
55. LOVE, L. *J. Am. M. Ass.*, 19: 56: 337.
56. *Idem.* *Zachr. Krebsforsch.* 1912, 1: 259-283.
57. *Idem.* *Biol. Bull.* 19: 5, 28: 59-76.
58. *Idem.* *Science* 19: 3, 38: 35-36.
59. *Idem.* *Ann. I. t. M.*, 1931, 4: 669-675.
60. LUTHER, W. *Arch. Entwemch.*, 1937, 137: 404-434.
61. MACCALLUM, W. G. *Textbook of Pathology* 7th ed. pp. 206-207. Philadelphia & London: W. B. Saunders Co., 1940.
62. McDONALD, S., JR. *Am. J. Cancer* 1938, 34: 4.
63. MAXIMOV, A. *Contr. Embryol. Carnegie Inst.*, 1924, 16: 47-107.
64. MOORE, F. E., and GUYER, M. P. *Anat. Rec.*, 1924, 19: 212.
65. MOLOTOW, W. G. *Virchows Arch.*, 1911, 28: 35-355.
66. NEWMAN, J. *Biochemistry and Morphogenesis*, 1923: 258-259, 507. Cambridge University Press, 1924.
67. *Ibid.*, pp. 101: 10-115, 305-306.
68. NEWMAN, H. H., and PATTERSON, J. H. *Zbl. M. (Wood's Hole)*, 1909, 7: 8-187.
69. O'FARRILL, T. T. *Brit. M. J.* 1931, 1: 370-371.
70. OBERLING, P. *J. Morphol.* 1921, 35: 1-117.
71. OPPENHEIMER, J. M. *Q. Rev. Biol.* 1940, 15: 1-17.
72. PEYRON, A. *Bull. Assoc. cancer* 1930, 23: 63-68.
73. POLLOCK, M. A. TAYLOR, A., and WILLIAMS, E. J. *Univ. Tex. Pub. N.* 4237: 1943, p. 56-71.
74. RAFFERTY, T. *Arch. Zellforsch.* 1922, 16: 37-61.
75. RICHARDS, A. *Outline of Comparative Embryology*. P. 190. New York: John Wiley & Sons, Inc., 1937.
76. *Ibid.*, p. 356.
77. ROFFO, A. H. *Bol. Inst. med. exp. B. Ar.* 1944: 419-588.
78. ROGERS, J. S. HUBBELL, T. H., and BYER, P. I. *Man and the Biological World*. P. 208. New York: McGraw Hill Book Co., 1942.
79. SCHMIDT, G. *Mitteil. med. Woch.* 19: 4, 57: 211-212.
80. SPITZER, A. *Zachr. ges. Anat. Abt. III, Exper. i. Anat. u. Entwicklungsgesch.*, 1933, 30: 1-239.
81. STALL, F. A. *Origin of Cancer*. Pp. 1-96. Chicago: Parker Printing Co., 1932.
82. STEWART, M. J. *J. Path.*, 1912-13, 7: 409-417.
83. STOCKARD, C. R. *Am. J. Anat.*, 1912, 26: 115-26.
84. STOWELL, R. E. SACHS, E., and RUSSELL, W. J. *Am. J. Path.*, 1945, 21: 787-791.
85. STRICKER, G. L. *Am. J. Obst. Gyn.* 1934, 24: 17-740.
86. TUR, J. *Polaka gaz. lek.*, 1936, 5: 585-586.
87. VERT, J. *Zbl. Gyn.*, 1900, 44: 1014-1046.
88. VILLASQUEZ, J. and EMMEL, P. *Endocrinology* 1945: 27: 53-544.
89. WADDINGTON, C. H. *Brit. M. J.*, 1936, 1: 861-864.
90. WALKER, C. E. *Theories and Problems of Cancer*. Pp. 28-49. London: University Press of Liverpool, Ltd., Hodder and Stoughton, Ltd., 1933.
91. WALKER, C. E. and WITTMORAN, H. E. *J. Med.*, 19: 1: 6: 85-98.
92. WEISMANN, A. *The Evolution Theory* (Translated by Thomson, J. A., and Thomson, M. R.). P. 424. London: Edward Arnold, Vol. 1904.
93. WELLS, H. C. *Am. J. Cancer* 1931, 15: 919-944.
94. WILLIAMS, R. *Correspondence. Lancet, Lond.* 1924: 378-1379.
95. WILLIAMS, T. J. *Am. J. Obst. Gyn.*, 1943, 45: 437-441.
96. WILLOCK, G. B. and BROWNETT, H. S. *Am. J. Anat.* 1943, 73: 335-440.

# SIMPLIFIED REPAIR OF THE COMMON DUCT

## Use of Umbrella Catheter to Produce Internal Biliary Fistula

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**I**N a surgical repair of the common duct in internal biliary fistula may be successfully produced by use of an umbrella catheter. If a dilated vestige of the common duct remains into which the head of an umbrella catheter may be inserted the entire duct may be reconstructed. The operative procedure is safe, requires less technical skill than other methods, and achieves better results with fewer complications.

In successful repair of the common duct over a rubber tube it is necessary to secure both ends of the tube in such a manner that it will remain in place permanently without the aid of sutures. When properly placed the catheter will not be extruded. We are quite certain from our own investigations that these rubber tubes will last for many years. Biliary obstruction is the only reason for removal. We have found that the new vitallium tubes are too short, must be held in place with sutures, and do not have enough flexibility. In 1943, Bettman and Tannenbaum reported a case in which an incrustated vitallium tube obstructed the common duct and had to be removed.

A new natural rubber umbrella catheter should be used for the reconstruction. The umbrella is inserted through a small stab wound in the bulging proximal end of the common duct to prevent the tube from slipping into the duodenum (Fig. 6). The catheter is then manipulated transduodenally through the opening at the distal end of the common duct if the opening can be found (Fig. 1). If not, the catheter is inserted through a minute stab wound into the duodenum. This stab wound is made small enough to grip the catheter, which could obviate the necessity of the customary silk pursestring suture. The catheter extends far enough into the lumen of the duodenum to prevent extrusion that might otherwise occur in postoperative traction due to position of the patient or visceral movements. The duodenum need not be drawn close to the liver as consid-

erable space may be bridged by the tube. All available viscera and fat are used to cover the catheter. Sulfathiazole powder (75 to 150 grains) is sprinkled along the course of repair. Closure is routine with one Penrose drain brought through the abdominal wall.

There is little or no bile drainage and no duodenal fistula occurs in cases repaired in this manner for three reasons: (1) the catheter is fitted securely at both ends and held in place with a silk pursestring suture; (2) there will be no intraductal pressure; the valvular action of the ampulla of Vater is eliminated when the catheter is inserted into the duodenum; and (3) sulfonamide compounds aid in combating infection.

In 1 patient the umbrella catheter has been in place for 3 years (Fig. 7). Whether it is incrustated or not, we do not know. This patient has no symptoms of obstructive jaundice and is normal except for an occasional mild attack of indigestion which may not be due to regurgitation of duodenal contents into the biliary tract. If these mild attacks are due to cholangitis, they are not as serious as attacks of obstructive jaundice or by the recurrence of strictures. The latter two conditions frequently arise in the usual methods of common duct repair and necessitate repeated surgical procedures. The relatively minimal effect of cholangitis has been proved by patients who apparently have been well for many years following cholecystoduodenostomy.

The common duct could not be located in a second case. Only the stubs of the right and left hepatic ducts remained. At operation a stiff T tube was inserted into the hepatic ducts; the catheter portion was introduced into the duodenum as described previously (Fig. 2). This tube slipped free from the ducts into the intestinal tract some time between the eighth and twelfth postoperative weeks. Roentgenologic examination in the eighth week showed the tube in place but on similar



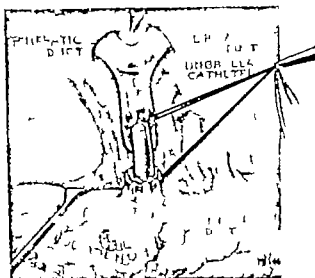


Fig. 1. An umbrella catheter bridges defect in the common duct.

examination in the twelfth postoperative week it was absent. As this patient's condition was good and has remained good, with no symptoms of obstructive jaundice present it would seem that the internal biliary fistula is functioning properly. This was true when the patient was last checked 14 months after operation. This particular case shows how quickly internal biliary fistulas will form and function. It is apparently true that some internal biliary fistulas (if the tube is not removed or extruded



Fig. 2. A T tube sidetracks the bile from the hepatic ducts into the duodenum.

too early) do function well and are not obstructed by cicatricial contraction. The percentage of internal biliary fistulas that will close by cicatrization is not known. It is likely that the pressure from the flow of bile aids in keeping many fistulas patent.

Many methods of common duct repair have been described. Sullivan in 1909 bridged



Fig. 3. X ray film of Case 7 shows umbrella catheter in place 3 months after surgery.



Fig. 4. Shows the cholangiographic study of Case 7 with complete stenosis of the common duct.

gaps in the common duct with a rubber tube. The omentum was wrapped and sutured about the tube. He concluded that the straight rubber tube should not pass into the lumen of the duodenum if required to stay in place for a long while. In later observations he concluded that this type of operation should be suitable for some cases of carcinoma extending up the duct the drawback being that the opening was not valvular. The Mayo technique of direct anastomosis, with a semilunar opening into the duodenum was popular because of the valvular effect obtained by the semilunar duodenal opening. Walton found the duct was often so short that the direct implantation into the duodenum was difficult. Lahey has reported best results from repair around a T tube. He also used a straight tube for repair and removed it after 7 years of normal biliary function and replaced it with another which is still functioning satisfactorily. Fascial repair is described by Davis and Lewis and others.

We have had 10 cases in which umbrella catheters have been used to repair the common duct. In 7 cases the tube was used to bridge malignant lesions extending from the junction of the cystic duct downward to and including the ampulla of Vater and the pan-



Fig. 5 Shows the umbrella catheter in place in Case 10.

creas. Anastomosis between the common duct and the duodenum was made quickly with an umbrella catheter. Jaundice and intense itching disappeared and the bile was retained in the intestinal tract. Six of these patients have

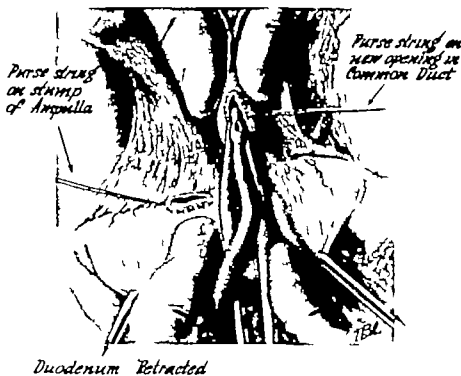


Fig. 6 Shows method of inserting head of umbrella catheter into side of duct.



Fig. 7 Roentgenogram of Case 8 taken 3 years after operation

died from metastatic carcinoma but were relieved of symptoms of obstructive jaundice.

The seventh patient is still alive. She had cholelithiasis and early adenocarcinoma at the junction of the cystic and common duct. On May 5, 1945, we removed her gall bladder and inserted a T tube in the common duct above the tumor. Her general condition at the time was not good and icteric index was 54. On January 14, 1946, she pulled out the T tube and immediately developed symptoms of biliary obstruction with an icteric index of 60 and intense itching. A second operation was performed on January 24, 1946. At this time we removed the common duct from the junction of the hepatics well down to the ampulla. The distal end was doubly ligated. The common duct stub was connected to the duodenum with an umbrella catheter. Biopsy of an enlarged regional lymph node showed no malignant condition. The liver showed no gross evidence of metastasis. On April 24, 1946, twelve weeks following operation, this patient's icteric index was 7. Her weight and general condition were normal. It was evident, on roentgenologic examination on April

30, 1946, that the umbrella catheter was in the same place as it was at the time of operation (Fig. 3).

In Cases 8, 9, and 10, there was no evidence of malignancy; the obstruction was due to benign causes, and the patients are enjoying a normal existence after similar operations have been carried out.

In Case 10, the patient was first operated upon elsewhere on November 1, 1942. The gall bladder containing stones was removed. Following the operation, there was bile drainage until December 1, 1942, when it ceased and was immediately followed by symptoms of obstructive jaundice. In January 1943, in a second hospital, a surgical attempt to relieve the obstructive jaundice failed. In June, 1943, in the same hospital, a second attempt to relieve the obstructive jaundice failed. In March 1945 (3 years and 5 months following the first operation), in a third hospital, a metallic tube was inserted in the common duct. There was a marked improvement in jaundice and general condition for 60 days. In June, 1945, the patient again became jaundiced and x-ray examination showed absence of the metallic tube.

In May 1946, 4 years and 7 months following the first operation, the patient entered the hospital. There were marked signs of obstructive jaundice and pain that required morphine,  $\frac{1}{4}$  grain every 3 hours. May 13, 1946, after the usual preparation of a severely jaundiced patient with proved marked liver damage, an umbrella catheter (Fig. 5) was inserted between the bulged proximal end of the common duct and the duodenum. Before closing the wound, cholangiographic examination (Fig. 4) shows the hepatic radicles open and the common duct completely obstructed. This patient was dismissed from the hospital on the eighteenth postoperative day. The icteric index was normal and, with the aid of a psychiatrist, no morphine had been given for 2 days. We are quite confident that the use of the umbrella catheter in this case will restore this individual to as nearly a normal existence as is possible after  $4\frac{1}{2}$  years of nearly complete obstructive jaundice.

We wonder how the complications following this type of repair will compare with those

following other types of procedure such as (1) transplantation of an internal biliary fistula, (2) end to-end anastomosis of the common duct, (3) hepaticoduodenostomy, (4) choledochoduodenostomy, and (5) repair of the duct over a T tube

#### SUMMARY

A simplified procedure has been presented for repair of the common duct by means of an umbrella catheter to form an internal biliary fistula.

1 An umbrella catheter is placed between the proximal and distal stubs of the common duct. The catheter is not removed unless obstruction occurs.

2 Incrustation of the tube is probably diminished by the direct and unobstructed flow of bile into the intestine due to the absence of the ampulla of Vater

3 In the 10 cases in which this operation was performed, no umbrella catheters have been displaced, there has been no bile drainage and no duodenal fistulas have developed

4 In 1 case (Fig 2) the internal biliary fistula is functioning 2 years after loss of the tube in the intestine

5 We believe that cicatricial contraction is less likely to occur the longer the tube remains *in situ* before it is removed

6 Cholangitis is not a complicating factor in these cases.

7 It is not known what percentage of internal biliary fistulas will close or how long they will stay open

The method which we have described might be called nonsurgical according to well known operative procedures but our experience continues to be encouraging. We believe this to be a most satisfactory method of repair of the common duct.

#### REFERENCES

1. BETTMAN, R. B. and TANODENBAUM. J Am M Ass. 1945 139 1165-1166
2. DAVIS, C. B. and LEWIS, D. D. Tr West. Surg. Ass. 1913, pp 217-219.
3. LAHEY, F. H. Ann. Surg., 1939 105 765-786
4. MAYO, W. J. Ann. Surg. 1905 42 90-96
5. SULLIVAN, A. G. J Am. M. Ass., 1909 53 774-777
6. WALTON, J. Surg. Gyn. Obst., 1944 79 57-60.

## UNILATERAL EXOPHTHALMOS AN EARLY SIGN IN THYROTOXICOSIS

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New Orleans, Louisiana

UNILATERAL exophthalmos appearing as an early sign of hyperthyroidism is not rare. It is very likely that the first physician to whom such a patient applies for help will be an ophthalmologist and several of the patients in our series were first seen by ophthalmologists who suspected the presence of thyrotoxicosis. Other such patients however apply to their family doctor for diagnosis. Exophthalmos either unilateral or bilateral occurring as the first sign of hyperthyroidism and preceding other clinical and laboratory manifestations of hyperthyroidism occurs often enough for any examining doctor to keep this possibility in mind. Unilateral exophthalmos may be the only sign of incipient toxic diffuse goiter and may precede by months all other subjective and objective findings.

Unilateral exophthalmos may be caused by many conditions but unless the cause is otherwise obvious hyperthyroidism should always be considered. Dixon believes that thyrotoxicosis is a relatively common cause of mild unilateral exophthalmos which he says is almost always retraction only of the upper lid and no other abnormality. Other causes of unilateral exophthalmos as pointed out by Davis and Martin are intraorbital inflammatory disease either primary or secondary to an infected paranasal sinus paralysis of the extraocular muscles, cavernous sinus thrombosis, congenital anatomic defects, angomas or aneurysm either within or behind the orbit. Of these vascular lesions and tumors are the most frequent causes of unilateral exophthalmos.

Cavity mentions that the term exophthalmos is often used loosely and sometimes is confused with a retraction of the upper lid simulating a protruded eyeball (Dalrymple's sign). He be-

lieves that many cases of unilateral exophthalmos are simply incomplete in terms of bilateral involvement. Not only is this true but also many cases of bilateral exophthalmos show some difference of proptosis in the two eyes. Most cases of unilateral proptosis in thyrotoxicosis will be provided the disease process is not checked eventually show similar changes of the other eyeball. Ruedemann explains the apparent unilaterality of exophthalmos under these circumstances as follows. He thinks the eyes are usually in a normal anterior posterior position with retraction of the lid on one side and with a partially successful attempt of the orbicularis palpebra to overcome the levator spasm of the other side. In his series of cases of real exophthalmos in hyperthyroidism the condition was always bilateral.

Cavity reported 3 cases in which unilateral exophthalmos was the first sign in Graves' disease and the diagnosis was not established until after intervals of 6, 8 and 20 months respectively. Ellett reported 2 cases with unilateral exophthalmos as the presenting sign and symptom in Graves' disease. His second case had a normal basal metabolism and exploratory operation was performed with removal of tissue from the muscle cone of the orbit. This was reported to be an epithelial like medullary tumor infiltrating the orbital fat. An orbital decompression was done according to Ellett and only hypertrophied extraocular muscles found. Two years later this patient had symptoms of hyperthyroidism and the basal metabolic rate was plus 46. This case and 1 in our series emphasize the fact that unilateral exophthalmos may appear as an early sign in thyrotoxicosis when no other signs or symptoms are present. The possibility of misdirected surgery on the eye under such circumstances is obvious.

The cause of exophthalmos in Graves' disease is still obscure. Within recent years many

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investigators including Shockaert, Loeb and Friedman, Pochin Paulson, Arid and others have demonstrated that thyrotropic hormone from the anterior pituitary gland when injected into guinea pigs will produce exophthalmos. Dobyns has shown that thyroidectomy alone will cause increased prominence of the eyes in guinea pigs. Pochin in his studies found no difference in the prominence of the eyes between the thyroidectomized and the nonthyroidectomized guinea pigs following injections of the thyrotropic hormone. Dobyns studied the exophthalmos producing effect of several different preparations of thyrotropic hormone and in addition the effect of the presence or absence of the testes and the thyroid on the development of exophthalmos. He found that antuitrin T caused exophthalmos in guinea pigs. A crude thyrotropic product produced both thyroid hyperplasia and exophthalmos whereas a purified product produced only thyroid hyperplasia. Dobyns also found that orchidectomy had no inhibitory effect on the exophthalmos produced by the thyrotropic hormone.

Naffziger has shown that exophthalmos after thyroidectomy may become progressive a fact noted by many observers. He reported such a case with the pathological findings. The exophthalmos was due to great volume increase in the extraocular muscles. This increase was not a true muscle hypertrophy but a result of fibrosis following edema. Rundie and Pochin in a study of the orbital tissues in thyrotoxicosis conclude that exophthalmos in Graves disease is accounted for quantitatively by an increase in bulk of the retrobulbar tissues. The increase was relatively greater in the eye muscles of which the average fat content was doubled in a series of 17 thyrotoxic cases. The changes are most marked in the levator palpebrae superioris muscle which is known to be responsible for lid retraction. Increase of fat in the orbital fibro-fatty tissues is, however, responsible for most of the increase in bulk. Arid defines malignant exophthalmos as the progressive and alarming proptosis which occurs in a small group of patients usually after thyroidectomy and in the presence of a low basal metabolic rate. In these cases he found the extraocular muscles to be en-

larged from three to eight times their normal size. Grossly the musculature of the orbital muscle cone is observed to be finer, paler and edematous. Various stages of degeneration were observed histologically with interstitial edema and proliferation of small round cells which showed a tendency to accumulate around blood vessels. Fibrosis appeared more dense and extensive in the advanced cases. Arid produced exophthalmos in guinea pigs by injection of the thyrotropic hormone and found the exophthalmos due to myopathy of the extraocular muscles. Smelser (20) produced experimental exophthalmos in thyroidectomized guinea pigs by injection of extracts of the anterior pituitary gland. His study revealed a hypertrophy of the orbital fat almost entirely due to an increase in the water content of this tissue. No change in the lipid content of the orbital fat was noted. There was also a marked increase in the water component of the muscles. Smelser (19) after further studies states that it is not clear whether changes in the orbit are primary causing exophthalmos or secondary resulting from it. He concludes that the hypertrophy of the extraocular muscles in guinea pigs with experimental exophthalmos produced by injection of anterior pituitary extract appears to be a sequence of the exophthalmos; however, there is some indication that the extraocular muscles are affected directly in the same manner as the fat. Smelser (19) points out that changes in the extrinsic eye muscles have been emphasized in the literature since the observations of Burch and Naffziger who noted hypertrophy of the muscles, marked edema, perivascular infiltration with round cells and many atrophic muscle fibers suggesting Zenker's degeneration.

Mulvany states that some cases of hyperthyroidism go for long periods of time without a definite diagnosis. He cites 2 cases of patients under his care for 6 and 10 years respectively with basal metabolic rates ranging from plus 15 to plus 40, he says without ill effects. In these cases Mulvany warns that removal of the thyroid may accentuate the exophthalmos by stimulating the pituitary gland.

It is our experience that immediately following thyroidectomy in such cases exophthalmos

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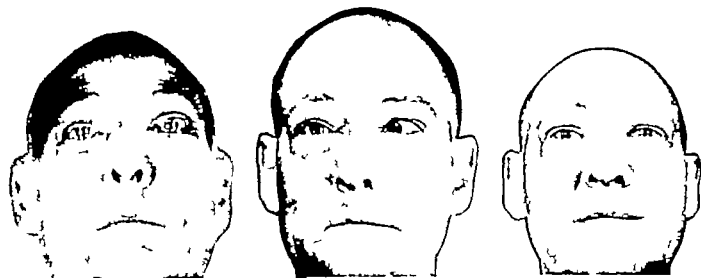


Fig. 3. These 3 photographs of a patient who had had a thyroidectomy in January 1942 were made May 1942, February 1943 and March, 1944. The first photograph shows marked exophthalmos, chemosis of the conjunctiva, and edema of the lids. The second photograph shows that he exophthalmos and edema have subsided but ophthalmoplegia is the residual of long continued severe exophthalmos. The third photograph shows the result after a "tuck"

ingers and the basal metabolic rate was elevated plus 18. Thyroidectomy was performed in January 1943. The pathological report was hyperplastic thyroid with areas of lymphoid infiltration. Following operation the exophthalmos progressed. He was not seen again until 1946. During this period of 3 years the exophthalmos had become severe and he went to a medical group in an adjacent state. There a Nafiger operation was done. The right orbit only was unroofed. Following this both eyes receded. However osteomyelitis of the skull resulted with considerable loss of bone in the right frontotemporal region. His health is now good but he has a depression and bone defect in the right frontal area.

CASE 3. A white female aged 27 years was referred by an ophthalmologist to whom the patient had gone because of a left unilateral exophthalmos. This patient noticed a prominence of her left eye 4 months before reporting for examination. The prominence of her left eye had gradually increased and 2 months after she first noticed the condition of the eye she began to suffer from extreme nervousness and irritability with crying spells. The patient stated that she had been nervous all her life so the increase in nervousness did not alarm her as did the exophthalmos. She had lost no weight and had no other complaints. On physical examination the patient was so nervous she was constantly moving her limbs and body and interrupting the history taking by outbursts of almost hysterical laughter. There was a moderate degree of exophthalmos of the left eye and the thyroid gland was firm, smooth and slightly enlarged. There was a marked tremor of the extended fingers and the skin was warm and moist. The basal metabolic rate was plus 35. This patient was given 0.4 gram of

operation performed by Dr. William B. Clark. The strabismus has been obliterated and the motions of the eyes are perfectly synchronized. There are two lessons to be gained from these findings. First exophthalmos, even if severe, may subside after thyroidectomy even though a long period is required. Second, a "tuck" operation for squint is sometimes of benefit in ophthalmoplegia due to long continued exophthalmos of hyperthyroidism.

thiouracil daily for 2 weeks and then admitted to the hospital. During the second week of thiouracil therapy 10 drops of Lugol's solution was given 3 times daily. After 1 week in the hospital on Lugol's solution thyroidectomy was performed. The pathological report was hyperplastic thyroid. She made an uneventful recovery and when recently seen, 4 months after the operation was free of signs of hyperthyroidism and the unilateral exophthalmos had subsided.

CASE 4. A negro female aged 30 years was seen because of a swelling in her neck of 1 month's duration. On examination the patient was found to have a right unilateral exophthalmos, the thyroid gland was enlarged firm and smooth. There was no tremor or other findings of thyrotoxicosis. The patient had not noticed the prominence of her eye but stated she had been nervous for the past 4 months and had lost 15 pounds in weight. She attributed this to worry over the death of her child 4 months previously. A friend of the patient had noticed the prominence of the right eye for several months but did not know the exact length of time. This patient was prepared with thiouracil and Lugol's solution and thyroidectomy was performed in March 1946. She made an uneventful recovery and was last seen 3 months after the operation when the condition of the eye had not changed. Later information on this patient has not been obtained.

CASE 5. A white woman aged 59 years was seen by an ophthalmologist because of unilateral exophthalmos. When first observed by us this patient had the classical signs and symptoms of thyrotoxicosis. She did not know how long her eye had been prominent but her chief concern was the unilateral exoph





Fig. 1



Fig. 2

Fig. 1. Man aged 35 years with unilateral exophthalmos. For 4 months this was the only subjective or objective sign of toxic diffuse goiter which later manifested itself characteristically (Case 1).

Fig. 2. Patient with severe exophthalmos which began 1 year ago in her remaining eye (Case 1). She has moderate

may be more marked but as weeks and months pass the prominence of the eyes diminish and the eye returns to normal anteroposterior position much more surely than if the case is neglected and thyroidectomy deferred. In deed extreme exophthalmos after adequate thyroidectomy for toxic diffuse goiter rarely fails to improve no matter how severe it may be. The gradual subsidence may take months or as long as 2 years.

Numerous laboratory investigators in the past working with guinea pigs have demonstrated exophthalmos by sympathetic nerve stimulation. To date there has been no proof that this is a factor in the production of exophthalmos in humans although there are some who feel that the sympathetic nervous system plays a part in this condition. As evidence against the sympathetics playing a part in the production of exophthalmos Brain reported a case history of a patient suffering from paralysis of the ocular sympathetic outflow as a result of syringomyelia who later developed Graves disease and showed both exophthalmos and retraction of the upper lids.

The following 5 cases of unilateral exophthalmos with thyrotoxicosis were observed on our private services.

CASE 1. A 47 year old white female first noticed prominence of her left eye in January 1931. If any

tely severe systemic signs of hyperthyroidism. The right eye was removed 15 years ago under diagnosis of retinobulbar sarcoma—the accuracy of which diagnosis now becomes doubtful. The impression is that the exophthalmos of the right eye was an initial sign of a long latent hyperthyroidism.

other symptoms of hyperthyroidism were present at that time they were apparently overlooked. In October 1931 her left eye was removed and the pathologic report was small round cell sarcoma. The authors have been unable to locate the original pathologic sections. Following the operation the patient was given radium treatments. Fourteen years later she was first seen by us. At that time she noticed her right eye becoming prominent and she began to complain of nervousness. Examination by the ophthalmologist failed to disclose any cause for the exophthalmos. The basal metabolic rate was plus 34. The patient's symptoms were mild but consistent with the diagnosis of hyperthyroidism. She did not report back until April 1946 at which time she had a basal metabolic rate of plus 31. Thyroidectomy was advised but as yet has not been performed. It is probable that the small round cell infiltration in the orbit was the result of exophthalmos in this patient apparently an initial sign of a toxic goiter which only became obvious years later with the then associated exophthalmos of the remaining eye.

CASE 2. A 51 year old white male was seen by an ophthalmologist in July 1942 because of a left unilateral exophthalmos of 7 months duration. He was referred to us and at that time the patient had no symptoms of thyrotoxicosis and the basal metabolic rate was normal. Physical examination was negative except for a left unilateral exophthalmos. It was suspected that the unilateral exophthalmos was an early and only sign of incipient hyperthyroidism. This, however, could not be substantiated at that time. The patient was seen again in December 1942 and a slight exophthalmos of the other eye was noted and the prominence of the left eye was more pronounced. The patient exhibited a slight tremor of his extended

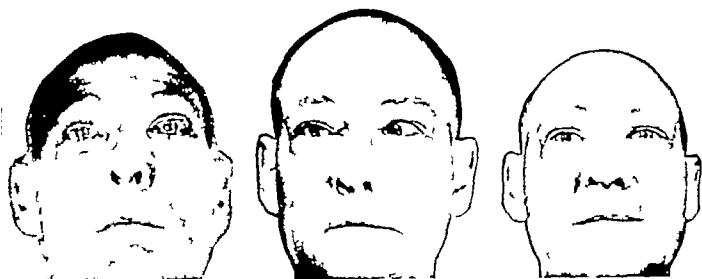


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thalmos. Thyroidectomy was performed. One year later the patient was examined. The basal metabolic rate was minus 16; she had gained 15 pounds in weight and the exophthalmos was improved. The patient was again seen 4 years and 8 months after the operation and the exophthalmos showed further improvement.

#### COMMENT

Some phases of the problem of exophthalmos in exophthalmic goiter are not clearly understood; some are debatable. The cause of exophthalmos is not established but from experimental studies made by the authors cited and others, it would appear that a factor in the anterior pituitary secretion has the property of producing exophthalmos and the same or a different factor has the property of inducing hyperplasia of the thyroid gland. The latter was observed in experimental work on dogs performed by one of us (Howard Mahorner). Whatever the exciting factor for exophthalmos the pathogenesis is not at all clear. Is the first effect a weakness of extraocular muscles, a contraction of Mueller's muscle or an edema of periorbital tissues, or does one of these changes precede another only to be replaced later as the cause of sustained exophthalmos? Overactivity of the orbicularis muscle of Mueller could be an early change; later edema of periorbital fat and edema and weakness of periorbital muscles could further enhance the process.

There is little doubt that in some cases of exophthalmic goiter the immediate effect of thyroidectomy on the exophthalmos is to make it worse. Some observers (Mulvany and Means) believe that the cases in which such an untoward effect is to be expected may be identified before operation. The identity Means says, is to be recognized in patients with exophthalmos and mild signs of hyperthyroidism and relatively low basal metabolic rates. Means goes so far as to advise that such cases be treated medically and that surgery is contra-indicated. This does not agree with our concept of what can be expected in subsidence of exophthalmos after thyroidectomy. Perhaps the general but erroneous impression exists that following thyroidectomy for exophthalmic goiter the exophthalmos immediately subsides. On the contrary even in cases with high basal

metabolic rates and exophthalmos, the exophthalmos is frequently a little worse in the weeks immediately after operation. Only after many weeks and months does the exophthalmos gradually subside and under these circumstances usually the eyes return to normal. After adequate thyroidectomy improvement of severe exophthalmos may be expected to continue to normal even though the time required for this accomplishment is over a year and up to 2 years. It is our impression that thyroidectomy is indicated for toxic goiter when the diagnosis is made even though the associated exophthalmos is accompanied by a basal metabolic rate which is not even moderately high.

Because of the long time over which improvement in exophthalmos after thyroidectomy may occur radical procedures such as the Naffziger operation should be deferred unless extreme proptosis greatly jeopardizes the sight of the eye.

Another interesting but little known fact concerning exophthalmos from exophthalmic goiter is that manifest strabismus resulting from ophthalmoplegia due to long sustained exophthalmos may be corrected after subsidence of orbital edema by a "tuck" operation. Figure 3 shows a beautiful surgical result obtained in such a case by Dr. William B. Charl.

#### SUMMARY

We have reported 5 cases of unilateral exophthalmos due to exophthalmic (toxic diffuse) goiter. In all of these cases the unilateral exophthalmos was a prominent—in some it was the only—feature of the disease noticed by the patient.

A discussion of the causes and some of the clinical features of exophthalmos due to toxic goiter is presented.

#### REFERENCES

1. ARID R. B. *Ann. I. t. M.*, 94, 556-581.
2. BRAIN W. R. *Lancet*, Lond., 1930, 211, 7-119.
3. BURCH, F. E. *Minnesota M.*, 999, 8, 668-675.
4. CAVITY L. C. *Am. J. Ophth.*, 1941, 24, 1433-1436.
5. DAVIS, L. and BLAXTEN J. *Surg. Gyn. Obst.*, 7, 557-567.
6. DIXON G. J. *Brain*, Lond., 94, 6473-69.
7. DOWNEY, H. M. *Surg. Gyn. Obst.*, 94, 82, 200-202.
8. ELLETT, L. C. *J. Am. M. Ass.*, 94, 16, 1-7.
9. LOEB, L., and FRIEDMAN H. *Proc. Soc. Exp. Biol.*, NY, 93, 29, 648.

10. MAHONY, HOWARD Arch. Surg. 1937 35:937
11. MEANS J. H. Ann. Int. M., 1945 23:779.
12. MULVANY J. H. Am. J. Ophth., 1944, 27 589-612
13. NAFFZIGER, H. C. Ann Surg. 1931 94 582-586
14. PAULSON D. L. Proc. Mayo Clin., 1939 14:828-831.
15. POCHIN E. E. Clin. Sc. 1944, 5:75-91
16. RUTEMANN A. D. Lancet, Lond., 1944 64 376-380
17. RUMBLE F. F. and POCHIN E. E. Clin. Sc., 1944, 5 51-74.
18. SHOCKAERT J. A. Proc. Soc. Exp. Biol., N.Y. 1931 20 306
19. SWEETSER G. K. Am. J. Anat. 1943 72 149-169
20. Idem. Am. J. Physiol. 1943, 140 308-315.

## THORACICOABDOMINAL APPROACH TO THE UPPER ABDOMEN

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THE organs of the left upper abdomen have always been difficult surgical problems because of lack of proper exposure. In working through an abdominal approach the surgeon is handicapped because the costal arch prevents adequate retraction. On the other hand an approach through the lower part of the chest necessitates reaching through the diaphragm to operate in the abdomen.

The approach that I am suggesting combines the thoracic approach with an abdominal approach. Adequate exposure is obtained by splitting the diaphragm. The incision is applicable for operations on esophagus, cardiac end of stomach, total gastric resections, diaphragmatic hernia, splenectomy, and vagus section when it is necessary to combine vagus section with gastroenterostomy.

The patient is placed on the table with the left side of the chest up in a true lateral position. The position is similar to the position used for posterolateral approach to the thorax. Intratracheal anesthesia is used. The incision is made over the ninth rib and extends from the angle of the rib across the costal arch and for about 2 inches into the abdomen. This brings the incision to the lateral border of the left rectus sheath. The ninth rib is removed from its angle to the costochondral junction. The thorax is entered through the bed of the ninth rib. At this point the pulmonary ligament is divided so that the lung falls away

from the diaphragm. The incision is then extended across the costal arch and for about 2 inches into the peritoneal cavity. The diaphragm is then split starting at the point where the costal arch was divided and extending the split in the diaphragm to the esophageal hiatus. Rib spreaders are then placed between the eighth and tenth ribs posteriorly. By opening the rib spreaders very adequate exposure is obtained from the aortic arch in the thorax to the duodenum in the abdomen. As shown in Figure 1 the exposure of the esophagus, stomach, and spleen is entirely adequate for any operative procedure involving these organs. After completion of the operation the diaphragm is sutured together with interrupted cotton mattress sutures.

In cases in which an esophagogastrectomy has been done the diaphragm can be sutured to the gastric side of the anastomosis at any desired level, thus leaving the stomach as an abdominal organ rather than transplanting it into the thorax. In such cases the phrenic nerve is crushed as it crosses the pericardium to prevent motion of the diaphragm postoperatively. After the diaphragm is sutured the incision is closed with interrupted cotton sutures with underwater drainage.

Postoperative course of these patients has been entirely uneventful. They have been ambulatory after 48 hours.

This approach has the following advantages:

1. The exposure is more complete by this method than with either the abdominal or thoracic approach.

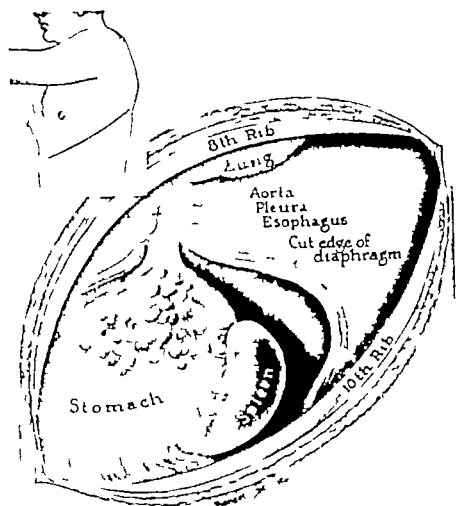


Fig. Drawing illustrating exposure of organs through the thoracoabdominal incision.

2 There is less danger of hemorrhage because the left gastric and the short gastric vessels can be divided under direct vision.

3 The diaphragm can be sutured at the desired level leaving the abdominal organs in the abdomen.

4 In the case of esophageal hiatus hernia the sack can be completely removed and also the abdominal organs can be explored at the completion of the operation.

5 In splenectomy adhesions of spleen to diaphragm can be separated under direct vision thus avoiding the danger of hemorrhage.

6 The patient suffers less shock because the plane of anesthesia is much lighter than is necessary for abdominal incisions.

7 The operating time is decreased because of the better exposure.

8 The convalescence is shortened because there is less danger of wound disruption in thoracic than in abdominal wounds.

In conclusion I have used this operation for carcinoma of the esophagus, total gastrectomy, splenectomy and diaphragmatic hernias and have found the operation to be entirely satisfactory.

# HISTOPATHOLOGY OF THE ANAL DUCTS

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IN 1880 Herrmann and Defosses noted in the anal regions of human embryos certain channels lined with epithelium which emptied into the anal crypts. These tubules, which occurred in simple and in branched forms, were seen at times to penetrate the fibers of the internal anal sphincteric muscle. Their lining of low columnar dark-staining cells was distinctly different from the goblet cell investment of the rectum and the stratified squamous epithelial mantle of the anal canal. These pioneer investigators suggested the thesis that the tiny ductular 'recesses' that they described might play a rôle in the initiation and spread of infection around the anus. The anatomic and embryologic aspects of their work were confirmed by Johnson, Lockhart Mummery, Harris, Tucker and Hellwig and Pope to name a few. Lockhart Mummery expressed the belief that these ducts were vestigial remnants of the sexual scent glands of lower animals but he could not ascertain their function in human economy. Observing that sometimes they terminated blindly in the ischiorectal fossa, he suggested that they were potential avenues for the lateral spread of anal infections.

Tucker and Hellwig remarked on the paucity of these ducts in the human subject as compared with the number found in certain lower animals. In a comparative embryologic study they detailed various modifications of the cells lining the ducts from the anus outward through the internal anal sphincter. They related the origin of certain anal fistulas to a primary infection in and about the anal ducts. In 1933 Pope described the presence of acinus-like buds in connection with the aforementioned structures. In 1936 Bremer noted the postnatal disappearance of secretory cells from the anal ducts in human beings. He ob-

served that usually not more than eight such ducts are to be found in any one rectum. In the same year Morgan observed that most of the ducts had their orifices in the posterior portion of the anal canal.

Briefly then, columnar lined epithelial ducts (anal ducts) are reported to exist in certain lower animals and in man. Their connection with the anal canal, their course through the internal anal sphincter and their blind termination reaching at times as far as the iliac fossa have placed them 'under suspicion' as avenues of perianal spread of infection. The present study was undertaken with a view to verifying or disproving certain statements relating to the incidence, position and significance of the anal ducts.

## MATERIALS AND METHODS

The apparently normal anal canals of a number of human embryos and of one male stillborn infant were secured for study of the developmental aspects of the ducts. For comparative anatomic studies similar material was obtained from 10 monkeys. For the study of possible early inflammation in anal ducts of human adults 100 specimens were selected in which removal of the rectum and anus had been performed because of sigmoidal or rectosigmoidal lesions. Finally the slides made during a previous study of 100 cases of cryptitis in the human subject were reviewed to check on the presence of associated anal ducts and their possible rôle in the spread of anorectal inflammation. In each instance blocks were selected so as to include the mucosa of the rectum as well as of the anus. In the case of the male stillborn infant serial sections were prepared from a block including the entire circumference of the bowel. In the case of the human embryos sections were semi serial. With the rest of the material the blocks taken were sufficient in number to yield the desired information. All blocks of tissue were embedded in paraffin, sectioned in the usual manner and stained routinely with hema-

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Fig. 1. Anal region of human embryo showing origin of anal duct in relation to anal crypt (hematoxylin and eosin,  $\times 68$ ).

toxylin and eosin. When demonstration of the presence or absence of mucus was necessary the Galantha method of staining this substance was employed.

#### FINDINGS

##### *A Male stillborn infant (eight months)*

**Serial sections of anorectal region.** Detailed study of 429 consecutive transverse sections revealed a total of 5 ducts, 2 of which were located in the anterior and 3 in the posterior half of the circumference of the bowel. The upper 312 of these sections were made through the rectal mucosa and in these no anal ducts were found, indicating that the direction of their penetration was not upward. The next 117 sections all showed one or more ducts, the openings of which were seen to be located at the level of the anal crypts where the mucosa of the bowel showed stratification of low columnar epithelium. The lining of the ducts was similar to that of the crypts. From 1 to 5 ducts were visible in each of these 117 sections and on 24 occasions actual penetration of the internal anal sphincter muscle was found to

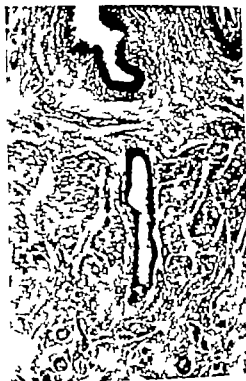


Fig. 2. Same duct as shown in Figure 1. At this level the duct has penetrated the sphincter muscle (hematoxylin and eosin  $\times 68$ ).

have occurred. In 42 sections the distal portions of the ducts were seen beneath a mucosal mantle of stratified squamous cells, indicating that the direction of ductular growth was away from the mucosa and downward. Moreover studies based on reconstruction showed their course to be irregular and even sinuous rather than direct, as was formerly believed. Definite lumina could not always be demonstrated probably as a result of tangential sectioning. In one duct there was a suggestion of an acinus-like bud with a single line of cuboidal epithelium. The lowest sections included perianal skin showing sweat glands, some of these being of the apocrine type. However these sweat glands were not easily confused with the anal ducts described previously. Rarely did the two types appear in the same section.

**B Study of human embryos.** Seven human embryos varying in length from 1.5 to 14.5 centimeters were obtained and from 4 to 6 small blocks of tissue were removed from the anorectal region of each. Slides from these prepared and studied in the usual way revealed

TABLE I.—STUDY OF SIX ANAL CANALS, FROM HUMAN EMBRYOS TO DETERMINE POSITION OF THE DUCTS WITH REFERENCE TO THE ANUS

Sex	Number of ducts	
	Anterior half	Posterior half
Female		
Female		5
Female		
Male		
Male		
Male		3
Total	5	

ductal structures similar in appearance and distribution to those described previously in 3 cases each from a fetus more than 10 centimeters in length. No acinar budding was observed (Figs 1 and 2)

To check further on the efficacy of "random" sections as a means of determining the number and location of these anal ducts 6 additional human embryos (3 male and 3 female) were studied in a similar manner. However in this latter series the locations of the blocks were oriented as to their position on the specimen whether anterior or posterior. The entire circumference of the anorectal region was thus included in the blocks which were then sectioned serially. Every twenty-fifth section was preserved, stained, and mounted for study. Results are shown in Table I. One to 5 ducts were found in the posterior segments in all 6 cases. In only 3 were ducts seen in slides from the anterior segments. No sex difference was observed in relation to incidence or location of anal ducts.

*C Study of anorectal regions of 10 monkeys*  
Tissues fixed in formalin were obtained from the anorectal regions of 10 monkeys. The animals in question had been killed in the course of experimental studies and they did not exhibit gross evidence of disease of the terminal portion of the bowel. From each specimen two blocks of tissue were removed for sectioning one from the anterior and one from the posterior portion of the anorectal region. In each instance the level of the anal crypts was selected on the basis of the findings cited in the



Fig. 3. Normal anal duct from an embryo. The section, which was taken near the blind extremity shows a lining of several layers of cuboidal epithelial cells (hematoxylin and eosin  $\times 395$ )

foregoing. From each block two sections were made one being stained with hematoxylin and eosin the other with a stain for mucus.

In 10 preparations from 5 of the animals anal ducts were not observed—a finding which does not surprise us considering the nature of the sampling. Ducts were observed in tissue from the remaining 5 monkeys. Proximally as in the human material, these ducts were lined by 4 or 5 layers of transitional epithelial cells which appeared to be more like low columnar than squamous cells. Distally a double layer of cuboidal epithelial cells was noted. Penetration of the surrounding muscle was found to be present in 2 and absent in 3 specimens. In 1 case mild periductal inflammatory infiltration with lymphocytes was noted. No acini were found but the mucicarmine stain gave a positive reaction in isolated regions of each duct confirming our assumption that the lining cells were entodermal rather than ectodermal. The ducts in each specimen numbered less than 5 with a 2:1 predilection for the posterior half of the anal canals.





Fig. 4. Anal crypt showing cryptitis. The ducts are shown with the transitional type of lining seen usually at their orifices. Subcutaneous periductal inflammation is present with many plasma cells (hematoxylin and eosin  $\times 9$ .)

*D Histopathologic study of 100 normal (?) anal crypts from human subjects* These crypts were considered more or less normal even though the rectum and anus had been removed for carcinoma of the rectosigmoid. In any event no gross evidences of anorectal disease processes were present. From each specimen one block of tissue was taken in such a manner as to include an anal crypt. In the original material it was seldom possible to satisfy our desire to select a posterior crypt inasmuch as orientation on the specimen was out of the question. However taking this into account it was interesting to note that one or more ducts were demonstrated by one microscopic section in no less than 55 of the 100 blocks which had been sectioned for study. Serial sections no doubt would have shown a much higher incidence (Fig. 3).

For information relating to the origin and cause of these ducts further sections were made on the 55 positive blocks and these sections were stained with hematoxylin and eosin and by the Galantha method for the demon-



Fig. 5. Anal duct in an adult. The lumen is filled with polymorphonuclear leucocytes and debris. Anal duct may be seen a few lymphocytes and considerable connective tissue (hematoxylin and eosin  $\times 12$ .)

stration of mucus. By means of this more or less random technique a definite origin of the anal ducts from a crypt was ascertained in 37 instances. In 33 slides the ducts were seen to penetrate the underlying muscle and a downward direction of growth was indicated in 22 sections wherein the epithelium overlying the deeper portions of the ducts was of squamous type. With minor variations the character of the epithelial lining of the ducts followed the pattern described in a foregoing paragraph. In 24 instances transitional columnar epithelium extended to the blind ends of the ducts. In 2 instances the proximal ends of the ducts were lined by stratified squamous epithelium. Results of staining for mucus were positive in 10 instances, the mucous cells appearing isolated or in small clumps scattered along the course of the ducts. No definite glandular acini were noted.

Of particular interest in this "normal" group was the presence in 13 cases of periductal inflammation. In 10 cases a chronic reaction was characterized by accumulations

# KRATZER DOCKERTY HISTOPATHOLOGY OF ANAL DUCTS

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TABLE II.—OBSERVATIONS ON 100 CRYPTS

	Cases	Per cent
Ducts not observed		
Ducts observed	45	45%
Showing ducts joining crypts	15	15%
Type of lining at entrance to ducts	37	67.31
Squamous		
Transitional	1	5.43
Columnar and transitional	33	89.2
Ducts penetrating muscle		
Type of lining of ampullae	33	5.43
Transitional		60.1
Columnar and cuboidal	24	7.14
Cuboidal		5.1
Columnar and transitional	8	5.1
Situation in respect to type of lining of anal canal superimposed	8	6.11
Squamous		
Transitional	22	40.1
Showing periductal inflammation	33	60.1
Associated with cryptitis	13	3.61
Showing columnar epithelium		81
Showing cancer with mucinome stain	0	24.61
Per cent of 100.	20	62.61
Per cent of 37.		
Per cent of 33.		
Per cent of 9.		

TABLE III.—REVIEW OF TWENTY FOUR SLIDES SHOWING DUCTS TAKEN FROM CASES OF CRYPTITIS

	Cases	Per cent
Normal ducts		
Showing cryptitis	4	16.6%
Showing ductal or periductal inflammation	9	37.5%
Number of these associated with cryptitis	11	45.8%
*Per cent of 24.	8	7.11
†Per cent of 1.		

these 9 cases an associated periductal inflammatory process of corresponding type was observed (Fig 4). In 1 instance only did the inflammatory process seem to spread solely within the lumina of the involved ducts (Fig 5). Two specimens showed periductal inflammation in the absence of cryptitis (Table III).

## COMMENT

In order to understand the possible importance of the anal ducts as avenues for the spread of anorectal infection one must realize the fact of their existence. The present study emphasizes that fact. These ducts are few and small. When they appear in the chance section made from the anorectal region, they may seem to be insignificant tubules having no apparent connection with the anal mucous membrane. Yet, as has been shown, their peregrinations through the internal anal sphincter theoretically expose such remote locations as the ischioanal fossae to the dangers of anal infection through their lumina or their periductal lymphatics. Therein lies their main interest, since this and other studies have not attributed to them any useful function in man.

Their relation in point of origin to the anal crypts is perhaps of some significance from the standpoint of infection (1-3 5 9 11 14 16).

In the present study periductal inflammation seemed to be definitely related to the coexistence of cryptitis. The discovery of cases wherein the crypts were normal and the ducts inflamed perhaps signified a condition of residual infection which had previously existed also within the crypts.

Are the anal ducts important in the production of anal fistula? The present study while not answering this question, has

of lymphocytes about the ducts, in 2 cases nests of plasma cells indicated the existence of a subacute inflammatory process and in 1 case an acute inflammatory reaction was noted with periductal accumulations of polymorphonuclear leucocytes and with edema of tissue. In no instance were the inflammatory cells located within the lumen of a duct. Cryptitis was associated in 12 of the 13 specimens in which there was periductal inflammation (Table II).

E. Review of some slides from cases of anal cryptitis incidentally showing anal ducts. In a previous study of 100 cases in which a gross diagnosis of cryptitis had been made ductular structures had frequently been noted. This material was again restudied and 24 specimens were selected as being pertinent to the present investigation. Of these 24 specimens 9 showed definite microscopic evidence of active cryptitis acute subacute or chronic as judged by the criteria outlined in section D. In 8 of

haps significantly confirmed the notion that the openings of the majority of the anal ducts lie posteriorly to the anus in the zone where anal fistulas are prone to develop. This phase of the problem needs further investigation.

#### SUMMARY

The present study has amply confirmed previous observations that epithelium lined ducts are to be found in monkeys, human embryos and human adults. Although few they may be demonstrated rather easily in about 50 per cent of human anal canals. From openings in the anal crypts (most often posterior) they course outward and downward often penetrating the internal anal sphincter. The majority are lined by transitional epithelium but definite mucus-producing cells may be demonstrated in 10 per cent of their linings. About 24 per cent of these ducts show focally or diffusely a periductal inflammatory reaction. When ducts are found in cases of anal cryptitis this incidence of periductal inflammation reaches 89 per cent. These ducts, we feel provide possible pathways for the lateral spread of such periductal infection once the latter is established, and it is conceivable that ischiorectal abscess might have such a patho-

genesis. Equally possible etiologically is the development of anal fistula, the problem of which for the posterior portion of the area corresponds to the principal site for the openings of the anal ducts.

#### REFERENCES

1. BACON, H. E. *Anus, Rectum, Sigmoid Colon: Its Goals and Treatment*. P. 203. Philadelphia: J. B. Lippincott Co. 1938.
2. BECKER, J. B. *M. J. & Rec.*, 1929, 129: 527.
3. BOCHNER, S. J. *Am. J. Surg.*, 1937, 56: 577-84.
4. BRIDGER, J. L. *A Textbook of Histology Arranged on an Embryological Basis*. 5th ed., p. 296. Philadelphia: P. Blakiston & Co., 1936.
5. GIVIS, J. A., and STOUT, A. P. *Arch. Surg.*, 1935, 90: 258-257.
6. HARRIS, H. A. *Proc. R. Soc. M. (Sect. Surg., 3d Sect. Proct.)*, 1929, 2: 1341-1352.
7. HERRMANN, GUSTAVE, and DEPOSSIER, L. C. *et Al.* *Acad. sc.*, 1880, 90: 301-302.
8. JORDAN, F. P. *Am. J. Anat.*, 1914, 14: 1-57.
9. KRAFFKA, JOSEPH. *Am. J. Surg.*, 1930, 49: 47-61.
10. LOCKHART MUMFERY, J. P. *Proc. R. Soc. M. (Sect. Surg., Sub-Sect. Proct.)*, 1929, 2: 1337-1347.
11. MILLAR, T. M. *Edinburgh M. J.*, 1913, 47: 69-72.
12. MORRIS, C. M. *Postgrad. M. J.*, 1936, 12: 15-22.
13. POPE, C. E. *Tr. Am. Proct. Soc.*, 1933, pp. 14-5.
14. RANKIN, F. W., BARGEN, J. A., and BRILL, L. B. *The Colon, Rectum and Anus*, pp. 595-596. Philadelphia: W. B. Saunders Co., 1932.
15. TUCKER, C. C., and HILLARIO, C. A. *Tr. Am. Proct. Soc.*, 1933, pp. 47-51.
16. TUTTLE, J. P. *A Treatise on Diseases of the Anus, Rectum and Pelvic Colon*. 3d ed. p. 9. New York: D. Appleton & Co., 1905.

# EXTRA-ARTICULAR REPAIR FOR RUPTURED COLLATERAL AND CRUCIATE LIGAMENTS

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## ANATOMY

THE cruciate ligaments of the knee are two intra articular ligaments that stretch between the tibia and femur and cross each other between their attachments. The anterior cruciate ligament extends obliquely upward and backward from the space in front of the intercondylar eminence of the tibia to the back part of the medial side of the lateral femoral condyle. The posterior cruciate ligament passes from the back of the tibial spine forward and inward to the intercondylar surface of the medial femoral condyle. The anterior ligament prevents the tibia from being displaced forward on the femur. The posterior ligament prevents backward displacement of the tibia on the femur. Both cruciate ligaments are fairly tense in all positions. The anterior is under more tension with extension of the knee while the posterior has increased tension with the knee in flexion. They act jointly to prevent anterior and posterior displacement of the tibia and also to limit the rotation of the tibia that occurs with flexion of the knee.

## PHYSIOLOGY

The action of the cruciate ligaments is dependent on the action of the muscles that control the knee and also to a great extent on the presence of satisfactory collateral ligaments. The cruciate ligaments act as check ligaments and work in conjunction with the collateral ligaments. They are dependent on the action of the quadriceps femoris muscle to give stability to the knee joint. A tear of the anterior cruciate ligament is not necessarily attended by loss of stability of the joint. A torn cruciate ligament has been established at operation without any instability of the joint. Studies on the cadaver have shown that the cruciate ligament may be divided without disturbance of function. However a torn cruciate ligament in the presence of a weak quadriceps femoris muscle will show some instability of the knee joint and lateral and posterior instability of the knee is always present when the tibial collateral ligament is divided along with division of the anterior cruciate ligament.

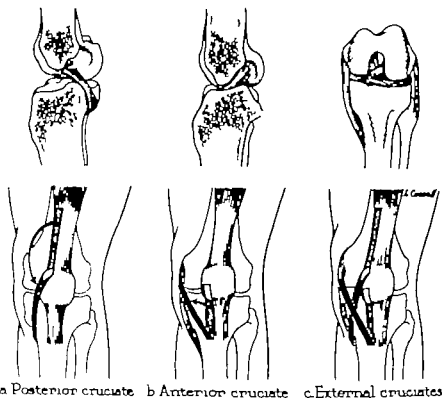
## MECHANICS OF TRAUMA

The anterior cruciate ligament is torn as the result of abduction or hyperextension of the knee. When sufficient force is exerted to rupture the cruciate ligament the tibial collateral ligament is also torn. The characteristic finding of a torn anterior cruciate ligament is the so called drawer sign with the knee flexed the tibia can be displaced forward on the femur. At the same time the force could result in a tear of the medial meniscus and more extensive involvement would include a depressed fracture of the outer tuberosity of the tibia.

It is not uncommon to overlook the tear of a cruciate ligament, because of the recognition of the more obvious injury to the medial meniscus and the fracture of the tibial collateral ligament. The tear of the quadriceps fibers is apparent in those cases where an exploration is made to repair the tibial collateral ligament. The torn muscular fibers may be in the deeper part of the muscle. The tear of the posterior cruciate ligament occurs when the tibia is forcefully displaced backward on the femur tending to cause a posterior dislocation of the joint. The clinical sign is the excessive backward mobility of the tibia on the femur. The posterior cruciate may be torn without serious injury to a collateral ligament, and frequently there is no disability.

## CONSERVATIVE TREATMENT

The treatment of a rupture of the cruciate ligaments is dependent on early recognition. If the joint is immediately immobilized in extension with the torn fibers intact, they can unite. In case the anterior cruciate is torn



a Posterior cruciate b Anterior cruciate c External cruciates

Fig. 1. Diagrammatic sketch comparing normal ligaments to reconstructed ligaments of the knee.

with the knee slightly flexed, the tibia is pushed backward and a cast is applied from the groin to the toes. Where the posterior cruciate ligament is torn the tibia is pulled forward on the femur and the extremity is fixed with a plaster of paris cast. The fixation should be retained for 2 to 3 months. Exercises of the quadriceps femoris are started immediately.

When a collateral ligament is torn fixation will allow healing. In those cases in which the meniscus is involved removal of the ruptured meniscus should be carried out and the torn tibial collateral ligament repaired at the same time. In the case of a depressed fracture of the tibia, adduction and compression should be carried out in an attempt to reduce the fracture. Here again fixation in extension by means of a cast to allow healing of the ligament is essential. Early activity of the quadriceps femoris must be urged and the return of normal function and active weight bearing instituted as soon as the symptoms have subsided. Where there are symptoms of instability or if the quadriceps is weakened re-

habilitation of this muscle will often give stability to the knee. In cases where the lateral collateral ligament is not repaired the instability can be great.

#### OPERATIVE TREATMENT

Many operations have been devised to construct cruciate ligaments from fascia or tendons. The results of intra articular operations have not been entirely satisfactory. Watson Jones reports recurrences after has elapsed. This is a difficult problem. It can hardly be expected that the repair of the cruciate ligaments would give a satisfactory result where the tibial collateral ligament remains ineffective. On the other hand, a simple repair of the tibial collateral ligament does not always result in relief of the symptoms when the cruciate ligament is also torn (Corybell). Since the tibial collateral ligament has been torn and stretched over a long period of time the structures are very weak therefore a shortening of this ligament after the manner of Mauck would not be adequate and supplementary tissue is necessary.

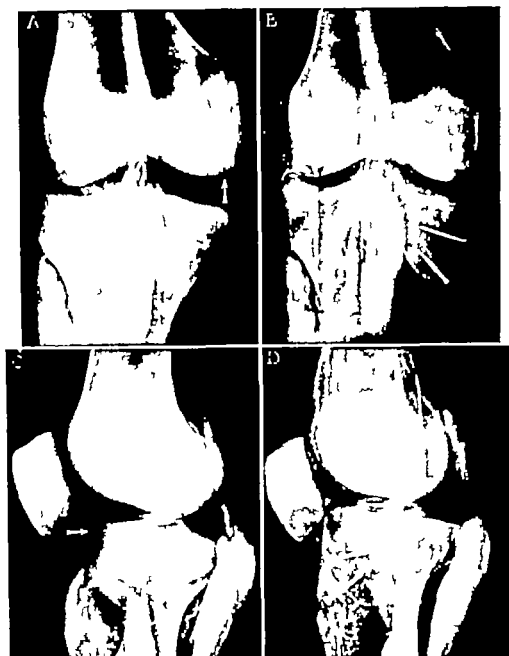


Fig. 2. A, Anteroposterior view of anatomical subject with division of tibial collateral and cruciate ligaments showing separation of the medial condyle from the tibia. B, After tendon transplant, showing decrease in the gap between the tibia and the medial condyle. C, Lateral view of anatomical subject with division of the tibial collateral and cruciate ligaments, showing posterior displacement of tibia on femur (positive "drawer sign"). D, After tendon transplant, showing normal relationship between tibia and femur with attempt to displace the tibia posteriorly on the femur (negative "drawer sign").

#### AUTHOR'S METHOD

The tendon of the quadriceps femoris offers a tissue that is strong and easily obtained and one of its attachments may be retained. A strip  $\frac{1}{8}$  inch wide and about  $2\frac{1}{2}$  inches long is made from the medial side of the tendon of the quadriceps femoris (Fig. 1 a). The proximal end is divided. The distal attachment is dis-

sected so that it remains attached only to the upper end of the patella. The proximal end is then reflected downward and attached on the medial and posterior side of the tibia. In this way a strong fibrous band passes obliquely from the anterior part of the knee at the level of the condyle to the posterior part of the tibia in the same direction and has the same effect

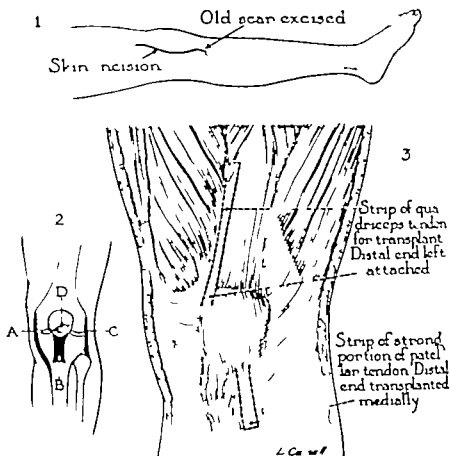


Fig. 1. 1. Skin incision over operation, old scar excised. 2. Diagrammatic sketch of the ligament of the knee. A. Medial collateral ligament. B. Ligament of the patella. C. Tibial collateral ligament. D. Cruciate ligament. (1) In this case C and D are torn. (2) D is torn. (3) Showing the source of transplants.

a an anterior cruciate ligament except that in this case it is outside the joint. It also is a strong ligament on the medial side of the knee re-enforcing the tibial collateral ligament. The transplant is fastened directly to the bone through an incision in the periosteum; the periosteum is turned back by means of an osteotome and direct contact is thus obtained between the transplant and the bone. The attachment can be made by using a nail or still better a staple. The ligament is held in place by means of mattress sutures of chromic No. 1 catgut passed from the periosteum through the transplanted part of the tendon. A good stable ligament is thus obtained.

In cases of severe tears further repair may be made by transplanting part of the ligament of the patella (Fig. 1 b). A  $\frac{1}{2}$  inch strip is made from this ligament on the medial side. This is dissected free and separated from its

attachment to the patella. The proximal end of the ligament is then transplanted primarily in the region of the medial surface of the lower end of the femur and attached to the fascia in this area. The lower end of the patella has the advantage that it is in the direction (see illustration) of the anterior cruciate ligament and at the same time it further re-enforces the weakened tibial collateral ligament.

A torn collateral ligament when repaired gives a weakened structure on the medial side of the knee and at the same time it prevents the function of the quadriceps femoris muscle in that area. The repair of the transplant from the tendon of the quadriceps femoris restores a functional attachment of the quadriceps femoris and activates the muscle in this area. The increased strength of the quadriceps is important in the restoration

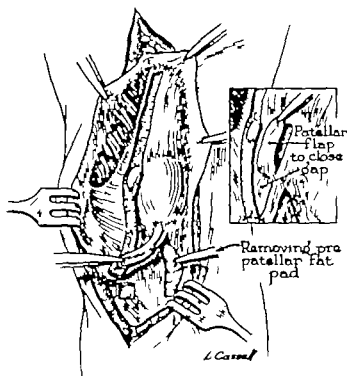


Fig. 4. Transplant from the tendon of the quadriceps femoris muscle and the ligament of the patella. Inset—shows source of fascia to cover gap

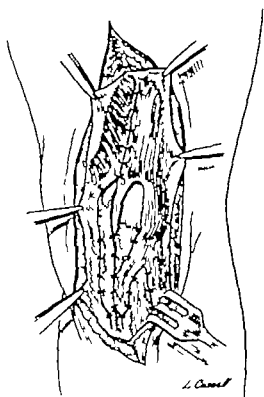


Fig. 5. Suturing.

function. In addition the transplant from the tendon of the quadriceps femoris muscle tends to activate the entire quadriceps muscle. The medial side of the muscle when the tibial collateral ligament is torn loses its function and becomes weak and powerless. With the repair by means of the tendon transplant the quadriceps power is restored and this increase in strength tends to stabilize the knee. The third advantage of this type of repair for a torn cruciate ligament is its oblique direction. The direction of the new ligament on the external surface of the knee is the same as that of the anterior cruciate ligament within the knee and thus acts as a check against excessive mobility. As can be seen from the illustration (Fig. 1 c) when the transplant from the tendon of the quadriceps femoris is in position and the transplant from the ligament of the patella is brought upward and posterior the ligaments cross to form a cruciate ligament on the external surface. This is suggestive of the action of the ligament but for clinical purposes it is more important that the repair of the tibial collateral ligament be emphasized. Next in importance is the increase in the ability to restore normal strength to the extensor

muscles of the knee. The operation is technically simple, is extra articular and excellent results have persisted.

In carrying out this procedure on an anatomical subject for demonstration we saw how a knee with definite instability which permits excessive abduction and internal rotation and also has a positive drawer sign was converted into a stable knee (Fig. 2 A and C). There was no possibility of abduction or excessive rotation nor displacement of the tibia, after the ligament had been transplanted (Fig. 2 B and D).

These principles for the torn cruciate ligament have been applied to 15 cases which have come under my observation. In the early cases of a torn tibial collateral ligament and a torn cruciate ligament fixation of the knee in extension with a plaster cast was carried out. Exercise for the quadriceps muscle was started immediately, weight bearing was started as soon as was possible without pain. The removal of the cast was followed by exercises of the extensor muscles of the knee. The patient was not permitted to return to work until the extensor group could carry out normal function. In this way instability and later develop-



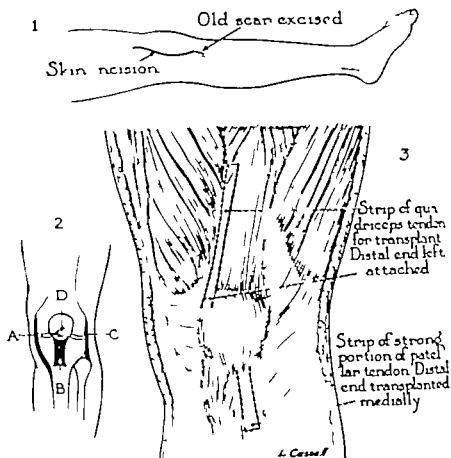


FIG. 1. Scar of previous operation and the incision. 2 Diagrammatic sketch of the ligament of the knee. A Medial collateral ligament B Ligament of the patella C Tibial collateral ligament D Cruciate ligaments (In this case C and D are torn) 3 Drawing showing the source of transplants.

an anterior cruciate ligament except that in this case it is outside the joint. It also is a strong ligament on the medial side of the knee re-enforcing the tibial collateral ligament. The transplant is fastened directly to the bone through an incision in the periosteum. The periosteum is turned back by means of an osteotome and direct contact is thus obtained between the transplant and the bone. The attachment can be made by using a nail or still better a staple. The ligament is held in place by means of mattress sutures of chromic No. 1 catgut passed from the periosteum through the transplanted part of the tendon. A good stable ligament is thus obtained.

In cases of severe tears further repair may be made by transplanting part of the ligament of the patella (Fig. 1, 3). A  $\frac{1}{2}$  inch strip is made from this ligament on the medial side. This is dissected free and separated from its

attachment to the patella. The proximal end of the ligament is then transplanted proximally in the region of the medial surface of the lower end of the femur and attachment is made to the fascia in this area. The lower end of the patella has the advantage that it is in the direction (see illustration) of the anterior cruciate ligament and at the same time also further re-enforce the weakened tibial collateral ligament.

A torn collateral ligament when repaired gives a weakened structure on the medial side of the knee and at the same time it prevents the function of the quadriceps femoris muscle in that area. The repair of the transplant from the tendon of the quadriceps femoris restores a functional attachment to the quadriceps femoris and activates the muscle in this area. The increased strength of the quadriceps is important in the restoration of

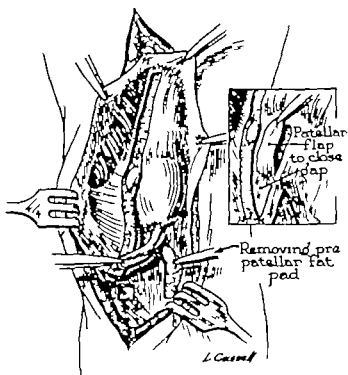


Fig. 4. Transplant from the tendon of the quadriceps femoris muscle and the ligament of the patella. Inset—shows source of fascia to cover gap

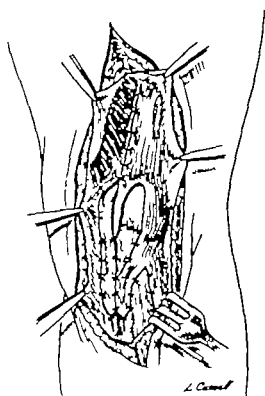


Fig. 5. Suturing

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Fig. 2. Left shows anterior-posterior instability of the knee. Right shows lateral instability of the knee.

ment of arthritis of the knee was prevented. In the early cases that required surgery the torn collateral ligament was repaired. In the older cases where there was very little instability but an uncertainty and a drawer sign with the knee relaxed, exercises for rehabilitation to full strength of the quadriceps muscle were sufficient to restore normal function and cure the cause of the patient's complaints. Where there was instability and signs of a definite tear of the tibial collateral ligament surgery was advised. Since this latter type of case is most difficult and most important a case report is included.

#### REPORT OF CASE

The patient was a 43-year-old man who complained of pain, weakness, and swelling in the left knee with lateral instability. He had injured his knee in a plane crash during the first World War and it had been getting progressively worse. When he came to me there was a definite drawer sign and it interfered with his occupation as the owner and manager of a large store. After the injury the knee kept troubling him and in 1930 after a diagnosis was made of a fractured medial meniscus he was operated upon and the meniscus was removed. He was still troubled when the symptom recurred. He began to flex and lock again with instability of the knee as well as pain and swelling. He was operated upon twice and the lateral meniscus was removed. Some improvement followed the

until 1930 when there was a recurrence of a definite deal of instability. He could not play sports and was unable to take part in other sports. He prolonged standing the knee would give him a painful. An attempt to swing a golf club with the knee into a rotary position caused a feeling of the knee slipping out of joint (subluxation). The knee became swollen and remained so. He was examined by the surgeon who removed the swelling and was told that he had a torn cruciate ligament with instability of the joint. He was advised to have an operation for repair of the cruciate ligament since in the surgeon's experience such repairs had been unsuccessful. He was told to avoid strain and to avoid strain and if the knee continued to worsen the best treatment would be an arthroplasty of the knee.

General examination of the patient was normal in every way with the exception of the knee. His blood pressure was 100/65 and laboratory tests were normal. Physical examination of the knee showed definite instability. The knee could be brought out into valgus at an angle of 15 degrees when the knee was slightly flexed. When the knee flexed and the foot brought into extension any attempt to put weight on the knee caused definite subluxation. The tibia could be drawn forward as well as pushed posteriorly on the femur (positive drawer sign). There was definite thickening and increased fluid. The fat pad was palpable and thickened.

Diagnosis was made of a torn cruciate ligament. The chief difficulty was the instability of the knee and the weakened tibial collateral ligament. Surgery was advised.

At the time of operation the tibial collateral ligament was exposed and in some areas was as thin as paper. The medial side of the femur and the patella was frayed out, stretched, and ineffective. A transplant was taken from the quadriceps femoris muscle and a segment was and posteriorly over the medial side of the knee and fastened on the tibia directly into the peroneal fossa (Fig. 3). A second transplant was then taken from the ligament of the patella. In removing the ligament from the ligament of the patella the proximal fat pad was exposed. It was found to be atrophied and showed signs of chronic inflammation and it was removed through this opening. A transplant of the ligament of the patella was attached to the patella. The distal part was transferred and attached to the tibia (Fig. 4). It was ligated from the proposed operation and placed to meet the extraordinary weakness of the ligaments on the medial side of the knee. The ligaments in place there was still a weakness of the structures between the two ligaments. A fascia to cover this gap was obtained from the anterior part of the patella (Fig. 5). The aponeurosis was reflected and placed between

ligament made from the tendon of the quadriceps femoris muscle and the one made from the ligament of the patella. The ligaments were sutured with No. 6 chromic catgut. The attachments to the peroneum were held in place with chromic No. 1 catgut (Fig. 5). The result was a firm collateral ligament which prevented the knee from any abnormal lateral movement. In addition the transplant from the tendon of the quadriceps femoris brought into play fibers of muscle which previously were not effective. Furthermore the pull on the newly formed collateral ligament was in the direction of the posterior cruciate ligament so that posterior displacement of the tibia on the femur was not possible. The skin was closed with black silk in the usual manner and a compression bandage was applied. The fifth day after operation quadriceps exercises were started. He had an uneventful convalescence. His temperature rose to 99 degrees the first 2 days and then became normal and remained so. The sutures were removed on the twelfth day and he was up in a chair 2 days later. On the twentieth day he was walking and he left the hospital on the twenty fourth day. The exercises were continued to increase the strength of the quadriceps. He returned to work after 2 weeks and continued his exercises. When seen 4 months after operation he was able to come to a squat position with all his weight on the leg operated upon. He was able to play golf and has continued his occupation without any return of symptoms. When last seen 2 years after operation he still had complete recovery without any sign of recurrence. The knee was normal in size and appearance and firm strong fibrous bands were palpable under the skin. The knee was stable and he was able to do all his work without symptoms (Fig. 6).

## SUMMARY

1 The symptoms of a torn cruciate ligament are dependent on the strength of the collateral ligaments as well as on the effectiveness of the quadriceps femoris muscle.

2 Torn cruciate and collateral ligaments will respond to early efficient conservative treatment.

3 Neglected cases of torn cruciate ligaments with weak stretched collateral ligaments, require surgical repair. For these cases an extra articular method of repair has been devised.

4 The author's operation is described. A section of tendon of the quadriceps femoris muscle is taken and division is made proximally the distal part being left attached to the patella. The proximal end of the section of tendon is then fastened to the posterior part of the upper end of the tibia. A section of the tendon of the patella about a centimeter in width can then be separated leaving the distal end attached. The free proximal end can then be transferred obliquely to be attached in the region of the condyle of the femur posteriorly. We thus have an extra articular cruciate ligament. More important is the fact that we have reconstructed a firm strong collateral ligament.

# ANATOMIC DISARTICULATION OF THE HIP

HAROLD B. BOYD, M.D., F.A.C.S., Memphis, Tennessee

**I**N order to obtain an ideal stump which will close without tension and minimize shock incident to disarticulation at the hip joint, a technique has been developed by which the dissection proceeds along fascial planes and the muscles about the hip are divided at either their origins from the pelvis or their insertions into the femur.

This technique is in accord with principles advocated by Callander and Kirk. Callander has found that, for amputations just above the knee, detachment of the muscles from their insertions or at their points of origin is much less shocking than amputations through the muscles of the thigh. Kirk, in describing amputations at the hip states: "All muscles except those normally belonging in the buttocks are removed from the stump, saving one

From the Walter C. Campbell Clinic.

muscle flap which is conserved to fill up the acetabulum if a disarticulation is elected. The muscles on the whole are cut at their origins.

In the operation to be described, detachment of the muscles from their origins or insertions permits closure of the wound in ease and without tension. The large gluteal flap forms an excellent stump. A familiarity with the anatomy of the structures about the hip joint is essential.

This operation has been performed by members of the staff of the Campbell Clinic on patients, and has been employed successfully in one additional case by Dr. Van Doozer in Buenos Aires.

**Technique.** The extremity is elevated and, unless contraindicated, an elastic bandage is applied to express as much blood as possible from the leg and thigh into the systemic cir-

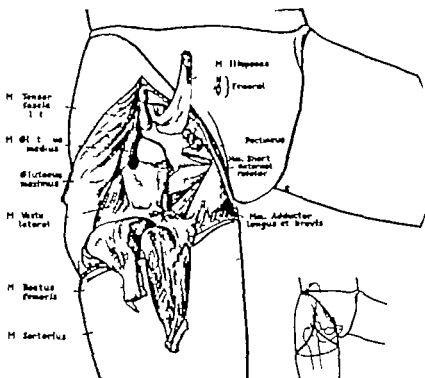


Fig. The stage of the anatomic disarticulation following ligation of the femoral vessels and nerves, and detachment of the sartorius, rectus femoris, pectineus, and iliopectineus muscles. Inset shows the line of the incision.

ulation The bandage should not be wrapped over a malignant tumor as cells from the epoplasm might be forced into the general circulation. An Esmarch tourniquet is applied tightly about the extremity 2 inches below the level of the disarticulation. Unless the tourniquet is placed below the point of amputation the limb will refill with blood during the operation despite primary ligation of the femoral artery and vein the blood coming through the anastomotic branches of the inferior gluteal artery with the medial femoral circumflex and highest perforating arteries.

The patient is placed on the unaffected side and after the routine surgical preparation sterile drapes are so applied as to permit free movement of the extremity.

A racquet type of incision is employed. Beginning at the anterior superior iliac spine, the

incision is curved downward and medially almost parallel with Poupert's ligament to a point on the inner aspect of the thigh 5 centimeters below the origin of the adductor muscles. Before proceeding farther the femoral artery and vein are isolated and ligated and the femoral nerve is injected with novocain and divided. The incision is then continued around the posterior aspect of the thigh approximately 5 centimeters distal to the ischial tuberosity and along the lateral aspect of the thigh about 8 centimeters distal to the base of the greater trochanter. From this point, it curves upward joining the original incision below the anterior superior iliac spine (insert Fig. 1). The sartorius muscle is now detached from its origin at the anterior superior iliac spine and reflected distally. The rectus femoris is detached from the anterior inferior iliac spine and also reflected distally and the

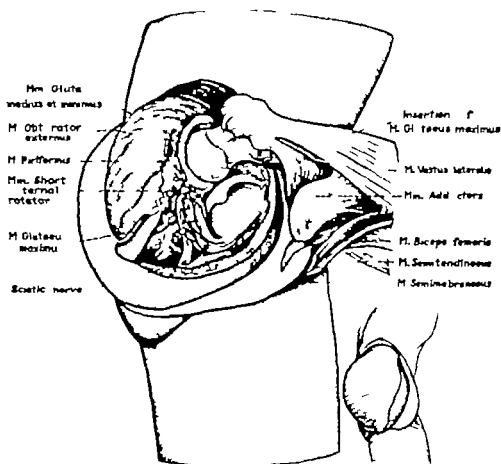


Fig. 2 The stage of the anatomic disarticulation following separation of the gluteal from their insertions, division of the sciatic nerve, severance of the short rotators, and detachment of the hamstring muscles from the ischial tuberosity. Insert shows the stump after closure of the wound.

TABLE I—ANATOMIC DISARTICULATION OF THE HIP

Patient No.	Age Yrs Sex	Diagnosis	Date of Operation	Result
J D 55900	40 M	Osteogenic sarcoma lower 3rd of femur	10-42	Died <sup>1</sup> Dec
E N H 55	5 F	Osteogenic sarcoma lower end of femur	10-4	Died June '94
H H 5573	41 F	Osteogenic sarcoma middle 3rd of femur	4-10-	Died <sup>1</sup> June '94
H J O 5442	15 M	Charcot hip secondary infection	8-	Living
Z B 50140	5 F	Fibrosarcoma right thigh	3	Living
E S 60008	7 F	Osteoblastic osteogenic sarcoma lower 3rd of femur	6-5	Died Nov '94
K L 57448	52 M	Fibrosarcoma above 1st femur	2-	Living

<sup>1</sup>Died with metastases

pectineus is divided approximately  $\frac{3}{4}$  inch from the pubis. By externally rotating the thigh the lesser trochanter is brought into view. The iliopsoas tendon is then severed at its insertion and reflected upward (Fig. 1). The adductor and gracilis muscles are next detached from the pubis and that portion of the adductor magnus which arises from the ischium is severed at its origin. The plane between the pectineus and the obturator externus and short rotators is delineated and the branches of the obturator artery are ligated. The obturator externus muscle is later detached from its insertion into the femur if the muscle is divided at its origin the obturator artery may be severed and retract into the pelvis, resulting in hemorrhage difficult to control.

The thigh is now rotated internally and the gluteus medius and minimus muscles are detached from their insertions into the greater trochanter and retracted upward. The fascia lata is divided below the insertion of the tensor fasciae latae muscle in the line of the skin incision together with the lowermost fibers of the gluteus maximus muscle and the tendon of the gluteus maximus is separated from its insertion into the linea aspera and retracted upward. The sciatic nerve is next injected with novocain and divided. The short rotators, of the hip i.e. the pyriformis, gemelli obturator internus, obturator externus and quadratus femoris are divided at their inser-

tions into the femur and the hamstring muscles are then severed from the ischial tuberosity (Fig. 2). The disarticulation is now complete except for incision of the capsule of the hip joint near the acetabulum, and division of the ligamentum teres.

From the description given, it will be observed that all the muscles are divided *distal to the bone* at either their points of origin or insertion and that the dissection proceeds along the fascial planes. All the arteries are clamped and ligated as they are encountered. Excessive bleeding during the operation is prevented by the initial ligation of the femoral artery above the profunda. The other major vessels which require ligation are the branches of the obturator artery and the inferior gluteal artery.

The disarticulation having been completed the gluteal flap is brought forward and the distal portions of the gluteal muscles are sutured to the points of origin of the pectineus and adductor muscles. The skin is closed in the routine manner. The gluteal flap is sufficiently large to permit closure without tension (insert Fig. 2). A drain is placed in the inferior portion of the incision, to be removed after 24 to 36 hours.

Five of the 7 operations performed by the method were for malignant tumors of the femur: 1 was for a Charcot hip with a secondary infection and 1 was for a fibrosarcoma of the thigh. There were no operative deaths. Four of the patients died of metastases from 1 to 10 months later (Table I).

These same principles have been followed in disarticulation of the shoulder. The deltoid muscle was detached from its insertion and retracted upward and the other muscles about the joint were severed at their attachments to the scapula or humerus. It was not necessary to divide any of the muscles through their bodies. The deltoid flap fell into place, permitting an ideal closure without tension.

#### CONCLUSIONS

Disarticulation of the hip is, at best, a shocking procedure. It should not be undertaken unless blood is available for transfusion during the operation. Experience indicates that the method presented is accompanied by

less shock than the conventional type of disarticulation of the hip. Dissection is carried out along fascial planes, permitting the surgeon to isolate and clamp the vessels as they are brought into view. Detachment of the muscles in avascular areas, i.e. at their origins or insertions is a major factor in the prevention of excessive blood loss. The procedure is a little more time-consuming than those in

which the muscles are divided through their bodies though the expenditure of the additional time is well justified by the better post operative condition of the patient.

## REFERENCES

1. CALLANDEY, C. L. J. Am. M. Ass., 1938 110 113
2. KIRK, N. T. Amputations. P. 84. Hagerstown, Md.: W. F. Pryor Co., Inc. 1943
3. VAN DOMSELAAR, P. L. Personal communication.



# THE ADVANTAGES AND LIMITATIONS OF THIOURACIL THERAPY IN THYROTOXICOSIS

EDSON F FOWLER M D and WARREN H COLE, M.D F.A.C.S. Chicago, Illinois

WHEN thiouracil was introduced by Astwood and other pioneer workers in this field the possibility seemed definite that no longer would there be need for surgical therapy in hyperthyroidism. However experience with the drug has revealed enough limitations to leave iodine a definite place in the treatment of hyperthyroidism. Nevertheless, the introduction of thiouracil and allied compounds can be considered epochal in the treatment of hyperthyroidism. Since several compounds are known to exert the same action on the thyroid as does thiouracil, it is of course likely that other drugs will be found which will be superior.

**Reactions.** The reactions sustained by the patient during treatment with thiouracil represent one of the greatest disadvantages of the drug. In a study of 1,543 cases reviewed from the medical literature, reactions were noted in 13.8 per cent of patients treated. The most serious reaction was agranulocytosis which was encountered in 0.78 per cent of patients in the series reviewed. Although much less serious, leucopenia was more common being reported in 3.11 per cent. Vomiting, dermatitis, and pruritis were encountered in 2.9 per cent, 1.1 per cent and 4.5 per cent, respectively. A great variety of other reactions, including purpura, localized edema, arthralgia, swelling of the salivary glands etc. have been observed. The mortality rate, which in the series of 1,543 cases was 0.45 per cent and is as great as that in thyroidectomy for moderately toxic goiter would indicate a most serious disadvantage or limitation in the use of thiouracil.

In our series of 79 cases the reactions were similar but slightly higher in incidence than were those reported in the literature (Table I) although most of the reactions were relatively

insignificant. We encountered no cases of agranulocytosis, although marked leucopenia developed in 4 cases.

We noted very little correlation between dosage and duration of drug therapy although the most serious reactions were apt to occur early in treatment. It must be remembered however that agranulocytosis may develop at any time during the course of therapy. No death in our series could be attributed to thiouracil. One death occurred while the patient was being treated with the drug, but a pharyngeal abscess and pneumonia seemed to account for the fatality without thiouracil being considered as a complicating factor. The patient did not have agranulocytosis, leucopenia or bone marrow changes.

**Advantages and indications for the use of thiouracil.** In our estimation thiouracil has its greatest usefulness in the treatment of moderately severe toxic goiter in patients who are so toxic that preparation with iodine will not lower the hyperthyroidism to a degree sufficient to allow bilateral thyroidectomy safely. Thiouracil likewise is strongly indicated in patients who have cardiac failure secondary to hyperthyroidism as seen most commonly in toxic nodular goiter. Treatment over a period of several weeks invariably results in improvement of the cardiac status; the nutritional state likewise improves remarkably. In recurrent goiter and in mildly toxic goiter with a small gland, permanent remissions are obtainable in a large percentage of cases. In patients who are sensitive to iodine or have tuberculosis (in which disease iodine is supposedly dangerous) thiouracil is strongly indicated.

**Disadvantages and limitations in the use of thiouracil.** The greatest disadvantage in the use of thiouracil is obviously the mortality rate produced by administration of the drug. Although we have not had any fatalities in our series which could be attributed to the use of the drug, the mortality rate in the 1,543 cases

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TABLE I.—TOXIC REACTIONS IN 79 CASES TREATED WITH THIOURACIL AT ILLINOIS RESEARCH HOSPITAL

	Cases
Pruritis, rash	8
Severe leucopenia	4
Edema	1
Arthralgia	1
Nausea and vomiting	2
Submandibular swelling	1
	17 or 21 per cent

Reactions were sufficiently serious to require cessation of the drug in 9 per cent.

reviewed (3) in the medical literature was 0.45 per cent. This one disadvantage is so serious that the drug can probably never be used with utter safety particularly since it is now being used with great care and only by a relatively few workers most of whom are making such a careful study of the drug that reactions are detected early. Even though the incidence of other reactions was 13.8 per cent, most of them can be considered as insignificant. The action of thiouracil is so slow that it literally takes weeks to eliminate the thyrotoxicity. This delay might be considered uneconomical and many patients as well as physicians may become impatient particularly since thyroidectomy can be performed in the mildly toxic goiter patient, with a very low mortality rate and with only 12 to 15 days of preliminary iodine therapy. In the presence of crisis the drug is dangerous and should not be given particularly since in this group of patients the effect is so slow that it would probably not decrease the mortality rate. Thiouracil produces increased vascularity of the thyroid gland thereby making the operation more difficult because of the additional hemorrhage encountered. The use of iodine for 10 to 12 days before operation, however, eliminates or minimizes this vascularity. Thiouracil does not produce a decrease in the size of the gland. Accordingly in toxic nodular goiter if the action is optimal and sustained so that operation is not indicated we still have to be concerned about the possibility of the development of carcinoma. The high incidence in a goiter belt of carcinoma in nodular goiter has been noted in a previous publication (2) and made the authors concerned as to the fate of patients with residual nodules after thiouracil

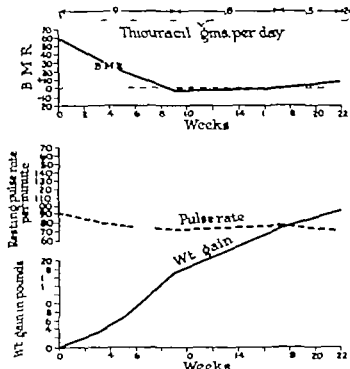


Fig. 1. Average response of hyperthyroidism to thiouracil. The basal metabolic rate was reduced from 60+ to 20 in 8 weeks, representing a drop of about one point in the metabolic rate for each day of therapy.

therapy. We have not, however, encountered any carcinomas in glands of patients treated with thiouracil and know of no such instances in the literature. Therefore we are of the opinion that the possibility of development of such a complication can be considered insignificant.

**Dosage and response to thiouracil.** We are using a dosage of 200 milligrams three times a day. The drug is maintained at this level for at least a few weeks and then dropped to one-third to one-half of this amount, depending upon the response of the patient. The patient must be watched at all times and leucocyte counts performed two or three times a week. Moreover the patient must be instructed to report all reactions regardless of severity or degree. Since severe reactions including severe agranulocytosis can develop at any time

TABLE II.—INDICATIONS OR ADVANTAGES OF THIOURACIL

1. Patients so toxic thyroidectomy not safe with iodine.
2. Mild toxicity with small gland. (Permanent remission in about half of this group.)
3. Recurrent thyrotoxicosis (following operation) with small gland.
4. Thyrocardiacs.
5. Patients sensitive to iodine or having pulmonary tuberculosis.

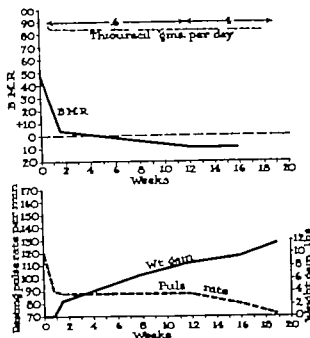


Fig. 2. Unusually rapid response to thiouracil which is perhaps explained for the most part by inaccuracy of the initial basal metabolic reading.

the fact that administration of the drug for 4 to 5 weeks has not resulted in reactions cannot be considered as an excuse for less critical observation. The danger of development of agranulocytosis is so unpredictable that the drug should be discontinued for 3 or 4 days before operation lest agranulocytosis develop on the day of operation and not be detected.

Reference has already been made to the desirability of giving iodine as Lugol's solution or iodide for 12 to 14 days preceding operation. This program will result in a great decrease in vascularity and the operation is thereby made much easier.

Lahey and others have noted that there is regression of hyperthyroidism during thiouracil therapy to a degree equal to about one point in basal metabolic rate for each day of

TABLE IV—RESULTS AFTER DISCONTINUATION OF THIOURACIL

No. of Cases	Average Initial BMR	Average duration to normal BMR	Remissions?
10	65.3	7.5	No. Symptoms returned in 7 mos.
9	59.1	6.8	Yes. 8-7 mos after discontinued.
7	51.7	6.4	Yes. But only 1-3 mos after discontinued.

BMR, Basal metabolic rate.

treatment. In an analysis of our patients, we noted, however, that it took a period slightly longer than this to bring the patients to normal basal metabolic rate. In our 1 with toxic diffuse goiter it took an 8.8 days in addition to the one day per point basal metabolic rate, to bring the rate to normal. Patients with toxic nodular goiter respond somewhat more slowly than do those with toxic diffuse goiter. For example, in the toxic nodular group it took an average of 8.1 days longer than the one day per point basal metabolic rate for return to a rate.

Although failure of thiouracil to reduce toxicity is seldom reported in the literature, we have had 3 patients with hyperthyroidism in whom thiouracil was ineffective. It is well known, however, that if iodine has been given before thiouracil is started, the beneficial effect of the latter drug will be reduced markedly.

**Remissions.** The number of patients whom we have observed over a prolonged period of time for determination of the possibility of permanent cure or remission has been relatively small, namely only 26 cases. We have learned as have others working in this field that treatment for less than 6 months is not apt to produce a remission with any degree of permanency. With one or two exceptions, of the patients in this series of 26 had taken the drug for 6 months or longer. Ten of them had recurrence within 1 to 7 months. It is somewhat difficult to determine exactly when a recurrence takes place, largely because the symptoms develop so insidiously that the patient is not entirely aware of the exact date of recurrence of symptoms. Nine of the 26 patients have had no recurrence of symptoms for 8 to 17 months (average 12.1 months) but

TABLE III—LIMITATIONS OR DISADVANTAGES OF THIOURACIL

1. High mortality rate (0.45 per cent in 1543 cases—Fowler).
2. Toxic reactions 13.8 per cent.
3. Slow action (uneconomical).
4. Useless in crisis (dangerous?).
5. No decrease in size of gland. (If remission permanent, is persistent gland dangerous—Carcinoma?)
6. Increases vascularity of gland,—thus adding to operating time and blood loss unless iodine is given.

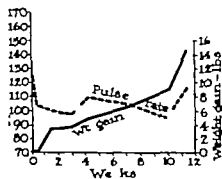
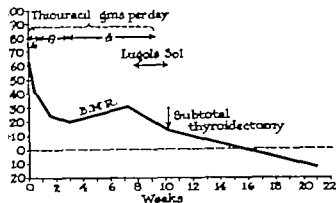


Fig. 3. Unusually slow response to thiouracil. After 73 days of therapy the basal metabolic rate had receded only 5 points.

Following cessation of thiouracil therapy. Seven of the 26 patients have had no recurrence of symptoms but observation has been for a much shorter time, namely only 1 to 5 months following cessation of therapy. In general we have found that patients with mild toxicity and those with relatively small glands are more apt to have a permanent remission than are other types of patients.

**Determination of operability.** In patients treated successfully with thiouracil it will rarely be necessary to make an appraisal of the patient's condition to determine operability or time for operation. However there will be a small number of patients who will have reactions following thiouracil and a few who will not respond to the drug thereby constituting an appreciable number of patients who must be treated by conventional methods consisting mainly of iodine and operation. It took us three or four decades to learn how to determine operability and optimum time for operation in thyrotoxicosis. The authors wish to make a plea that the profession not abandon all this information which required years for accumulation. All of us have certain pre-

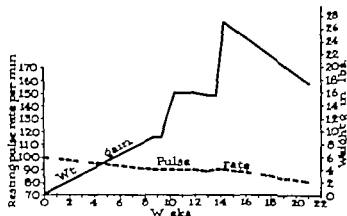
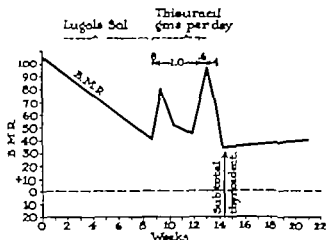


Fig. 4. Deleterious effect of preliminary course of iodine on thiouracil response. Previous to 6 weeks' treatment with thiouracil the patient had received Lugol's solution for 8½ weeks. The 6 weeks period of treatment with thiouracil resulted in no reduction in basal metabolic rate although there was considerable weight gain and a slight decrease in severity of symptoms.

requisites to determine operability. Unfortunately not many have taken the time or trouble to convert these prerequisites into terms that can be transmitted to others. From a teaching standpoint, we have learned that to transmit information of this type to students, it must be converted to mathematical status or its equivalent. We have utilized the pre-

TABLE V—PREREQUISITES FOR BILATERAL THYROIDECTOMY IN TOXIC GOITER

1. Gain in weight and strength.
  2. Resting pulse below 110.
  3. Basal metabolic rate below 50.
  4. Response to iodine or thiouracil.
  5. No untreatable complications.
- During operation: If pulse rate goes to 135 not explainable on basis of anesthetic, consider possibility of removing only one lobe. If pulse rate goes above 145, indications are to stop the operation or remove only one lobe.

requisites in determination of safety for bilateral thyroidectomy in toxic goiter (Table V)

The surgeon has the opportunity to save many lives by asserting good judgment in the operating room. For example, as suggested in Table V if the pulse rate goes to 135-140 unrelated to anesthesia, it is obvious that the patient was more toxic than the surgeon anticipated; therefore he should consider the possibility of removing only one lobe. On the other hand if the patient's pulse rate goes to 145 or higher during the operation without relation to the anesthesia, the surgeon should consider stopping the operation at once or at least removing only one lobe. On many occasions the authors have returned patients to the ward when they arrived at the operating room with a fast pulse which did not settle down under anesthesia. If the pulse rate does not come down to 130 or thereabouts under anesthesia the incision should be delayed; it may be wise to cancel the operation and wait several days for a more opportune time. This decision is particularly indicated if an excess amount of oxygen seems to be required during the anesthetic, and if there is difficulty in eliminating cyanosis.

#### SUMMARY

Thiouracil has been of great assistance in the treatment of hyperthyroidism. It will reduce the basal metabolic rate to normal in at least 95 per cent of patients with hyperthyroidism except that reactions may prevent continuation of the drug (in 9 per cent of our series). A survey of the literature reveals an incidence in reaction of 13.8 per cent. Agranulocytosis occurred in 0.78 per cent of patients (1543 cases studied from the literature, with a mortality rate of 0.45 per cent). Besides agranulocytosis, reactions consisted of leuco-

penia, nausea and vomiting, dermatitis, pericarditis, fever, swelling of the salivary gland, arthralgia and other minor complaints. In a series of 79 patients, reactions were slightly greater in number but of less severity than noted in the literature. We had no deaths attributable to thiouracil.

The greatest advantage of thiouracil over iodine is in the group of patients who are so toxic that bilateral thyroidectomy is contraindicated under iodine therapy. The drug is particularly useful in patients with cardiac decompensation secondary to hyperthyroidism. In our experience about one half of the patients treated will have remission of prolonged or permanent type but these patients must be watched. Patients with mild toxicity and small glands are more apt to have permanent remission than are other types. Patients with toxic diffuse goiter respond slightly better than those with toxic nodular goiter.

The most serious disadvantage is the toxicity and particularly the mortality rate. If slow action is uneconomical many and internists feel that treatment of patients with mild hyperthyroidism with iodine and thyroidectomy may be superior to the thiouracil, particularly since the mortality rate of operation is so low in that group.

Since there are numerous drugs which produce cessation of hormone formation, it is likely that a better drug will be found which will not be toxic. A new drug, propylthiouracil appears to be much superior to thiouracil.

#### REFERENCES

1. ASTWOOD, E. B. *J. Am. M. Ass.*, 1942, 122, 76.
2. COLP, WARREN H., SLADGUTH, DORIS P. & ROSSITER, LEWIS J. *J. Am. M. Ass.*, 1945, 127, 887.
3. FOWLER, EDSON F. *Surg. Gyn. Obst.*, 1946, 81, 3.
4. LARLEY, FRANK H. *Surg. Gyn. Obst.*, 1945, 81, 328.

# OBSERVATIONS ON THE USE OF G-11 IN THE SURGICAL SCRUB

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THE following studies were undertaken in the attempt to confirm the observations of Traub and others (3, 4) who have reported the remarkable effect of the compound G-11<sup>1</sup> (2,2'-dihydroxy-3,5,6-trichloro-4,4'-biphenyl methane) in reducing the resident flora of the skin. In general we have been able to substantiate these results, the data presented below indicate certain modifications in the methods of using and evaluating the material which may be employed to advantage.

Traub found that persons using for all skin washing purposes a soap containing 2 per cent G-11 showed very low numbers of skin organisms when tested by the Price technique (2). He states (4) that if the material is to be used in a surgical scrub it must also be employed exclusively whenever soap is used on the skin, application only at the time of the actual scrub would be ineffective, since a preliminary period of contact is required for the action of the disinfectant to appear. Such a requirement presents some inconvenience and more supervisory difficulty; the effectiveness of the agent has therefore been tested when its use was restricted to operating room procedure.

According to Traub there is no evidence for the carry-over of disinfectant into the medium to account for the low numbers of organisms seen in the tests. Since his evidence for this is only indirect, we have examined the possibility in greater detail. Moreover, since the basis for the activity of G-11 must be primarily chemical, the effect of eliminating the scrubbing brush from the surgical wash was investigated.

*Method of determining numbers of skin organisms.* The technique was essentially that of Price as modified by Pohle and Stuart. The

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<sup>1</sup>William S. Gump, U. S. Patent 2,350,430.

individual to be tested wet his hands to a point 1 inch above the wrist joint in 1 liter of sterile distilled water in a sterile basin. Ivory soap was applied to the wet skin area for 25 seconds after which the subject massaged his hands thoroughly for 75 seconds. The hands were then rinsed in the basin for 25 seconds. Poured plates containing 0.1 and 1.0 milliliter of the thoroughly stirred basin water were prepared. Counts were made after 48 hours at 37 degrees C. The serial basin portion of the Price method was not used since the first basin which gives the highest counts analogous to the dose of micro-organisms released in the event of tearing a glove was our main interest. The skin counts reported here are expressed as the number of organisms per liter of wash water, or per basin.

*Susceptibility of normal skin organisms to G-11.* The plating medium in this experiment consisted of bacto-tryptose 10 per cent, bacto-beef extract 0.5 per cent, sodium chloride 0.5 per cent, and agar 1.5 per cent. A 1 per cent alcoholic solution of the monopotassium salt of G-11 was diluted serially in broth of the same composition as above. Organisms were tested both in broth and in agar. The stated concentrations of G-11 represent final concentrations in the medium. The strains employed were obtained from skin tests as described on two individuals who had gone through a thorough wash with plain green soap solution, and had worn sterile gloves for 45 minutes. They had not been in contact with G-11. Ten colonies were isolated from each, all 20 strains were staphylococci, either lemon yellow or nonpigmented. No gram negative forms were found. In testing G-11 in broth 5 milliliter amounts containing 10 fold dilutions of G-11 were inoculated with 0.1 milliliter of a barely turbid suspension of the test organisms made from a 24 hour slant. Agar plates containing 10 fold dilutions of G-11 were inoculated on the surface with a loopful of the same suspen-

TABLE I—INHIBITORY EFFECT OF WASHINGS FROM G-11 TREATED SKIN ON NORMAL SKIN ORGANISMS. SURFACE INOCULUM METHOD

		Subject A	Subject B	Subject C
	Sum of lawn sample added to agar (ml.)			
Medium	Test strain			
		± —	± —	+ —
		—	++ —	++ —
Tryptose-extract		+ —	++ —	++ —
		± —	++ —	++ —
		+++ —	+ +	+++ —
		+++	+++ +	+++ —
Infusioo		+++	+++ ±	+++ +++
		+++ —	+++ +	+ —
Tryptose-extract 1% serum		VI +++		

± indicates barely perceptible film of growth  
 +++ indicates growth equal to that on control plate

sions each spread over an area of about 1 square centimeter. Readings were made after 48 hours at 37 degrees C.

Three strains tested in broth were completely inhibited at a dilution of  $10^{-6}$  with partial inhibition at  $10^{-7}$ . Twenty strains were tested on agar at a  $10^{-6}$  dilution 2 strains showed only partial inhibition 3 showed almost complete inhibition and the remaining 15 failed completely to grow. At  $10^{-7}$  all 20 strains grew as well as on the control plates. Three gram negative organisms (coliforms) tested in the same manner grew in concentrations of G-11 10 to 100 times greater. Parallel tests on zephiran chloride showed similar bacteriostatic levels, including the greater resistance of gram negative bacilli.

*Bacteriostatic effect of wash waters obtained from individuals in contact with G-11.* In view of this demonstration of marked bacteriostasis in low concentrations of G-11 the wash waters obtained from skin tests on persons in contact with G-11 were tested directly for their bacteriostatic effect when incorporated in agar plates in 0.1 and 1.0 milliliter amounts. Three persons who had been subjected to the standard G-11 surgical wash (see below) once daily for 5 days, followed by a 2 day lapse were again given the standard G-11 wash and re-

quired to wear dry sterile gloves for 45 minutes. They were then tested and 1 water added to agar plates in 0.1 ml; milliliter amounts. Four of the strains on normal skin were tested by inoculation of the surface of these plates. The results given in Table I showing that with the medium described in the previous section, no inhibition was present in the plates containing the 1.0 milliliter samples against all strains with partial inhibition in the 0.1 milliliter samples. Taking into account the 10 fold dilution of wash water in agar with the 1.0 ml. liter sample from 1 to 10 milligrams of G may be carried over into the bath from the skin under these conditions. On a few occasions there has been evidence of slight inhibition from samples obtained 24 hours after the last G-11 application but this was less striking than that seen in samples taken 45 minutes after contact. In no case was a G-11 serum used in the procedure for obtaining counts.

In the attempt to neutralize this inhibitory effect in the medium infusion agar was tested since it had been employed by Traub with indication of bacteriostasis. It is evident in Table I that some neutralization has occurred since the 0.1 milliliter samples, with a few exceptions, showed no inhibition. However, the 1.0 milliliter samples were still markedly inhibitory. The addition of sterile sheep serum in a concentration of 1 per cent to the tryptose-extract agar completely obliterated the bacteriostatic effect of the traces of G-11 carried over from the skin. Table I. In explanation of this effect it was found that the bacteriostatic potency of G-11 was depressed about 100 fold by the addition of 1 per cent serum to the agar or broth used for testing.

The method of testing for bacteriostasis given in which relatively large numbers of organisms are applied to a small agar surface is not as sensitive as are poured plate tests in which isolated organisms are exposed to the material. Therefore, poured plates containing known numbers of normal skin bacteria in the presence of measured amounts of wash water were prepared in order to approach more closely the conditions under which the skin counts are obtained. The results are given in

able II the inhibitory effect of 10 milliliter wash water (Specimen A in Table I) was again demonstrated in all media except those containing 1 per cent serum. The substitution of Witte peptone for tryptose resulted in a slight improvement. It is difficult to reconcile these findings with those of Traub who disclaims any such effect. He does not state the interval between the last application of G-11 and the collection of the sample in his studies; this interval would presumably be variable. It is possible that his infusion medium happened to contain more inhibitory substances than did ours. As a result of these observations all counts referred to hereafter were made in tryptose-extract agar containing 1 per cent serum unless otherwise specified.

**Surgical wash with G-11.** A liquid soap containing G-11 was used since a more uniform application is possible in contrast to a bar soap with which an undeterminable amount is applied to the skin. A 1 per cent preparation was finally adopted made as follows: 10 grams of the monopotassium or monosodium salt of G-11 were dissolved in 30 milliliters of hot 95 per cent ethyl alcohol. The alcoholic solution was added with thorough mixing to 1 liter of soap solution prepared by dissolving 200 grams of clear potash soap in 800 milliliters of hot distilled water. Both solutions were cooled before mixing. The final product contained 5 per cent alcohol and all control soaps were also made up to 5 per cent alcohol for comparison. The standard wash procedure was as follows:

1. The hands and arms were wet in tap water and a large palmful of G-11 soap solution applied to each hand and arm. Persons with small hands used 2 palmfuls. Over a period of 1 minute the soap was lathered into the hands and arms.

2. This was allowed to remain for 2 more minutes during which waiting period the nails were cleaned.

3. After a tap water rinse, 1 and 2 were repeated with the omission of the nail cleaning. Thus the skin was in contact with the solution over a 6 minute period.

4. After another tap water rinse the hands and arms were immersed for approximately

TABLE II—INHIBITORY EFFECT OF WASHINGS FROM G-11 TREATED SKIN ON NORMAL SKIN ORGANISMS POURED PLATE METHOD

	Test strains							
			3	4			3	4
Medium								
Tryptose-extract agar + ml wash water A. No serum.							80	
Infusion agar + ml wash water A. No serum.	40	37	0.4	4.3		48	8	4
Witte peptone-extract agar + ml wash water A. No serum.	65	3	60	7		6	65	57
Tryptose-extract agar + ml wash water D. No serum.	504	36	304	328	456	30	70	208
Tryptose-extract agar + 5% serum + ml wash water A.	534	3	54	55	474	3	80	4
Tryptose-extract agar + 1% serum N wash water.	458	260	206	564	450	23	80	276

Plates represented in each vertical row received the same number of organisms. As is evident in the last horizontal (control) row the numbers of organisms in the inoculum varied from one strain to another.

Wash water A from subject A (Table I) washed with G-11 45 minutes before sample was taken. Culture on 1 ml. of ash at alone + 1% serum gave 1 colony.

Wash water D from individual treated with control soap without G-11. Remainder of treatment as the same, including the alkaline rinse. These washings were autoclaved before use. Culture as sterile.

5 seconds each in an aqueous solution of zephiran chloride 1:1000 and dried on a sterile towel. The disinfectant rinse contributes nothing to the effect beyond destroying hypothetical organisms in the tap water left on the hands. If a fresh sterile water rinse is available for each individual the zephiran rinse may be omitted.

In testing the effectiveness of this procedure under various conditions the test subjects after washing powdered their hands with sterile talc and wore dry sterile gloves for 45 minutes before determining the skin population. Questions relating to practical operating room routine were investigated. Direct comparison with a conventional 10 minute surgical scrub with a brush followed by an alcoholic zephiran chloride 1:500 rinse was carried out. The effectiveness of the first G-11 application was tested. The not uncommon practice of changing gloves between operations with only a limited skin cleansing was also considered in relation to the use of G-11. The effect of its interrupted or nondaily use was examined and its effectiveness in alcohol rather than in soap solution was tested.

Five subjects, 3 men and 2 women, were tested through 3 consecutive mornings of



TABLE III.—COMPARISON OF SURGICAL SCRUB AND G-11 WASH

Day and procedure	Subject	First 5 minutes	Second 45 minutes	Third 45 minutes
First day 10 minute scrub with Ivory soap, 1:1000 a/c zephiran rinse. Same rinse preceding each glove change.	A	8	60	35
	B	720	800	5
	C	320	870	220
	D	73	46	5
	E	06	27	
	Average	280	380	544
Second day 6 minute standard G-11 wash 1:1000 aqueous zephiran rinse. Same rinse preceding each glove change.	A	45		90
	B	63	63	20
	C		54	270
	D	35	24	44
	E	4	66	65
	Average	70	26	146
Third day Same as second day	A		90	90
	B	28		83
	C	6		3
	D		4	5
	E		less than 1*	20
	Average	8	40	36

\*Less than (less than 2000 per liter) indicates that the plate containing all of wash water was sterile.  
Each skin count obtained after 45 minutes in fresh sterile gloves.  
Multiply figures by 1000 to obtain counts per liter of wash water.

simulated operating room conditions. None had been in contact with G-11 previous to the experiment. The results appear in Table III. On the first day they scrubbed for 10 minutes with Ivory soap cleaning the nails during the scrub. They then rinsed in tap water and in a 1:500 zephiran chloride solution in 70 per cent alcohol. The hands were dried on a sterile towel, and dry sterile gloves worn for 45 minutes during which the usual laboratory work was performed. The skin organisms were then estimated the residual Ivory soap resulting from this determination rinsed off in tap water the alcoholic zephiran rinse repeated the hands dried on a sterile towel and gloves again worn for 45 minutes. This was repeated giving a total of three 45 minute periods in gloves. On the second day the standard G-11 wash was introduced no brush was used. Again 3 glove changes at 45 minute intervals were made and the aqueous 1:1000 zephiran rinse was used throughout. This procedure was repeated on the third day. It will be noted that only two 6 minute applica-

TABLE IV.—SKIN COUNTS AFTER 5 SECONDS DAILY G-11 APPLICATIONS

Subject	Count
F	2
G	less than 1
H	1
I	5
J	3
Average	2.4

Three glove changes on fifth day with brief G-11 preceding each. Counts after third 45 minute period in gloves.

Multiply figures by 1000 to obtain counts per liter of wash water.

tions of G-11 soap were made the material was not used at any other time.

Several points of practical interest are seen in Table III. The rise in the skin population following a surgical scrub with glove changes is apparent, and is in agreement with the findings of Price. Moreover the first application of G-11 without previous contact results in counts lower than those obtained with a surgical scrub. An individual could be introduced into a surgical group after only one 6 minute contact with G-11 although an additional contact on the preceding day would be preferable. The progressively increasing effectiveness of the agent is seen in Table III from the counts obtained on the second day of its use.

The data presented in Table III do not represent the maximum effect obtainable probably because the 3 skin counts performed on each person each day with the attendant prolonged Ivory soap lathering extended G-11 from the skin. It has been found that alcohol rinses have the same effect and are to be avoided. To demonstrate a greater effect of the material which would obtain under normal conditions of use 5 other persons, 3 men and 2 women were given the standard G-11 wash daily for 4 days. No skin testing was done nor was any other G-11 used. On the fifth day they changed gloves at 45 minute intervals as before but, instead of being tested between each change they washed their hands briefly (15 seconds) with G-11 soap, rinsed with tap water and with aqueous zephiran. The counts appearing in Table IV were obtained at the end of the third 45 minute period and were consistently low throughout. These superior results are attributable to the

TABLE V—EFFECT OF A 2 DAY LAPSE OF G-11 APPLICATION

Subject	Count
A	9
B	38
C	1
Average	12.7

Multiply figures by 1000 to obtain counts per liter of ash water

maintenance of a higher level of the agent in the skin and show that a brief wash with G-11 between glove changes will prevent the rise in bacterial numbers which occurs with ordinary procedures.

**Effect of interruption of daily G-11 applications.** Three persons after going through the standard G-11 wash for 5 days were not treated or 2 days. On the third day thereafter they again carried out a standard wash wore gloves or 45 minutes and were tested. The results appear in Table V and indicate that there is persistence of the effect over this interval. It seems unnecessary to subject the surgical team to daily contact with the agent in order to maintain the effect unless a lapse of more than 2 days takes place.

**Effectiveness of G 11 in alcoholic solution.** It was found that 33 per cent ethyl alcohol by volume was required to hold 1 per cent of the monopotassium salt of G-11 in solution at room temperature. The effectiveness of this 1 per cent G-11 in dilute alcohol in contrast to a solution of the material in 20 per cent soap was tested as follows: 5 subjects who had not been in contact with G-11 for over a month washed their hands briefly (about 15 seconds) in Ivory soap and cleaned their nails. They then rinsed in tap water and dried on a non-sterile clean towel. After immersing each hand for about 5 seconds in the alcoholic G-11 solution they allowed this to remain for 2 minutes after which they repeated the 5 second G-11 immersion again allowing it to remain on the hands for 2 minutes. This time interval was employed since the skin dried almost completely in 2 minutes after the first immersion. Following a tap water rinse the hands were immersed for about 5 seconds each in aqueous zephiran chloride 1:1000 and dried on a sterile towel. Gloves were worn for 45 minutes followed by the usual estimation of skin organ-

TABLE VI.—EFFECT OF ALCOHOLIC SOLUTION OF G-11

Second day of treatment with G-11 in 33% alcohol without soap. Counts made after 45 minutes in gloves.		Control counts of individuals using same procedure but omitting G-11 from the alcohol. Second day of treatment. Counts made after 45 minutes in gloves.	
Subject	Count	Subject	Count
A	9	F	135
B	2	G	4400
C	1	H	920
D	3		
E	1		
Average	3.2	Average	1818

Multiply figures by 1000 to obtain counts per liter of wash water

isms. The results obtained on the second day of this treatment including 3 control persons treated in the same manner except for the substitution of 33 per cent alcohol without G-11 are shown in Table VI. It may be seen that the alcoholic G 11 is as effective as a soap solution of the agent, however the possibility was pursued no further because of the marked preference of the subjects for the soap solution which proved to be considerably less irritating. It appears that more G-11 is released into the test basin in this procedure than was found in the studies on soap solutions. Five per cent serum was required to eliminate the bacteriostatic effect of these washings in contrast to the 1 per cent serum needed for the soap solution of G-11.

#### DISCUSSION

The compound G-11 incorporated in soap appears to be a valuable agent in the cleansing of skin. The available evidence suggests that it is taken up by skin and retained for considerable intervals exerting a constant bacteriostatic (if not bactericidal) effect on the resident flora. It is equally effective in dilute alcohol solution but this has been found to be more irritating than the soap preparations. Under certain conditions bacteriostatic amounts of G-11 are extracted from the skin and carried over into the medium in the process of enumerating the skin bacteria a fact which must be recognized as a source of error in evaluating effectiveness. With proper attention to details of concentration and length of exposure of the skin to this agent, the use of both the scrubbing brush and the somewhat irritating alco-

hol rinses may be eliminated from preparation of the surgeon's hands and arms. Its exclusive use whenever soap is employed is unnecessary for persons going through a single surgical wash as outlined above on each of 5 days a week. Lapses of longer than 2 days reduce the effectiveness of the material. No irritation or sensitivity has been encountered in our studies on G-11 with the exception of one scrub nurse who developed a measles-like eruption about 6 hours after her first application. This disappeared on subsequent applications. It would not be surprising if occasional instances of true sensitization were to appear.

Another obvious use of G-11 is in the preparation of the patient's skin in elective surgery in which a few days are available to attain the full effect. It should be pointed out that G-11 is not a substitute for more potent materials such as iodine which though limited to the superficial skin organisms exert a prompt action. For example the contamination of the skin by pus would have to be dealt with in the usual way. One might anticipate that G-11 would be ineffective in open wounds in view of the inhibitory effect of serum.

#### SUMMARY

The incorporation of G-11 (2,2-dihydroxy-3,5,6-trichloro-4,4'-diphenyl methane) in

soap used for the preparation of the surgeon's skin reduces the numbers of skin organisms considerably below those found after conventional scrub procedures. Broadly speaking, bacterial counts of the washings of untreated hands range in the millions of organisms per liter. Conventional surgical scrubs followed by germicidal rinses reduce the number about tenfold and the G-11 wash accomplishes a reduction of about a thousandfold from normal skin counts. In addition the time consumed is shorter and the scrubbing brush and strong germicidal rinses are unnecessary.

Individuals receiving the 6 minute application described, once each day 5 days per week, would require no further daily contact with G-11 to maintain its effect. When changing gloves between operations, a brief wash with G-11 soap is sufficient to keep the skin counts at a low level. Prolonged lathering with plain soaps, and the use of alcohol rinses decrease the effect, presumably by extracting G-11 from the skin.

#### REFERENCES

1. POHLE, W. D. and STUART, L. S. *J. Infect. Dis.*, 1934, 67: 275.
2. PRICE, F. B. *J. Infect. Dis.*, 93: 63-90. *J. Am. M. Ass.*, 1933, 11: 1903.
3. TRAUB, E. F., NEWHALL, C. A., and FULLER, R. J. *Surg. Gyn. Obst.*, 1944, 79: 805.
4. *Idem.* *Arch. Derm. Syph.*, 94: 51-55.

# PLASMA FRACTIONS—"FIBRIN FOAM," THROMBIN, AND "FRACTION NO 1"—IN GENERAL SURGERY

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**A**n active preparation of beef thrombin was announced by Mellanby in 1933. Seegers and McGinty later reported a preparation of greater activity. Parfentjev's monograph on the fractionation of rabbit plasma provided the basis for the study of the globulin-containing fraction with thrombic activity (18). Several clinical applications of animal thrombin were reported by Tidrick. Additional reports on its use in cases with prolonged bleeding time (hemophilia, symptomatic thrombocytopenic purpura, hypoprothrombinemia, and hereditary thrombasthenia) were made by Lozner and his associates. The antigenicity of thrombin was studied by Light (11) who also with others (12-16) reported the use of thrombin applied on special gelatine sponges instead of fibrin foam.

Cohn and his co-workers in fractionating pooled human plasma produced fraction No 1 thrombin and fibrin foam.

Foam is a sponge-like brittle solid which soaked in thrombin becomes gelatinous and applied topically produces rapid clotting. For more detail of the physical and chemical properties the reader is referred to the original reports (3, 7, 8).

Bailey and Ingraham (2, 9) studied the hemostatic properties of the foam thrombin combination. In the experimental animal bleeding from wounds in the liver, peritoneal cavity, kidney and lungs was controlled. It was shown that the presence of foam did not impair the efficiency of the sulfa drugs or penicillin. Use of the foam thrombin combination in man first was reported by Ingraham (10) and later by Woodhall both of whom

The products of plasma fractionation employed in this work were developed from blood which was collected by the American Red Cross, by the Department of Physical Chemistry, Harvard Medical School, Boston, Massachusetts, under a contract from the Office of Scientific Research and Development and Harvard University.

used it in neurosurgical operations. Anderson and Kentros reported a successful application at dental extraction in the case of a hemophilic patient.

Cohn's fraction No 1 derived from plasma, consists of light amorphous particles which are approximately 80 per cent fibrinogen. Cronkite and others are credited with the first application of fibrinogen and thrombin as an adhesive for skin grafts. Dees reported their use at pyelolithotomy to form a coagulum in the pelvis which would trap stones.

We have used plasma fractions obtained through the courtesy of Drs. Franc D. Ingraham and John T. Edsall, 250 times in 210 patients. The fractions used were thrombin, fibrin foam and fraction No 1. The purpose of the study was the development of applications for these substances in general surgery.

## THROMBIN

Thrombin alone applied on a sponge, was used in 2 cases. The results were unsatisfactory.

## FRACTION NO 1 AND THROMBIN

Fraction No 1 and thrombin were used in 12 cases to remove gravel from a renal pelvis in 1 case with only partial success as an adhesive for the skin flaps in 9 mastectomies as an adhesive under split thickness graft in 1 case around a split thickness skin graft in 1 case making of an artificial vagina in 1 case. Results were good except in 3 cases in which more than the usual amount of serum accumulated lifting parts of the skin from the bed. In 1 of the latter cases infection developed with extensive loss of graft. The fluid accumulation may have been fortuitous, or it may have been from overproduction of secretion. We suspect, however, that it was from mechanical interference with drainage. Therefore we now are making it a practice to leave channels for

TABLE L.—HEMOSTASIS OF INCISIONS INTO SOLID ORGANS

	No. Cases
Thyroid (cut surface)	12
Cervix (biopsy conization, avulsion of polyp)	0
Uterine sinuses (cesarean section)	3
Uterine wall (myomectomy)	
Liver (laceration)	2
Kidney (nephrostomy)	2
Pancreas (resections)	3
Suprarenal gland (biopsy)	1
Breast (biopsy)	8
Total	43

drainage and inserting small rubber tissue drains.

#### FOAM AND THROMBIN

Fibrin foam soaked in thrombin was used 236 times in 196 patients for one or more of three purposes first, as a hemostatic second as a filler of cavities and third as a dressing.

*1 Use as a hemostatic* While the bleeding is controlled by pressure, a block of foam, cut to size by razor blade or scalpel, was soaked in fresh saline solution of thrombin. The resultant jelly like mass then was held against the bleeding area by gentle pressure with a sponge or preferably the finger itself. Sometimes it was advisable to remove by suction excess thrombin which might interfere with adherence of foam.

Usually clotting was instantaneous. To some degree clotting time depends upon the strength of the thrombin solution. Occasionally one portion of the bleeding area continued to bleed. We interpreted this as meaning that the amount of thrombin in the first application was insufficient or that the application to the bleeding area was uneven. Invariably bleeding was controlled by a second or third application. We found that the release of pressure should be gentle to avoid disturbing the clot. Before foam was used it often was advisable to control the oozing by simple pressure until manipulations in the immediate neighborhood were finished. Sometimes it was advantageous to prepare in advance a flap of peritoneum or other tissue to suture over the foam pad. Interestingly this work with foam increased our respect for simple pressure as a hemostatic. Oozing areas ordinarily were controlled by pressure while foam was being prepared.

Sometimes bleeding which we would not have expected to control without suture had stopped by the time foam was ready. However when foam was used in addition we felt more secure against recurrence. Because of the possibility of generalized intravascular thrombosis, never under any circumstances should thrombin be injected intravenously. To prevent accidental aspiration into open veins on a bleeding surface one should apply pressure enough to close the veins from the instant when the pad is applied until clotting is complete.

The most commonly useful application was at thyroidectomy. Only the larger sporting vessels were clamped with 8 to 12 instead of 20 to 40 clamps per lobe. These clamps were tied. No second round of clamps was applied. The gland remnant was not sutured. Sheets of foam on the cut surface completed the hemostasis. The advantage is not just reduction of sutures and clamps. It is avoidance of trauma to the thyroid remnant. One may intend to leave a fifth or sixth of the gland. But if the sixth is full of compressing ties and sutures it may be physiologically a tenth. Also, the usual final suture of the gland remnant endangers the recurrent nerve behind the gland and necessity for this suture is eliminated by the use of foam.

Pancreatectomy demonstrated another useful application. In 1 case a considerable amount of pancreatic parenchyma at the junction of body and head was resected. Both pancreatic ducts were cut. One was ligated the other anastomosed after resection of 3 centimeters. Foam was packed into the cavity and around the anastomosis. The cut surfaces were sutured together and the suture line covered by a foam dressing. The patient died on the 9th postoperative day from pancreatitis and bronchopneumonia. Postmortem examination showed leakage at the anastomosis but no bleeding. A cardiac patient whose pancreatic resection had necessitated anastomosis of the duct died from cardiac decompensation on the 5th postoperative day. Postmortem examination showed no infection or pancreatitis. The anastomosis was tight and there was no evidence of hemorrhage.

Foam not only has controlled bleeding from incisions into pancreas, liver and kidney but

TABLE II — HEMOSTASIS ON SOFT SURFACES  
OR IN AREOLAR SPACES

	No. Cases
Skin and subcutaneous tissues	
Base of bladder or broad ligament	17
Vaginal operations for prolapse	
Abdominal hysterectomy	14
Cervical bladder	10
Pedicle	
Iliad	5
Stomach, intestine, mesentery	15
Resections, incisions, abscess walls	
Kidney pedicle	10
Peritoneum (lymphaticectomy)	1
Deep tissues of neck	8
Axilla (inguinal region (gland dissection)	5
Vulva (vulvectomy)	5
Venae (stripping)	2
Hemorrhoids (hemorrhoidectomy)	5
Total	8
	117

blood pressure had returned to normal new applications of foam held. Two arteries of 4 millimeters could not be controlled by foam until the blood pressure had fallen to dangerous levels.

We do not propose the use of foam for open incisions in major vessels. In arteries there is the risk of delayed hemorrhage from a high head of pressure acting over a broad area. In veins there is the risk of undrawn thrombin. However suddenly faced with a laceration of the vena cava one of our colleagues held a pad of foam on the opening by suturing peritoneum over it. The patient ultimately came to post mortem examination which showed neither hemorrhage at the site of operation nor distant thrombosis.

It is reiterated that foam is not recommended for the large vessel whether artery or vein.

*Use as a filler of cavities.* In 31 cases foam thrombin was used as a hemostatic filler which later was replaced spontaneously by reparative tissues. Usually only a small amount was needed. However we have used up to approximately 25 cubic centimeters without bad

TABLE III — FOAM THROMBIN AS FILLER OF  
CAVITIES

	No. Cases
Coccygectomy	2
Excision Bartholin's cyst	7
Excision wen	15
Excision pilonidal sinus	2
Excision ganglion	4
Excision lipoma	1
Total	31

by replacing deep sutures it has avoided the bleeding which such sutures themselves cause and the danger to ducts which they involve. At every application in this group the foam was completely successful in hemostasis usually at the first application but sometimes only at the second or rarely the third.

Foam thrombin purposely was used 17 times in the skin or in the immediately subcutaneous tissues to allow naked eye observation of healing. The group included 10 applications at hemiorrhaphy. No gross difference was observed in those parts of the wounds where the foam was implanted.

Throughout this group of applications foam invariably succeeded in controlling bleeding. Foam thrombin was particularly beneficial when applied to tissues distorted by pathology which lay near vulnerable structures such as the hepatic duct the ureter the hypoglossal spinal accessory or phrenic nerves. Here foam substituted for blind clamping and deep suture. Commonest application in this group was to the subvesical veins at hysterectomy and in vaginal operations. The areolar tissue of the neck, erectile tissue of the labia, retroperitoneal spaces, mesentery and intestine proved practical sites for application. Several times foam was used for minor oozing around the cystic artery stump which otherwise would have been left uncontrolled for fear of injuring hepatic ducts by clamping. Profuse bleeding from one severed aberrant cystic artery or major branch thereof was stopped immediately by foam. Following proctoscopic resection of a polypoid polyp was controlled by foam held in place by suture.

We did not use foam for control of direct hemorrhage from large vessels in the human. The largest artery that we tried to control and it was controlled immediately and satisfactorily was the rather small cystic artery resected in a patient with normal blood pressure. However in 8 operations upon dogs major arteries up to 4 millimeters in diameter were opened or transected. At normal blood pressure arteries of 2 millimeters and some as large as 3 millimeters were controlled by foam and digital pressure. Some clots blew off when hypertension was induced. After the

effect. In our experience the most satisfactory application of foam after thyroidectomy was in the removal of a Bartholin's cyst. Often in the past the small artery at the upper end of the cyst escaped our clamps retreated into the spongy perivaginal tissues, and bled. Wounds of operations for pilonidal sinus, wen and ganglion that is, cavities which could be watched from the surface healed well with foam fillings. In addition to the cases listed in Table III considerable amounts of foam were used in deeper cavities in other cases listed in Tables I and II (e.g. presacral neurectomy breast biopsy, some of the gastrointestinal resections) with the secondary purpose of space-filling. None of these cases showed complications attributable to foam.

3 *Use as a dressing.* Following an accidental observation that better epithelium seemed to grow more quickly under foam foam thrombin dressings were applied to 2 skin defects and 2 small mucosal defects (epulis, rectal polyp) and the results were satisfactory in each.

After preliminary trial in the dog foam also was used 5 times as an internal dressing wrapped around an intestinal anastomosis and as mentioned previously foam dressing has been used around pancreatic duct anastomosis. It was used once over an incision into the renal pelvis with inconclusive result. There seems to be some indication for its use in anastomosis but our experience has been too limited to be conclusive. In cases of femoral embolectomy foam worked well as an outer coat around the artery. However because of the normal risk of thrombosis in arteriorrhaphy our judgment in applying foam in these instances was questionable.

Foam proved an excellent dressing after anal operations. The anoscope could be reinserted after operation without fear of hemorrhage when it was followed by a foam thrombin plug in the anal canal. Foam from containers which had been opened for other operations was used for anal cases.

#### COMPLICATIONS

The absolute contraindication to the injection of thrombin intravenously and the danger of accidental aspiration into an opened vein

on a surface or in a cavity which we have tried to prevent by preliminary digital pressure, have been mentioned. Two of our 210 patients had femoral thrombosis. This incidence is high but the group is too small to form definite conclusions. It should be recorded also, that the group was picked from a larger series and contained most of those individuals of the total who were likely candidates for thrombosis. The increased accumulation of fluid under skin flaps or grafts when fraction No. 1 and thrombin were used was produced more by interference with drainage we believed, than by increased secretion. The consequent advisability of leaving drainage channels has been mentioned.

No other complications were met. Foam was used freely in conjunction with topical sulfathiazole or penicillin. Foam was used in infected cavities when they were near enough to the surface so that they could be watched, no complications were noted in these cases.

#### SUMMARY AND CONCLUSIONS

A few experiences with fraction No. 1 and thrombin are recorded. In 236 applications, foam thrombin proved an efficient hemostatic agent for incisions into solid organs and at sites such as soft surfaces or areolar spaces where ordinary methods of hemostasis are difficult of application or unsatisfactory in result. It may substitute for blind clamping and deep suture with their consequent danger to adjacent vulnerable structures such as a hepatic duct, ureter or nerve. It should not be used for large arteries or veins. Complications and dangers are discussed.

These blood fractions like their parent fraction plasma, are neither an excuse for sloppiness in technique nor a substitute for judgment. But, like plasma, they promise to extend a little the present boundaries of technical operability.

#### REFERENCES

- ANDERSON, B. G., and KENTROG, G. A. *Am. J. Orthodont. Oral Surg.* 945, 3: 697-699.
- BAILEY, O. T., ISORAHAM, F. D., SWENSON, O. LOWREY, J. J., and BERINO, E. A. *Jr. Surg.* 1945, 8: 347-369.
- BERINO, E. A. *Jr. J. Clin. Invest.* 944, 23: 185-190.
- CORDE, E. J., OXLEY, J. L., STENO, L. E., HICKS, W. L. Jr., and ARMSTRONG, S. H. *Jr. J. Clin. Invest.* 944, 3: 417-432.

5. CROWKITT, I. I. LOZNER, E. L., and DRAVIE, J. M.  
J Am M. Ass., 1944 124 976-978.
6. DEES, J. E. J Clin. Invest. 1944, 23 576-579.
7. FERRY, J. D. and MORRISON, P. R. J Clin Invest.,  
1944, 23 566-572.
8. EDSALL, J. F. FERRY, R. M. and ARMSTRONG, S. H.  
Jr. J Clin Invest 1944 23 557-565.
9. INGRAM, F. D. and BAILEY, O. T. J Am M Ass  
1944 126 680-685.
10. INGRAM, F. D. BAILEY, O. T., and NULSEN, I. L.  
J Neurosurg 1944 1 171-181.
11. LIGHT, R. U. J Neurosurg 1945 2 516-523.
12. LIGHT, R. U. and PRENTICE, R. J Neurosurg. 1945  
2 435-445.
13. LOZNER, E. L. MACDONALD, H. FINLAND, M. and  
TAYLOR, F. H. L. Am J M Sc., 1941 202 593-598.
14. MILLANBY, J. Proc R. Soc. M Lond., S B., 1933  
113 93-106.
15. PARFENTJEV, I. A. Am. J. M. Sc. 1941 202 578-584.
16. PILCHER, C. and MEACHAM, W. F. Surg Gyn Obst  
1945, 81 365-369.
17. SIEGERS, W. H. and MCGINTY, DANIEL A. J Biol  
Chem 1942 146 511-518.
18. TAYLOR, F. H. L. LOZNER, E. L., and ADAMS, M. A.  
Am J M Sc., 1941 202 585-593.
19. TIDRICK, R. T. SIEGERS, W. H. and WARNER, E. D.  
Surgery 1943, 14 191-196.
20. WOODHALL, B. J Am M Ass 1944 126 469-471.



# CLINICAL OBSERVATIONS ON FURACIN SOLUBLE DRESSING IN THE TREATMENT OF SURFACE INFECTIONS

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**F**OLLOWING the report by Snyder Kiehn and Christopherson that 5 nitro-2 furaldehyde semicarbazone (furacin) 0.2 per cent in a water soluble base (furacin soluble dressing) was effective in the treatment of infected battle wounds, a study of this preparation on a series of infected surface lesions encountered in the patients in a civilian hospital was begun. The material presented here is the clinical and bacteriological results obtained during the local treatment of 90 cases of superficial infections.

## FURACIN

Furacin is a yellow crystalline material having the structural formula  $O_2N-\text{C}_4\text{H}_2-\text{CH}=\text{NNHCONH}_2$ . It has been shown by Dodd and Stillman (2, 4) to be both bacteriostatic and bactericidal for a variety of gram-positive and gram-negative pathogenic bacteria, and Cramer and Dodd (1) have demonstrated that the activity is maintained in the presence of body fluids. In addition oral administration of the compound has been found (2) to produce a therapeutic effect on experimental infections in mice with both gram-positive and gram-negative bacterial species. Tests (3) in both rabbits and humans have shown the material to be nonirritating upon local application and no toxic symptoms have been observed in animals on which large amounts have been applied for long periods of time. Meloney and Johnson (7) have recently stated that this compound is active against gram-negative bacteria and satisfies the requirements for use in the local treatment of infection.

The compound is fairly insoluble in water (1:4100). However it was used as a 0.2 per cent solution in a mixture of carbowaxes

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and propylene glycol in which it is soluble up to a concentration of 1.0 per cent. This base is water soluble, nonirritating and nontoxic, liquefies at body temperature and can be removed easily without scrubbing by washing with water. Many investigators (5, 8, 9) have reported on the safety of the ingredients. Recently Meloney and Johnson (7) have noted the advantages of this type of base for local use on the skin.

## PROCEDURE AND METHOD OF EVALUATION

In all cases the preparation was applied to the area to be treated so as completely to cover the area. On superficial infections furacin soluble dressing was spread on gauze handkerchiefs, and laid over the wounds and held in place with gauze bandage. Deep wounds and cavities were filled with the ointment, and a dry dressing used to cover the area. Sinus tracts were irrigated with the melted ointment. Many patients were treated by covering the area with furacin soluble dressing without bandaging.

Cultures were taken by swabbing the worst appearing area of the wound following the removal of the ointment, every other day or at the time the dressings were changed if they were left in place for longer periods. Ninety-seven of the strains isolated were tested *in vitro* for susceptibility to the drug.

It was realized that the evaluation of a new agent of this type is a very difficult task. As a result an attempt was made to control as many of the extraneous factors as possible, such as bed rest, systemic therapy and surgical intervention.

Also the same criteria for evaluation were used wherever possible throughout the study and classification of results was done according to the method proposed by Meloney (6) for the evaluation of the effect of materials

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following local application He advises the division of results into four groups (a) brilliant, (b) good, (c) questionable and (d) with no effect. In order to prove any definite benefit from a material Meleney (6) believes that without controls the results must fall into the brilliant or good classes in most cases.

## CLINICAL RESULTS

Following the classification given it was found that of the 90 cases reported 26 fall into the brilliant group 44 into the good group 13 into the questionable group and 7 into the group showing no effect. Thus, 77 per cent of the cases fall into the first two groups which would definitely qualify the treatment as valuable by this classification. It must be realized that many of the lesions treated consisted of a superficial infection superimposed on a previously existing skin lesion such as lupus vulgaris herpes zoster or erythema multiforme. No effect was noted on the original condition in these cases but the superficial infection responded well and rapidly to the application of furacin soluble dressing. The number and types of lesions treated and the results are summarized in Table I.

In the treatment of diabetic gangrene it has been realized that any local application including furacin soluble dressing has no effect on the infection and on the gangrenous process unless early adequate surgical intervention is carried out. Unless adequate drainage is instituted early furacin soluble dressing will not prevent a lymphatic or tendon sheath spread of the infection upward. In the 8 cases of diabetic gangrene reported 6 cases showed good results. In each of these 6 cases, early adequate surgery was instituted. In 2 cases surgery was not carried out, but it was found that where furacin dressing came in contact with the infected areas that were draining there was a marked improvement. There was a marked decrease in the odor from all 8 patients treated with furacin soluble dressing.

Two patients with compound fractures were treated with furacin soluble dressing. This ointment stops any spread of infection and prevents to a great extent the slough and the drainage seen following a large compound of a fracture.

TABLE I — LESIONS TREATED WITH FURACIN

Diagnosis	No. cases	Brilliant	Good results	Questionable	No effect
Diabetic gangrene	8		6		
Compound fracture	2	1	0		
Chronic osteomyelitis	3			1	
Loss of skin—burns and vulnion	8	3	3		0
Various skin lesions with secondary infection	28	14	1		
Wounds	6	1	3	1	1
Ulcers	1		1		
Epidermophytosis	5		1	3	
Acne vulgaris	6	3		0	
Total	90	26	44	13	7

Three patients with chronic hematogenous osteomyelitis have been treated by irrigation of sinuses with the melted ointment and by local application. The results here have been very disappointing. In 1 patient there was some reduction in the amount of drainage and some tendency to heal, but these results were entirely questionable.

Under the heading of loss of skin we have classified the patients who have been burned and patients who have had avulsion of large areas of skin. In each case there has been a marked reduction in the number of organisms present on culture. There has been a very marked reduction in the discharge from the wound and all wounds have healed and granulated well. In 6 cases in which skin grafting has been carried out either by the split thickness or punch technique the majority of the grafts have taken. In none of these cases was an attempt made to clean the recipient area of the furacin soluble dressing before the grafts were applied.

In 28 cases of infected lesions of the skin such as lupus vulgaris, erythema multiforme, chronic eczema and herpes zoster the results could be classified as brilliant in 14 and as good in 12. In every case the infection was superficial, and the ointment could reach the invading organism. Two cases of tuberculosis cutis and 1 of lymphogranuloma inguinale, showed only questionable results.

The treatment of deep-seated abscesses such as deep abscess of the buttock and ab-

cesses of the thighs following infusions, the ointment has been of no avail unless early adequate surgery and drainage have been carried out. If drainage is adequate and the abscess cavity is packed with furacin soluble dressing the walls appear healthy in 48 to 72 hours, and healing time is shortened by several days. At the same time, the odor and discharge from these wounds are markedly reduced.

Many infected wounds have been seen at this hospital either following an operative procedure or following trauma and it has been found that if these wounds are adequately drained surgically and the ointment is applied there will be a marked reduction in the number of invading organisms a reduction in the amount of drainage and a great diminution in the odor from the infected area. One patient developed a fulminating wound infection in a right paramedian incision which followed an emergency small bowel resection. Twenty three days after the development of this wound infection but while the wound was still open the patient developed an obstruction. A left paramedian incision was made with no attempt being made to wall off the original infected wound. The second incision did not become infected, both wounds having been covered with furacin soluble dressing.

Fifteen ulcers of the leg due to vascular disturbances have been treated with furacin soluble dressing. In each case the superficial infection has been controlled very well and very rapidly. No change has been noted in the primary lesion except those changes that would be compatible with an improvement in the infection. These ulcers granulate well and there seems to be no retardation of epithelization. Several of these ulcers have been skin grafted over furacin soluble dressing with an excellent take of the grafts.

Six cases of acute athlete's foot have been treated with furacin soluble dressing. There is almost an immediate response of the secondary infection superimposed on the epidermophytosis, and the patients noticed much relief in 12 hours. In 3 cases the patients have noticed a rapid healing of the original epidermophytosis, and in 2 cases of chronic epidermophytosis not listed in Table I there

has been some improvement in the athlete's foot. This is probably due to the 25 per cent propylene glycol in the ointment base which is somewhat fungicidal.

Four cases of acne vulgaris of the face have been treated with furacin soluble dressing. It has been found that the number of comedones and the number of acute pustules has been diminished greatly by the use of furacin soluble dressing once a day at bedtime.

Several cases not listed in Table I have been treated with furacin soluble dressing in an attempt to prevent any expected infection. In 2 patients who had a Torek operation, the scrotal-thigh incision was covered with furacin soluble dressing in the operating room, and no slough or infection occurred. In 2 patients who had a Mikulicz colostomy through an inguinal incision the incision healed by early granulation even in the presence of fecal material.

In all cases, special attention was given to the effect of treatment on the base of the lesions and the effect on the discharge and odor. In these respects the following generalizations can be made:

The base of the lesions treated has shown no change in 14 of the 90 cases. In the majority of cases with secondary infection the infection disappears almost at once, leaving a clean base. Granulations in the base of ulcers appear early appear healthy and red, but do not tend to overgrow the skin edges. There is no retardation of the epithelization of these wounds by use of the dressing.

The discharge from a wound is lessened in the majority of cases 79 of our 90. The discharge decreases in amount within 24 to 48 hours after the original use of the ointment. This diminution prevents the maceration of the wound by a purulent discharge.

The odor of foul wounds is improved within 24 hours after the use of furacin soluble dressing. The reduction in the odor is closely allied with reduction in the number of invading organisms. Particularly is the reduction of odor noted in the treatment of foul draining stasis ulcers of the extremities.

*Irritation Comparison with other drugs*  
Fifteen of the patients treated with furacin soluble dressing had had local applications of

TABLE II.—CLINICAL SUSCEPTIBILITY OF STRAINS OF BACTERIA ISOLATED FROM LESIONS TO FURACIN SOLUBLE DRESSING MEASURED BY BACTERIOLOGICAL CULTURE RESULTS

Organism	Total N strains	Total reduced		Total negative		Total not reduced		Total—N data
		N	Per cent	No.	Per cent	No.	Per cent	
<i>Staphylococcus aureus</i>	20							
<i>Staphylococcus albus</i>	35	4	0.3					
<i>Staphylococcus hemolyticus</i>			87.5		80			
<i>Staphylococcus aureus</i>	3	3	0.0	14	58			
<i>Pseudomonas pyocyanea</i>	7	3	75	8	57	1	0.0	14
<i>Proteus vulgaris</i>		3	0.3		3			
<i>Escherichia coli</i>	3	0	0.0	3	0.3			
<i>Aerobacter aerogenes</i>	3		0.0	4	40	3	37.5	4
<i>Diphtheria</i>		3	75		0.0			
<i>Aerobacter fecalis</i>	23		0.3	1	7.5			
<i>Pseudomonas fluorescens</i>	4	4	100		0.0			
<i>Micrococcus luteus</i>	5	4	80	4	80	0	0.0	7
<i>Micrococcus flavus</i>			0.0	3	75			
Total	7	87	8	68	61	30	0	65

sulfathiazole ointment 5 or 10 per cent for 1 to 2 weeks prior to their coming to us. In these patients the sulfathiazole ointment either showed no effect on the lesion or caused some type of local irritation. In all cases after discontinuance of the sulfa ointment and the application of furacin soluble dressing there has been a marked improvement in the lesions.

Patch tests have been done on 30 patients by use of furacin soluble dressing sulfathiazole ointment 5 per cent and a tyrothricin ointment. In the 30 cases there has been no reaction to furacin soluble dressing. There have been 4 patients who have shown a red weeping macular to papular area under the lesion treated with sulfathiazole ointment. Nine patients of the 30 have shown a marked edema and bulla formation under the patch test for tyrothricin ointment. This high incidence of skin reaction to the ointment base used. In our usual experience the reactions to tyrothricin ointment are fewer in number. This lack of reaction of the tissues to furacin soluble dressing is borne out well in the treatment of the 90 patients. In this series only 2 patients developed any dermatitis at all. One patient developed a fine red papular

rash under the area treated after 44 days application of furacin soluble dressing. The other patient developed a similar rash after 8 days' application of furacin soluble dressing. In both cases the rash disappeared within 48 hours after discontinuance of the ointment. In this respect furacin soluble dressing appears to be superior to other ointments so far presented for local application.

# BACTERIOLOGY

**Culture findings.** The lesions of the patients treated with furacin soluble dressing in this study were carefully cultured before and during treatment. Swabs from the lesions pus or body fluid were cultured aerobically and anaerobically on appropriate media. These samples were plated in a uniform manner so that rough estimations of the numbers of colonies produced could be made and by this method reduction as well as disappearance of the wound flora could be determined within the limits of error of the method.

As shown in Table II column 1 172 strains comprising 13 species of organisms were isolated. The gram positive cocci and diphtheroids predominated appearing as 71 per cent of the total cultures. Among these were *Staphylococcus aureus* *Staphylococcus albus*

hemolytic streptococci and diphtheroids. The last named were not classified further as to species but grouped under the one general heading. Of the gram-negative flora encountered *Proteus vulgaris*, *Pseudomonas pyocyanea* and *Aerobacter aerogenes* were most frequent. Surprisingly only 3 strains of *Escherichia coli* were isolated. Except for this infrequent occurrence of *Escherichia coli* these findings are in good agreement with all reports on the pathogenic flora of civilian wounds and lesions.

*Clinical susceptibility as measured by culture reduction* In Table II are also given the actual numbers and the percentage of the cultures isolated which showed a reduction in the number of colonies produced from the clinical material. This is shown in column 2. Column 3 shows the numbers and percentages of cultures which were completely negative and column 4 the number of cultures showing no change during the period of time which the cultures were followed. The last column presents the number of cultures which were not followed beyond the original isolation and identification either because the patient did not return or subsequent examinations showed the lesion healed.

The criticisms inherent in the procedure used in determining merely the reduction of the flora of lesions is clearly recognized, i.e. the type of lesion, the method of obtaining the samples, the presence of drug carried over in the sample and the plating technique. However the data are presented in light of this criticism as an effort to present as careful and controlled a study as was possible under the conditions. Thus the findings in column 2 showing that 87 or 81 per cent of 107 cultures (total cultures minus those on which no data were available) are subject to the above criticisms as to their value in showing the effect of the drug treatment.

It is generally accepted however that negative cultures are of value in estimating the effect of treatment on the infecting agent. In this study column 3 shows that of the 107 strains followed 68 or 63 per cent became negative during treatment with furacin soluble dressing. An examination of the data showed that this action was accomplished in some

cultures in as little as 24 hours while others required as long as 30 days for reversal. For their correlation of these figures with the clinical improvement in the lesions is not possible because of the presence of several organisms in any one patient, all having variable susceptibility. Thus, in some cases, healing of the lesion progressed rapidly with the disappearance of one species originally present, although another might remain without any noticeable effect even after completion of treatment.

In column 4 are given the numbers and percentages of strains which showed no change in the quantity of colonies produced by succeeding clinical samples during the course of treatment and thus labeled resistant or nonsusceptible to furacin. It is only fair to point out, however that in some cases, the period of time on which such a conclusion is based is relatively short and may not represent a fair test of the drug. For example, many strains were exposed to the drug for only 3 to 4 days, at which time the lesions were improved clinically or had healed sufficiently to stop treatment, yet the organism remained. In addition many of these cultures were found to be susceptible to furacin when tested *in vitro*.

As a group the gram negative species showed a larger number of nonsusceptible strains than the gram-positive group with the exception of the diphtheroids. *Proteus* (45%), *Bacillus pyocyaneus* (37.5%), *Escherichia coli* (33.3%) and *Aerobacter aerogenes* (25%) were resistant in the order given. In the gram-positive group only the diphtheroids showed a similar resistance. The pyogenic cocci on the other hand, were on the whole most susceptible. Resistance in this group was as follows: Diphtheroids (37.5%), *Staphylococcus albus* (12.5%), *Staphylococcus hemolyticus* (7.1%), *Staphylococcus aureus* (6.6%), *Staphylococcus anhemolyticus* (0).

It is quite possible that the high percentage of resistance in the diphtheroid group may be due to lack of sufficient exposure to the drug because of a limited treatment period, and perhaps to the existence in this group of a particular species which is more resistant than others.

**Susceptibility *in vitro*** Ninety-seven strains of the cultures isolated in this study were examined *in vitro* for their susceptibility to furacin soluble dressing furacin (1-500) in carbowax and water and to the base alone (carbowaxes 1500 and 4000 and propylene glycol). In this way, the relative merits of furacin and the base ingredients as antibacterial agents could be evaluated.

The tests were done by a modification of the standard F. D. A. cup plate test the medium employed being the only variation from the standard procedure. Brain heart infusion agar (difco) was substituted because of its ability to produce better growth of streptococci and diphtheroids. All zones of inhibition measuring 1.0 millimeter or more were considered proof of antibacterial action.

The results are listed in Table III. It is pertinent to point out that the base itself minus furacin showed an antibacterial effect on only 4 strains out of 97 while furacin soluble dressing affected 93 of the total and furacin itself 89. The discrepancy in the latter two figures is due to a finding of 1.0 millimeter for furacin soluble dressing and zero for furacin with several strains.

Only two groups *Pseudomonas pyocyanea* and *Staphylococcus albus* showed strains resistant to furacin soluble dressing *in vitro* susceptibility being 83 and 89.4 per cent, respectively. With furacin in carbowax and water these two groups were 58.3 and 84.2 per cent susceptible respectively. *Pseudomonas fluorescens* group were 100 per cent susceptible to furacin soluble dressing but only 87.5 per cent susceptible to furacin. All other groups were 100 per cent susceptible.

The results obtained on the clinical and *in vitro* susceptibility of *Pseudomonas pyocyanea* are surprising in view of the previous reported facts (2, 4) that this organism is resistant *in vitro* to the maximum aqueous concentration of furacin possible (1-5000). Also Snyder Kiehn and Christopherson reported that this organism was not susceptible clinically or *in vitro*.

Several factors may explain these apparent discrepancies. Clinically *pyocyaneus* usually appeared in combination with one or more organisms. In many cases these latter were

TABLE III.—STRAIN SUSCEPTIBILITY *IN VITRO* TO FURACIN SOLUBLE DRESSING FURACIN AND BASE

Organism	No. strains isolated	Percent susceptible furacin soluble dressing	Zone (1.0 mm or more)	
			Furacin	Base alone
<i>Pseudomonas pyocyanea</i>	1	83	58.3	16.6
<i>Staphylococcus aureus</i>	4	100	100.0	
<i>Staphylococcus albus</i>	19	89.4	84.2	
<i>Diphtheroids</i>	7	100.0	100.0	0
<i>Staphylococcus hemolyticus</i>	8	100	100	0
<i>Proteus vulgaris</i>	8	100	100	12.5
<i>Pseudomonas fluorescens</i>	8	100	87.5	
<i>Aerobacter fecalis</i>	5	100	100	80
<i>Aerobacter aerogenes</i>	6	100	100	0
<i>Mikrococcus</i>	100	100		
<i>Staphylococcus epidermidis</i>	100	100		
<i>Friedlander's bacillus</i>	100	100		
Total	27	100		

susceptible and as they disappeared an apparent symbiosis with *pyocyaneus* was destroyed so that it perhaps disappeared because of the natural body processes and only secondarily as the result of the drug.

The *in vitro* susceptibility may be the result of the ten fold increase in concentration available in furacin soluble dressing over the tests run in aqueous solution. Also it was noted that the majority of zones of inhibition produced in the tests on *Pseudomonas pyocyanea* were about 1.0 millimeter in size the minimum required for a rating of susceptibility whereas all zones on *staphylococci* for example measured from 5 to 10 millimeters. It is therefore probable that the variation occurring in strain resistance in this species causes the appearance of some strains susceptible to 0.2 per cent of the drug. However *Pseudomonas pyocyanea* probably should not be listed as susceptible until more data are available.

#### CONCLUSION

The usefulness of furacin soluble dressing in the treatment of superficial infection has been fairly well established. It is known that the drug must reach the invading organism to cause any bacteriostatic or bactericidal effect.

Furacin soluble dressing does not remove the need for adequate surgery. The outstanding property of this ointment is the immediate reduction of the odor and drainage from a wound. There has been no evidence that the ointment retards or prevents epithelization or granulation of a wound. In fact the wounds appear healthy almost at once. The incidence of local skin reactions has been very low (2 in 90). The improvement in the appearance of a lesion has followed closely the decrease in the number of organisms plated out on culture.

It has been interesting to observe that the clinical improvement has paralleled the disappearance of one or more of the infecting organisms from the wound. The lesions have healed well when the symbiosis of the organisms has been broken up. The gram positive and gram negative species usually seen in surface infections showed a high degree of susceptibility to furacin clinically and *in vitro*.

#### SUMMARY

1. Ninety patients with local infections have been treated with a new ointment—furacin soluble dressing.
2. The ointment has been found useful in the treatment of superficial infections.
3. There has been a very low incidence of skin reactions to the drug (2 in 90).
4. The ointment must reach the organisms to obtain a bacteriostatic effect.

5. Clinically granulation tissue is not retarded in its growth.

6. Epithelization of the wound is not inhibited clinically.

7. The ointment will decrease rapidly the odor and drainage from a wound.

8. Furacin soluble dressing has shown less skin irritation or reaction than has sulfathiazole ointment or tyrothricin ointment to patch testing.

9. Culture results show a high degree of susceptibility to the drug of the gram-positive and the gram-negative flora which was encountered.

#### REFERENCES

1. CRAMER, D. L., and DODD, M. C. *J. Rect. Res.* 1946, 51: 293-303.
2. DODD, M. C. *J. Pharm. Exp. Ther.* In press.
3. DODD, M. C., HARTMAN, F. W. and WARD, W. C. *Surg. Gyn. Obst.*, 1946, 83: 73.
4. DODD, M. C., and STILLMAN, W. B. *J. Pharm. Exp. Ther.* 1944, 82: 12-18.
5. HANDEK, P. J., NEWMAN, H. W., VAN WICKLE, M., LEIDMAN, A. J. and KENNEDY, A. K. *J. Pharm. Exp. Ther.* 1939, 67: 1-126.
6. MELENEY, F. L. *J. Am. M. Ass.*, 1944, 24: 2811-1946.
7. MELENEY, F. L., JORDISON, B. A., FULAKI, E. J. and COLONNA, F. *J. Am. M. Ass.*, 1946, 130: 21-24.
8. SMYTH, H. F., JR., CARPENTER, C. P., SALAFER, C. B., SEATON, JAKE, and FISCHER, LOUISE. *J. Indust. Hyg.*, 1942, 24: 28-34.
9. SMYTH, H. F., JR., SEATON, JAKE, and FISCHER, LOUISE. *J. Indust. Hyg.*, 1941, 3: 359-364.
10. SNYDER, M. L., KEEFE, C. L., and CHRISTOPHERSON, J. W. *Mil. Surgeon*, 1945, 97: 380-384.

# EDITORIALS

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## SURGERY Gynecology and Obstetrics

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MARCH, 1947

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### PROGRESS IN THE SURGICAL TREATMENT OF CARCINOMA OF THE ESOPHAGUS

HERE is an interesting parallelism in the evolution of the surgical treatment of carcinoma occurring in various organs of the body. After centuries of hopeless inaccessibility each important anatomical region has at last been brought within the reach of the surgeon's art. At first the attempts to extirpate the dread disease in each organ have met with failure and disappointment because of the imperfection of technical methods and the fact that the problem has usually been given over to the surgeon at first with reluctance and suspicion. Establishment of the correct diagnosis has often been delayed and an attitude of hopelessness has been assumed by the physician.

Various attempts to extirpate a cancer-bearing segment of the esophagus were made in the early years of this century. Notable among these was the work of Torek who per-

formed the first successful esophagectomy in 1912. But although the concept of the procedure was clear its performance was hampered by a lag in the technical developments needed to make the procedure sufficiently safe to justify its use routinely in the treatment of the disease. The passage of years was required for the realization of this goal as a result of improvements in the administration of the anesthetic, the conduct of the operation and the general preparation and subsequent care of the patient. It has therefore fallen to a new generation of surgeons to accomplish what was foreseen by the pioneers.

Although a few satisfying results have followed the use of the Torek operation the time has come to abandon this procedure because it is notoriously inadequate as a method of palliation and inefficient as a method of cure. During the last few years it has become possible to perform an operation which more nearly approaches the ideal of removing the esophagus and enough of the regional lymph nodes to afford a reasonable prospect of effecting a cure and which at the same time provides excellent palliation by restoring the continuity of the alimentary canal. This procedure consists of a radical excision of a large segment of the esophagus often including a portion of the cardiac end of the stomach, and of the majority of the regional lymph nodes to which metastases first go. It is completed by performing an esophagogastric anastomosis within the thorax. If the growth happens to be a high one, the anastomosis can be made in the very apex of the chest.

The advantages of this operation are obvious. It has been used in a sufficiently large number of cases to know that the operative



mortality is low enough to make the procedure practicable and to prove without question that it provides the most acceptable degree of palliation. This is particularly clear because it is most unusual for a recurrence of the disease to develop at the anastomotic stoma, so that the patient continues to swallow without obstruction as long as he may live.

From the standpoint of end results, the procedure is yet too new to allow accurate conclusions. There are only a few patients who have been operated upon more than five years, and relatively few more than three years. An encouraging beginning has been made, however and when we consider the progress which has already been made in the treatment of carcinoma of other organs, the future prospects of patients with carcinoma of the esophagus are indeed hopeful.

RICHARD H. SWEET

## FRACTURES OF THE OS CALCIS

**F**EW fractures present so many and such difficult problems in their management as do fractures of the os calcis. The great variation in the severity of the injury the frequent involvement of the subtalar joint and the technicalities involved in the reduction of the fracture combine to make this a major treatment problem in the field of fracture surgery.

Experience with fractures of the os calcis has been enormously broadened by the recent war. Land mines (both antitank and anti personnel, but especially the former) and ship sinkings by mines and torpedoes, made fracture of the os calcis a frequent injury with features so distinctive as to create almost a new kind of fracture characteristic of this war. Such war fractures caused when the floors of

vehicles and the decks of ships were driven up with great force against the heel, were of great severity the os calcis shattered into many fragments which were grossly displaced. The injury was explosive in its effect upon the bone, and the fracture often was compound. Effective early treatment was handicapped by the exigencies of forward-area surgery by the problems of an open wound, by circulatory embarrassment from swelling and trauma, and by transportation problems which made it impossible to segregate them for special treatment. Many came to amputation. Feet which escaped amputation presented major problems in reconstructive surgery with little hope of restoration of the tarsus to normal shape and function. So severe were war fractures of the os calcis that they constitute a group almost by themselves, related only distantly to the fractures of the os calcis of civil life.

No fracture illustrates better than does fracture of the os calcis the truth of the axiom that, in fractures, early treatment determines irrevocably the result in terms of structure and function. There is a brief and early period in which the maximum can be accomplished by treatment. If this moment of opportunity is allowed to pass by adopting a policy of wait and see, what can be accomplished by later treatment will never be as satisfactory. In fractures of the os calcis this period is short, for the cancellous fragments of the bone quickly cement themselves together into a mass which resists molding.

For the occasional surgeon the initial injury may seem a deceptively simple problem. The external appearance of the foot is changed little more than can be accounted for by the soft tissue swelling and the roentgenograms may be imperfect or difficult to interpret. The loss of function which will result from the injury is learned only by painful experience.

This is a fracture problem in which the services of an experienced and expert fracture surgeon are needed, and these should be sought in the early stage of treatment.

Imperfect or poor results after fractures of the os calcis are frequent and the degree of functional disablement is greater than might be expected from the magnitude of the fracture. A stiff, painful foot is the common end result and is caused by involvement of the subtalar joint by the fracture. As is the case with other intra articular fractures, joint function is certain to be impaired and painful if the fractured articular surface is not meticulously restored to normal position. Even the attainment of such perfect reduction of the fracture does not provide perfect assurance of good joint function. Other factors may combine to limit the most important, but at the same time the least recognized is avascular necrosis of a bone fragment carrying articular cartilage which has been isolated from its surrounding contacts by fracture fissures. When this occurs in such a manner as to deprive the fragment of blood supply even the most perfect restoration of position will not ensure perfect joint function. During the period of avascular necrosis the articular cartilage dies in whole or in part and is never perfectly restored. There is a rough patch on the articulation which hampers the joint with every movement. Difficulties of treatment and imperfection of results have led certain surgeons deliberately to advocate that no active treatment be undertaken for fractures of the os calcis, merely fixation in plaster in the position of the injury. Union has occurred. It is argued that active treatment is simple and can be carried out by one and that the results are no more different than those obtained from more elaborate methods of treatment.

Such a policy of studied neglect is a confession of defeat. There is little to support its advocacy save its simplicity. Os calcis fractures like all other fractures will yield the best results when the fracture fragments are most perfectly reduced. This is especially true in intra articular fractures. Though this may be difficult to attain in fractures of the os calcis it is an ideal to be aimed at. The realization that it is difficult is the first step to devising effective measures of treatment. Boehler emphasized the value of traction to secure accurate reduction of the fragments. The use of traction can be broadened far beyond Boehler's concept with advantage. All other mechanical aids should also be used.

Because of the frequent involvement of the subtalar joint, it should be recognized that stiffness and painful function of this joint may result even when good reduction has been secured. Arthrodesis is a valuable form of treatment for this and should be utilized more frequently than it now is. Nearly every patient whose fracture shows serious fragmentation of the articular surface of the posterior facet of the calcaneus would be the better for arthrodesis. The suitable cases should be selected and the patients operated upon at an early date.

It is probable that for the extremely severe fractures with great comminution and great separation of the fragments as in war fractures, the removal of the whole bone as advocated by Pridie may prove to be a simple and reasonably satisfactory solution of a difficult problem.

The frequent occurrence of fractures of the os calcis in industry, the complexity of the problems involved in treatment and the importance of the end result make them a challenge to stimulate improved measures of therapy.

ROBERT I HARRIS

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## THE BOOK SHELF

### THE INTERDEPENDENCE OF ARTIST AND ANATOMIST

VERA MOREL, New Orleans, Louisiana

**F**ORTUNATE is the medical illustrator whose workshop adjoins a medical library. Within the restful quiet of book-filled walls, the eye and the mind may derive abundant and profitable pleasure from the study of plates that enrich and elucidate many of the treasured classical works. Present-day students and artists should be encouraged to 'take time out' for browsing among historic volumes, thereby discovering and knowing intimately the illustrations of the early masters to whom we are so deeply indebted.

Contemplation of great works provides first surprises and interest, and as they become familiar there arises a desire to shift our attention to the individuals who created them. To learn something of their personalities, their surroundings, their problems—what they thought and felt and mainly how they worked together—this becomes a fascinating pursuit.

Collaboration and interdependence always have been essential to the peculiar requirements of medical illustration. The production of a medical book demands the concerted efforts of many minds and many hands, a co-ordination of crafts that are diverse yet closely interrelated. The artist is dependent upon guidance and in turn exchanges an ability to transfer his observations with accuracy, clearness, and technical proficiency. Possibly with the exception of the extraordinary genius Leonardo da Vinci, few artists have become scientists in the true sense of the word and while there have been medical men who were creditable illustrators only rarely did they attain greatness as artists.

How did the artist and the scientist work together—what was the attitude of one toward the other—was there friction and clash or harmony and possibly deep friendship? Expressions of warm admiration and gratitude for the contributions made by illustrators and engravers have

been recorded in the writings and biographies of medical men. In contrast, others have been silent, even secretive, and unsigned illustrations in some important anatomical works have brought about spirited controversies, speculation, and an absence of literature. Artists seem to have been strangely inarticulate about themselves.

Although there exists no published work of the brilliant young Veronese patrician, Marc Antonio della Torre (1478-1512?) and no book of illustrated anatomy was ever completed by his friend and countryman, Leonardo da Vinci (1452-1519) it is known that the two scholars were associated for a brief period of time. The influence of one upon the other is a matter of conjecture. Leonardo's passion for the study of anatomy long antedated his meeting in the year 1506 with della Torre who had come to establish a chair of anatomy at the University of Pavia. Giorgio Vasari (1511-1571) art historian of Italy records that della Torre was one of the first to throw true light upon anatomy which up to that time had been plunged in the almost total darkness of ignorance. In this he was wonderfully aided by the talent and labour of Leonardo, who made a book drawn with red crayon annotated with the pen (of the subjects which he dissected with his own hand and drew with the greatest diligence). Vasari had visited Milan in the year 1566 and met Francesco Melzi to whom Leonardo had bequeathed his fugitive manuscripts and precious drawings which were destined to be scattered, hidden, and forgotten for two centuries.

One of Leonardo's later biographers, Edward McCurdy writes "Leonardo was della Torre's senior by almost thirty years and Melzi supposed that he occupied the position of master with a pupil in these researches; others have supposed the position reversed. It seems natural that in the case of the two rare intellects working in unison toward a common purpose there would be neither master or pupil in the ordinary sense of the terms."

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Any attempt to evaluate Leonardo's contributions to anatomy is beyond the intent of this study and difficult would it be to measure his certain influence upon modern medical illustration. Many of us have been inspired by the zeal and intense devotion he gave to anatomical science as well as by the intellectual force and unparalleled beauty of his impromptu anatomical drawings.

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Meager and confusing are the facts concerning the artist or artists who worked with Andreas Vesalius (1514-1564) in the creation of his impressive and revolutionary publications. Many historians have been attracted by the romantic and enigmatical character of the young anatomist from Brussels who at the age of twenty-eight attained the summit of scientific greatness. In *De Humani corporis fabrica Libri septem* (1543) the structure of the human body was properly portrayed for the first time. Traditional methods of teaching anatomical science were supplanted by independent investigation and drawings after nature. As to the real hero of the *Fabrica*, opinions vary. Vesalius has been credited with the magnificent drawings as well as with their accompanying descriptive text. However, in more recent years cudgels have been taken up in defense of Jan Stephan van Calcar (1499-1547) who had come down from Flanders to work under the great painter Titian in Venice where he acquired a mastery of the then new tridimensional effect achieved by the use of but two dimensions. For many years the beautiful woodcuts of the *Fabrica*



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a signed *croquis* of the *Fabrica* title page bearing the name of Calcar. This fourth line of evidence is possibly more presumptive, but taken in association with the first three, it serves further to confirm their close relationship.

In the *Venesection Epistola* (1539) Vesalius writes his patron the physician Nicolaus Florenas of Brussels: "We have tried to make out a scheme of the dissections of this present year in the most convenient manner possible, but in view of the great crowd of spectators it proved altogether impossible to complete it and concludes: 'So if I have a number of suitable cadavers, and Joannes Stephanus (Calcar) the most admirable artist of our time does not refuse his assistance I shall not run away from my task.' At another time Vesalius refers to Calcar's ability but the artist's name is omitted from the illustrations of the *Fabrica*. Whether this omission was for reason of ill-feeling, envy or mere inadvertence remains a perplexing puzzle.

Undoubtedly the impetuous Vesalius was a driving master and became impatient and grieved over any delay on the part of his coworkers. Calcar and other assistants may have preferred the pleasantness of ivory towers to the turmoil of the dissection scene where the dynamic young anat-

omist held the spectacular anatomical demonstrations at Padua which are so graphically portrayed in the frontispiece of the *Fabrica*. Vesalius refers to his own ability as a draftsman and three drawings of the six anatomical tables (1538) are by his hand, but the plates of the *Fabrica* are unmistakably the work of a trained and skilled artist who transcribed with fidelity and beauty what he observed and comprehended.

Despite personal difficulties that may have existed and the great amount of labor involved in the preparation of a comprehensive systematic anatomy in the space of a few years, the work reached completion and immortality. While no written account is available of the manner in which Vesalius and Calcar worked together, the *Fabrica* remains a perpetual source of inspiration and of joy and may be accepted as a glorious and certain instance of artist-anatomist teamwork and interdependence, although uncertainty as to the identity of the artist may still exist.

No name is signed to the copperplates in the early works of Guilio Casserio (Casserius) (1559-1616) but the following passage from the writings of Casserius is cited by Choulant: "I observed this muscle in the year 1593 on the seventh of March and immediately had it drawn for everlasting memory by that distinguished man Joseph Maum, the German artist, who was at that time living in my household for the purpose of painting anatomic illustration. Casserius died before his ambitious anatomical projects were completed. In later editions of his works the drawings bore the name of Odoardo Fialetti and Choulant adds that owing to the correctness of Casserius' plates and their tasteful arrangement and the beauty of their technical execution, they mark a new era in anatomic representation and have become models for anatomic illustrations in copper.

Refreshing and illuminating are the accounts of Bernard Siegfried Albinus (1697-1770) whose investigations established an entirely new approach to illustrative anatomy. Albinus, professor of anatomy at Leyden from the age of twenty-one until his death, was an able draftsman and had keen appreciation of artistic ability in others. He secured the services of the most skilled artists and expended huge sums of money for the illustrations in his many works. We are told that he was assisted by the talented Jan Wandelaar (1690-1759) of Amsterdam, who had previously worked for Frederick Ruysche and Arent Cant.

Albinus describes in detail his methods of illustration and tells of the extra and occasionally burdensome effort required to train artists, stressing the fact that his illustrator reproduced nothing

that was not first thoroughly understood. He gives accounts of the various ingenious contraptions devised by himself for drawing of skeletons and musculature in exact proportions. Of Wandelaar he writes: "And so he had to be trained and guided and practically directed by me as if I were myself making the pictures, using him as a tool." Upon another occasion he remarks: "I have often wondered at his spirit, his patience and resolution; he is moreover ardent and never without a certain impetuous eagerness of effort."

Again he writes: "He (Wandelaar) has reproduced everything with truth and accuracy and with a marvelous refinement of skill. He has reproduced all the smallest details and what is more difficult, the very appearance in so far as that art could. Still better is the fact that he draws beautifully and, what is even more important, draws the pictures on copper after the objects themselves. The great amount of attention that Albinus gave to the production of his illustrations was well repaid in the unparalleled results that he attained. Every word, and there are many that he has written is worthy of study and remembrance for he brings in strong relief the necessity for close co-operation between author and illustrator."

We have a fondness for the extraordinary personality of Samuel Thomas von Soemmerring (1755-1830) who was a devoted follower of the great teacher Albinus. From the days of his boyhood Soemmerring was skillful with his pen both in drawing and in writing. His accounts of interesting travels, of friendships formed with noted medical men in other countries, and of personal struggles, make stimulating reading. Theodore Best writes: "That his careful transfer of his observations and experiences into writing and sketches no doubt was a fundamental factor in his keen observation, accurate descriptions and clear illustrations later."

Soemmerring was fortunate to find Christian Koeck, a young artist, employed as a stucco-worker and model maker in an art shop near the University of Mainz who developed into an outstanding medical illustrator. He turned out admirable illustrations, unexcelled in purity, certainty and truthfulness, writes Choulant. But Koeck caused him a great deal of trouble especially when he went to Moscow where he was very unfortunate and could only return to Munich in 1809 after great pecuniary sacrifices on Soemmerring's part. In Frankfurt as in other cities Koeck lived with Soemmerring. He died in 1818.

Here also is an anatomist and an artist who left



us record of personal experiences in the preparation of graphic representations. Among Koeck's most beautiful drawings are those in Soemmerring's treatise on the eye. In the preface of this book, the author wrote: "therefore I begged the artist to try his best to combine the greatest accuracy of individual details with the strongest retention of the whole, so that the finished product would produce the proper impression both from near and distant view." Truly accurate sketching costs no more effort than incorrect! Does it not, for example, cost the same effort whether I picture the hair of the eyebrow slanting as they lie in nature or horizontal as one finds them pictured so often?

The story of how Soemmerring created a female counterpart to the perfect representation of Albinus' male skeleton is a familiar one and it is interesting to surmise the extent of the mutual assistance required and the dependence of artist and author in this particularly difficult task. After many comparative studies the completed drawing was, as Choulant says, necessarily an idealized one since it had to represent not an individual form but the most beautiful form as it was imagined to exist in life. We quote the same authority, who explains the strong and lasting influence of



Soemmerring's illustrations in these words "They displaced all the repulsive, unaesthetic, and unnatural features so often prominent in earlier anatomic representations by the substitution of incomparably better ones."

Another great anatomist William Hunter (1718-1783) contributed great care and great sums of money in the production of his works. His volume of the *Anatomia uteri humani gravida* (1774) from the press of Joannes Baskerville, represents the work of many artists and many engravers. In the preface of this beautiful volume illustrated by talented men, including the famous Rieumadijk, are the following words written by John Hunter the famous brother of the author "He owes much likewise to the ingenious artists who made the drawings and engravings and particularly to Mr Strange not only for having by his hand secured a sort of immortality to two of the plates, but for having given his advice and assistance in every part with a steady and disinterested friendship. Sir Robert Strange was one of the many engravers contributing to the beauty of Hunter's great work."

Instances of the reciprocal relationships that existed between other anatomists and their artist coworkers may be recited but we are eager to mention an example that is near and familiar to contemporary medical illustrators. This is the association of a group of illustrious medical men at Johns Hopkins University with three talented artists who left their studios in Europe to come to America just before the turn of the past century. Max Brödel (1870-1941) who was the first to arrive (1894) has been titled the greatest medical illustrator who has ever lived by his friend and coworker Dr. Thomas A. Cullen.

Upon the occasion of the seventy fifth birthday of Dr. Howard A. Kelly (1858-1943) Max Brödel spoke and from this address we have taken the following words that relate to our subject. He (Dr. Kelly) had a way of making little modest outline sketches when he explained his operative procedure to his illustrators. There were three of us now. Hermann Becker came in 1895 August Horn in 1898. Dr. Kelly had endless patience with us. He invented diagrams to show variations of form and relationship motion pressure, tension rupture the development of a pathologic

process, the sequence of operative steps, the placing of ligatures, sutures, etc. In short, every clinical phenomenon, every operative procedure flowed in simple, eloquent lines from the end of his pencil. Few medical men can do that. What if the work was not correct. It did not matter, the spirit was there. We understood his diagrams, they were eloquent. In this way Dr. Kelly taught his artist the secret of the correct conception of an illustration which is the basis of all creative drawing. This is one great debt we owe Dr. Kelly. Of another debt, Max Brödel continued.

Dr. Kelly always permitted the artists to make original investigations to clear up the obscure point. That meant temporary cessation of illustrative output until the question could be answered. Few authors of medical books will do that. Without his sympathetic attitude we could not have learned our trade so well.

Through the vision and effort of Dr. Cullen, the opportunity to aid other artists was provided Max Brödel when the first school in the world for training medical artists was established at Johns Hopkins with Brödel as its director. It is significant that the fame of this modest artist and teacher will endure not alone because of his contributions to education and to art, but because his spirit was an investigative one and he keenly appreciated the need for close co-operation between author and artist.

#### REFERENCES

1. BEST, THEODORE H. The Life and Works of Samuel Thomas von Soemmerring. Ann. Med. History 1924, 6:369.
2. CASTIGLIONI ARTURO. A History of Medicine. Translated from the Italian and edited by E. B. Knoblauch. New York: Alfred A. Knopf, 1941.
3. CHOUILLANT LUDWIG. The History and Biography of Anatomic Illustration. Translated by Mortimer Frank. Chicago: University of Chicago Press, 1900.
4. CULLEN THOMAS S. Max Brödel, 1870-1941, Director of the First Department of Art as applied to Medicine in the World. Bull. Med. Lib. Ass. 1945, 33:7-9.
5. CUSHING, HARVEY. A Bio-Bibliography of Andrew Vesalini. New York: Schuman's, 1943.
6. GARRETT, FIELDING H. An Introduction to the History of Medicine. 4th ed., rev. & enl. Philadelphia: W. B. Saunders Co., 1939.
7. SIMON, CHARLES. Some Vesalian problems. Bull. Hist. Med., 1943, 7:435-440.
8. TAYLOR, RACHEL ARNOLD. Invitation to Rembrandt. Italy: New York: Harper & Brothers, 1930.

# REVIEWS OF NEW BOOKS

THE fourth edition of Key and Corwell's *The Management of Fractures, Dislocations and Sprains* has the same physical appearance as the third edition but many new illustrations have been added and older ones have been deleted. The book has been brought up to date and experiences gained by many workers during World War II have been incorporated.

The general principles of débridement, chemotherapy, and immediate internal fixation of fractures are aptly discussed and briefly presented in a readily understandable style. The chapters which are devoted to workmen's compensation laws and medicolegal aspects of fracture cases are well worth studying.

The discussions of fracture of the skull and brain trauma and fractures of the jaws and face are well presented by competent specialists in the fields mentioned.

The reviewer wonders whether the illustrations of the use of Kirschner wire traction through the distal third of the humerus and ulna for skeletal traction in the elbow region may lead inexperienced men who will be guided by this excellent book to attempt a method which requires skill, experience and judgment. A more lengthy discussion of its dangers and perhaps an illustration of "picture hook" traction of the olecranon, as used by Cubbins for years might help to diminish the risk associated with this procedure.

The authors are to be congratulated on maintaining the excellent standard of this work and for keeping the material abreast of the times. It is well worth study by student general practitioner and specialist.

CARLO SCODARI

THE influx of women into industry which began during the recent war has created a need for the book entitled *Women in Industry: Their Health and Efficiency* by Dr Baetjer who has arranged in orderly fashion pertinent information gleaned from the recent medical literature.

The following subjects which are covered in this work indicate its scope: the ability of women to work the types and conditions of work for women; sick absenteeism among women employees; occupational injuries to working women; occupational diseases; case, gynecological and obstetrical problems associated with the employment of women; mortality and fertility of women in relation to occupation. In a

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. By John Albert Key, D.S. M.D. and H. Earle Corwell, M.D. F.A.C.S. 4th ed. St. Louis, The C. V. Mosby Co. 1945.  
 WOMEN IN INDUSTRY: THEIR HEALTH AND EFFICIENCY. Issued under the auspices of the Division of Medical Sciences and the Division of Engineering and Industrial Research of the National Research Council. By Anna M. Baetjer, Sc.D. Philadelphia and London, W. B. Saunders Co. 1945.

single chapter Dr Baetjer helpfully summarizes the above subject matter and arrives at some logical conclusions. The appendix lists some useful facts including labor laws for women and the bibliography is most complete.

In my opinion this book is of value to all physicians and a must for gynecologists and for those engaged in industrial medicine and surgery.

F. L. SATTIN

THE work entitled *Le fibro myome uterin* by J. Ducuing is based on 1300 cases personally observed of which 547 had not been previously published. The illustrations consist of many gross and photomicrographs as well as a considerable number of line drawings.

The importance of the book lies in the author's vigorous championing of radiation therapy in preference to surgery in the treatment of fibromyomas. In a series of 434 cases whose management he reports in detail 74 cases were treated surgically and 360 cases by radiation. The author states that he realizes the ideas which he defends on radiotherapy of fibromas have provoked much criticism especially from surgeons. He attacks in detail the conclusions of the French Surgical Congress of 1924 in which on the treatment of fibroids, a minor place was given to radiotherapy and a major one to surgery.

The book presents also many and complex aspects of the subject such as surgery, endocrinology, jurisprudence, experimentation, physiology and pathological anatomy. In Chapters I through VI the author presents a number of composite studies including age groups affected, menarche and menopause, fibroids and pregnancy and gross characteristics of fibromyomas. In Chapter VII he considers the present state of research and after a review of anatomy and physiology he discusses the fibroblast of the muscle fiber in the fibromatous uterus, the relationships in myomas and the uterine mucosa. Circulatory of corrosion specimens. A note on the physiology of the female genital cycle, on the sex hormones and on the synchronization of the menstrual and ovulatory cycles immediately precedes the discussion of the pathogenesis and mechanism of bleeding associated with fibroids. Treatment indications and techniques are reviewed in Chapter X. Surgical conservation of the ovary is definitely inferior in the author's opinion to radiation castration. Operative procedures on the uterus are reviewed by a series of line drawings. The author emphasizes postoperative embolism while minimizing the possibility of any late

LE FIBRO MYOME UTERIN. By J. Ducuing. Paris: Masson et Cie Editeurs, 1945.



the rectal sphincters. He states that one should always remove 15 centimeters of bowel above the tumor and 5 centimeters below. If this can be done and the rectal sphincter preserved well and good if not the sphincter must be sacrificed, and a good if not routine standard procedure the abdominal plus the sacral route with preservation of the sphincter. This operation requires more time is more precise and often is followed by fistulas as compared with the abdominal operation in which the sphincter is sacrificed but which practically never is followed by fistulas.

The work is illustrated by excellent photographs and the author belongs to the group of surgeons who believe in the importance of the rectum.

The work is illustrated by excellent drawings of all the crucial steps in the operative procedures. The author belongs to the group of surgeons who advocate a wide exposure. If one wishes to avoid a structure one makes a generous incision exposes it, and identifies it. This procedure is advocated for the ureter vs bladder prostate vagina seminal vesicles, and uterus. He also advises that if any of these structures are adherent to the tumor mass, they in whole or in part should be removed en bloc with the tumor.

In discussing the preservation of the anal sphincter preservation of the anal mucosa and anastomosis of the sphincter and anastomosis of the rectum.

In discussing the preservation of the sphincters by preservation and anastomosis or by removal of the anal mucosa and drawing the bowel through the sphincter he states that the "pull through" technique gives an imperfect sphincter that rarely holds liquids or gas, but does hold solids. He believes that an abdominal colostomy is preferable to a perineal one, contrary to the opinion of some American surgeons.

To everyone interested in the cancer of the rectum this book should be read. It is well written by a surgeon who has had considerable experience with the disease.

to everyone interested in the carcinoma of the rectum this book should prove of great interest. It is written by a surgeon of wide experience who reviews and analyzes all the recent world literature on the subject.

A completely new approach to the induction anesthesia is presented in the titled *Conduct* by VICTOR L. LINDHART.

World literature  
VICTOIRE LEEPTINSE

AN entirely new approach to the science of con-  
duction anesthesia is presented in Pitkin's volume  
entitled *Conduction Anesthesia*.<sup>1</sup> Such a complete  
coverage of the subject is to be found in no other an-  
gle volume. The book is edited by Southworth and  
Hingston and there are eight collaborators. It con-  
tains the author's personal approach to the science,  
authenticated by years of practical application, and  
a coverage of closely allied developments by well-  
known collaborators. Throughout, a direct applica-  
tion of a knowledge of anatomy and pharmacology  
to conduction anesthesia is emphasized and the sub-  
ject matter is presented in as simple a manner as is  
possible. The author states, "Block anesthesia is  
neither complicated nor difficult."  
The book is written in a simple manner as is  
familiar with the pharmacology of local anes-  
thetics and with osseous and neuro-anatomy can be  
come a proficient local and neuro-anesthetic in a  
time. He elucidates a number of fallacies in local  
anesthesia which have been perpetuated from the  
time of early workers in this field. Crile's work in  
this field is particularly noted.

<sup>1</sup> "Conduction Anesthesia," Clinical Studies of George P. Pitkin, M.D.,  
F.A.C.S., F.A.A.E., Edited by Joseph W. Southworth, M.D., and Robert  
A. Hingston, M.D. Philadelphia, London, Montreal: R. Lippincott Co.,  
1944.

of early workers in this field. Crile's work is  
 P.A.C.S. P.I.C.A. Edited by James L. Southworth, M.D. and Robert  
 A. Hargrove, M.D. Philadelphia, London, Montreal / J. B. Lippincott Co.  
 1964.

The text is intended as a guide to the more common procedures employed by the average physician as well as a source of technical information for those interested in specialised fields of surgery. The anatomy of the cranial and cervical autonomic nervous system and the body. The entire

The anatomy of the cranial and spinal nerves and the autonomic nervous system is completely discussed. The entire nerve supply of various organs of the body is given under a separate heading for each organ. This subject matter is arranged so that easy reference is possible when needed. The concept is presented that the autonomic as well as somatic pathways must be blocked for successful anesthesia. The underlying principles of conduction anesthesia, the incorporated and specific techniques of anesthesia are discussed. There is a section on the pharmacology and toxicology of local anesthetics. The section on shock includes a basic review and the pharmacology and toxicology of the various drugs used in shock. The section on shock includes a basic review and the pharmacology and toxicology of the various drugs used in shock. The section on shock includes a basic review and the pharmacology and toxicology of the various drugs used in shock.

There is no area of the body and few combinations of complicating factors which have not been considered. Easy reference may be made to any specific nerve block desired and in each instance complete directions are given. Repetition of anatomical descriptions and techniques of injection is completely purposeful, included so that all pertinent information is present under each heading without referring the reader to previous or subsequent pages.

Sections on spinal and continuous infusions follow. Applicable and continuous pages.

Pharmacology, various knowledge.

The excellent illustrations and drawings are outstanding features and are numerous and clear.

The excellent illustrations and drawings are perhaps the outstanding feature of the book. They are numerous and clearly illustrate every phase of the techniques described. The volume will have a widespread availability to anesthesiologists and surgeons. The ready availability of its subject matter and completeness of coverage make it an unsurpassed reference text. The editors made it an unsurpassed work. We regret that Dr Pitkin is no longer with us to receive well deserved acclaim.

WILLIAM H. J.

WILLIAMS E. PEARSON  
RALPH M. TOWNE

THE monograph entitled *Endocrine Function of the Hypophysis* reprinted from the set *Oxford Loose-Leaf Medicine* is a compact terse yet complete treatise on a subject which still in spite of the extensive study which has been carried out on the functions of the pituitary gland remains incompletely explored and a matter for contention among investigators. The author, a well known clinical endocrinologist and research worker in the field of endocrinology, has obviously accomplished a rather heroic success in sweeping together and co-ordinating up to the present day all the pertinent data concerning the form and functions of the hypophysis.

The book is divided into five parts: (1) anatomy, embryology and phylogeny of the hypophysis cerebri (2) cytophysiology and biochemistry of the adenohypophysis (3) biological, biochemical physiological and genetic concepts of growth (4) clinical disorders of growth and (5) cytophysiology, biochemistry and pharmacology of the neurohypophysis. Each of these sections is furnished with an exhaustive bibliography which reaches from the present day back into the early investigations of the past century thus providing for the serious student of this particular study a valuable source material.

*ENDOCRINE FUNCTION OF THE HYPOPHYSIS.* By HARRY B. FRIEDGOLD, M.D. Reprinted from *Oxford Loose Leaf Medicine*. Edited by HENRY A. CHRISTIAN, A.M. M.D. LL.D. Sc.D. (Hon.) F.A.C.P. Hon. F.R.C.P. (Can.). New York: Oxford University Press, 1946.

The section on anatomy and embryology of the gland is one of the best to be found in English probably being written in an authoritative and scholarly manner to lead up to the facts concerning the physiology of the organ which is described later. The section on clinical disorders treats briefly but adequately and with good illustrations, of the various dysa syndromes which follow disease of the hypophysis. The paragraphs on dwarfism are gratifying in that the subject is handled so as to leave the reader with the feeling that he has just read about a new subject. In this as in most of the other parts of the book, the writer's style is direct and factual, yet never laborious or hackneyed.

With the background of information relative to the anatomy and physiology of the entire organ, the author has been able clearly to show the pharmacologic and clinical applications of this knowledge to the distinctly two separate parts of the gland, the adenohypophysis and the neurohypophysis. If the average medical school student or doctor is not entirely clear on the individual functions of these two actually separate organs, and is not entirely certain of the rational application of the commercial biological preparations of the gland, he has but to review this monograph. It is not fast or easy reading, but it is stimulating and informative. After reading it one feels that that is just about all there is to the subject."

JOHN MURPHY

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return or the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

*THE ANATOMY OF THE BRONCHIAL TREE.* By R. C. BROCK, M.S. (Lond.), F.R.C.S. (Eng.) London, New York, Toronto: Geoffrey Cumberlege, Oxford University Press, 1946.

*THE ESSENTIALS OF OBSTETRICS AND GYNECOLOGY.* By WILLIAM ALBERT SCOTT, B.A., M.B. F.R.C.S. (Can.) F.R.C.O.G. (Eng.) and H. BROOKFIELD VAN WYCK, B.A., M.B., F.R.C.S. (Can.) F.R.C.O.G. (Eng.) Philadelphia: Lea & Febiger, 1946.

*E CYCLOPEDIA OF ENDOCRINOLOGY.* By HANS SELYE, M.D. Ph.D. (Prague) D.Sc. (McGill) F.R.S. (Canada) Sect. IV. The Ovary Vol. VII. Ovarian Tumors. Sect. IV. The Ovary Vol. VII. Bibl. Ovarian Tumors (Bibliography). Montreal: Richardson, Bond and Wright, 1946.

*DA CONSERVACAO DO OVARIO NAS HISTERECTOMIAS.* By ANGELO DE ABREU LIMA. Recife, 1946.

*A INTEGRATED PRACTICE. MEDICINE.* By HAROLD THOMAS HYMAN, M.D. Vols. I, II, III, and IV and Index. Philadelphia and London: W. B. Saunders Co., 1947.

*THE COMPLETE PEDIATRICIAN.* By WILBURT C. DAWSON, M.D., D.Sc. M.D. Durham, N.C. Duke University Press, 1946.

*PENICILLIN IN NEUROLOGY.* By A. EARL WALKER, M.D. and HERBERT C. JOHNSON, M.D. Springfield, Ill. Charles C. Thomas, 1946.

*SIGNIFICANCE OF THE EXTRACELLULAR FLUID IN CLINICAL MEDICINE.* By L. H. NEWBURGH, M.D. Ann Arbor: Michigan J. W. Edwards, Inc., 1946.

*PARENTAL ALIMENTATION IN SURGERY WITH SPECIAL REFERENCE TO PROTEINS AND AMINO ACIDS.* By ROBERT ELMAS, M.D. New York, London: Paul B. Hoeber, 1947.

*CARDIOVASCULAR DISEASES.* By DAVID SCHER, M.D., F.A.C.P., and LINN J. BOYD, M.D. F.A.C.P. Philadelphia: London, Montreal: J. B. Lippincott Co., 1947.

*GYNECOLOGICAL AND OBSTETRICAL PATHOLOGY WITH CLINICAL AND ENDOCRINE RELATIONS.* By FRANK A. A.B., M.D. D.Sc. (Hon. Dublin) F.A.C.S. Philadelphia and London: W. B. Saunders Co., 1947.

*FURTHER STUDIES IN ENCEPHALOGRAPHY.* By E. GRUBB ROBERTSON, M.D. (Melb.) F.R.C.P. F.R.A.C.P. Melbourne: Macmillan & Co. Ltd., 1946.

*TRATAMIENTO MEDICO DE LA ULCERA GASTRODUODENAL EXPERIMENTAL.* By Dr. JUAN VASCO. Buenos Aires: La Prensa Medica Argentina, 1946.

*LA VIDA DE LOS MEDICOS EN MEXICO.* By CARLOS ZUCKERMANN. Mexico: Ediciones Minerva, 1945.

*OFFICE ENDOCRINOLOGY.* By ROBERT B. GORTON, B.A., M.D. C.M. 3rd ed. Springfield, Ill. Charles C. Thomas, 1947.

March, 1947

# SURGERY

## GYNECOLOGY AND OBSTETRICS

*Supplement*

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# INTERNATIONAL ABSTRACTS OF SURGERY

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## COLLECTIVE REVIEW

### MEDIASTINAL TUMORS AND CYSTS

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**A**s the experience of practically all authorities on mediastinal tumors and cysts appeared to be relatively limited because of the apparent infrequency of most of these conditions a rather extensive attempt was made to assemble the various observations and views expressed in the literature, particularly in the last 15 years during which period rapid developments have taken place in thoracic surgery.

#### TUMORS OF THE THYMUS

In 1917 Bell discovered in 56 autopsies on patients who died of myasthenia gravis that the thymus was enlarged in 17 and that there were thymic tumors in 10. This series was increased through the addition of autopsy or operative findings in myasthenia gravis as reported in the reviews of Norris Blalock (21) Blalock with his colleagues (23, 24) and Poer. In the paper of Poer the series consisted of a total of 129 cases with abnormalities in 71 (55 per cent) of which 30 demonstrated enlargement or persistence and 41 presented tumors. Of the 41 tumors 37 were benign thymomas and 4 were classed as malignant (found at autopsy) to which the first malignant tumor removed at operation was apparently added. Blalock, *et al.* (24) cited the collection of Levre consisting of 67 patients with myasthenia in which autopsy findings of tumor in the thymic area were noted in 24 persistence or hypertrophy in 32 and no abnormality in 11. This writer observed that most of the thymic tumors in individuals with myasthenia were benign while those

in persons without it were malignant. Apparently since the report of Poer in 1912 2 thymomas were excised by Campbell Fradkin and Lipetz. Turnbull recorded the removal of 1 malignant thymoma. Clagett and Root (38) reported 10 thymectomies for tumor and enlargement or persistence apparently including those of the previous report of Clagett and Eaton (36) of 5 for tumor plus 1 for myasthenia gravis without tumor. Hardyman and Bradshaw explored 3 cases of myasthenia gravis and found 1 benign thymoma and 1 cystic partially involuted thymus (both removed) but were unable to find the gland in the third case. Blalock (22) recently reported 20 cases of myasthenia gravis subjected to operation in which a thymoma was removed in 2 while in the others this gland presented the picture of hyperplasia. He read a letter from H. R. Viets during the discussion of the paper giving the results of operation on 14 patients, and it was noted that there were 3 thymic tumors in the group (There has been no attempt here or apparently by others recently to bring the autopsy incidence up to date.) It would seem that at least 6 malignant thymic tumors were observed in myasthenia gravis (143, 165). Heuer and Andrus (98) stated that there were other benign tumors not associated with myasthenia gravis which were somewhat similar pathologically although they were apparently less frequent. Perhaps the huge tumor of Andrus and Foot (10) might be considered in this connection. Heuer and Andrus (98) further stated that benign thymomas in general were less common than the malignant ones.

Bell collected 73 cases of thymic tumor excluding the lesions associated with myasthenia gravis and leucemia which were designated as

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various forms of sarcoma with lymphosarcoma predominating or were unclassified in 51 cases, 10 as carcinoma 6 as thymoma, 1 as fibroma and 5 as miscellaneous types. Crosby was able to collect 122 cases of sarcoma and 44 of carcinoma to which Decker added 40 cases plus 2 of his own for a total of 208 malignant thymic tumors. Decker also pointed out that the usual abnormalities of the thymus were benign hyperplasia of infancy hyperplasia in Hodgkin's disease, exophthalmic goiter myasthenia gravis, leucemia, and status lymphaticus. He believed that malignant tumors were rare and cited Symmer's figures of 25 malignant tumors found in 17,000 autopsies. Heuer and Andrus (98) in 1940 collected 230 malignant tumors of the thymus including the previous reviews, which included lymphosarcoma carcinoma sarcoma, granulomatous tumors such as Hodgkin's disease, teratoid and other types.

Ewing stated that the thymus gland increases in size to the age of 15 and described the simple hypertrophy in infants and Graves disease as being due to lymphocytic hyperplasia. He discussed several groups of cysts of the thymus gland (1) those consisting of epithelial canals of embryonal type persisting with cystic formation, some associated with syphilis at times those described in Graves disease some lined with pavement epithelium and some demonstrating polypoid masses (2) dermoid cysts, (3) cysts demonstrating invasion and distention of Hassel's corpuscles by lymphocytes—small cysts lined with cubical or flat epithelium, and (4) cystic lymphangioma, lined with endothelial cells.

Regarding primary tumors of the thymus, Ewing considered that the age incidence with other factors suggested that thymic carcinoma may be affected by disturbances in involutional processes and that certain reticulum cells may respond to infection with later neoplastic changes. He classified the primary malignant tumors into three main groups

1. Lymphosarcoma or thymoma—a growth of round polyhedral and giant cells. The chief source is probably the reticulum cells, although lymphocytes are present. The tumors were described as occasionally being cystic and creamy yellow or lemon colored. An encapsulated group was recognized but apparently considered less malignant. The group suggestive of the granuloma of Hodgkin's disease, those consisting of small round cells in which the reticulum was said to be missing and the class described as perithelioma were also noted by him.

2. Carcinoma from the reticulum cells with invasion of the surrounding tissue apparently less

active than in other carcinomas. He observed that these may be of a mixed type and difficult to determine

3. This group was considered as a rare specific cell or myosarcoma and was believed to originate from the stroma but it might be a part of group 1. Ewing apparently believed that thymic round cells differ from those of the lymph nodes, but reticulum cells are the source of tumor in what is termed lymphosarcoma and that many tumors may fall in the class of granuloma malignum.

Andrus and Foot (10) noted that the greatest difficulty in classification was the unknown origin of the lymphoid type of cells, whether they were of mesodermal or entodermal origin, and classified the thymomas as follows

Nonmalignant thymomas (Thymic reticulisarcoma variety are a type.) The usual type are tumors of disarranged normal tissue elements, such as peripheral reticulum cells and central thymocytes in the lobules. Characteristic corpuscles are present although eosinophilic thymic cells are difficult to find.

#### Malignant thymomas

1. Thymocytic or lymphocytic type—composed of small round cells with dark staining nuclei, in which Hassel's corpuscles may or may not be present

2. Large celled or lymphoblastic type—consisting of large round to ovoid cells similar to early reticulum cells, with or without corpuscles

3. Thymic reticulum cell type. These are the largest and most frequent variety with cells resembling thymic reticulum cells, although they may be somewhat pleomorphic and may form ductlike structures. They are epithelial in appearance and corpuscles may or may not be present. (Schminke's lymphoepithelioma<sup>1</sup>)

4. Perithelial type. These are composed of fusiform cells radially placed about vessels, there are no areas of necrosis and thymic corpuscles are minor findings.

5. Granulomatous type—Hodgkin's involvement.

6. Epithelial or carcinomatous type. In these the thymic corpuscles predominate in all stages, with a pearly appearance. Reticulum cells may form radiating cords and ductlike structures.

7. Teratoid type. All of the elements in these undergo abnormal proliferation in various degrees and there may be glandlike structures or plugs of epithelium present.

Decker stated that some believed that sarcoma and endothelioma may be of parenchymal origin

<sup>1</sup>The respective author's own usage of the term thymoma was considered throughout the section.

He also emphasized the penepithelioma of Symmers as a separate group but did not consider the teratoma as proved at that time. He desired that the term thymoma be dropped as it was used by various writers for practically any type of thymic tumor. All malignant tumors of the thymus were considered by him to be grossly similar in that they tended to compress and surround rather than invade the mediastinal structures, they tended to be encapsulated and metastasized late, although involvement by direct extension occurred. Poor observed that the determination of the presence of thymic neoplasms depended on the location, shape, and morphology of the growth, its failure to invade bone, its tendency toward extension to the pleura and pericardium and its failure to metastasize below the diaphragm. Heuer and Andrus (98) indicated that the malignant thymomas grew anteriorly with involvement of the sternum at times, and posteriorly surrounding the mediastinal structures, but that distant metastases were uncommon. He described the tumors as being usually hard and nodular but sometimes soft and vascular. Crosby stated that both sarcomas and carcinomas not only involved the adjacent organs including the sternum, myocardium, thyroid and trachea but metastasized widely—even below the diaphragm. He observed that sarcomas involved the abdominal nodes and spleen more frequently than carcinomas, but that the latter metastasized more frequently to the central nervous system. Apparently carcinomas occurred for the most part in individuals over 40 or 50 years of age whereas most frequent in younger individuals (10 to 42 years). According to Crosby lymphosarcomas and carcinomas occurred much more frequently in males than in females.

Bell was of the opinion that the thymic tumors in myasthenia gravis were distinct, and described them as small benign tumors composed of young thymic tissue which was frequently hemorrhagic. He noted the lymphocytic foci in the muscles and believed that the abnormal thymus in this condition was due to some more fundamental disorder which was also responsible for the muscle weakness. Norris believed that the change in the gland was more of an epithelial hyperplasia than a benign thymoma and was due to an extraglandular stimulus or demand. McEachern was of the opinion that the tumors in myasthenia gravis were nearly always benign and encapsulated adenomas. He suggested the possibility of an endocrine-like dysfunction of the thymus in the condition as it was affected by other endocrine gland distur-

ances. Blalock *et al* (24) wrote that the prevailing theory regarding this disease was that there was a disturbance in the neuromuscular mechanism of transmission of impulses across the myoneural junction, possibly on an endocrine basis.

Heuer and Andrus (98) state that clinically when myasthenia gravis is present thymic tumors should be looked for as they are usually small and there are frequently no symptoms of mediastinal compression present. Regarding malignant thymomas these authors indicated that the symptoms were predominately thoracic and appear although late external signs might appear. The course was described as rapid in malignant types and the patients usually died of suffocation. Decker wrote that in the case of malignant tumor the usual signs and symptoms of mediastinal tumor such as dyspnea, cough, pain and hemorrhage, were present and that occasionally the cervical glands were enlarged or there was a swelling in the neck or upper anterior chest. He added that the signs may be fairly silent and evidenced only by metastasis. It was also found by him that physical signs were only suggestive in one half of the cases of malignant thymic tumors. Roentgenological evidence in one third in one-sixth of the cases. Decker further observed that the duration of life was usually between 1 and 18 months after the onset of symptoms. He suggested biopsy when possible and the use of bronchoscopy as diagnostic aids. Crosby found the most common complications of malignant thymic tumors to be pleurisy and pericarditis with effusion, obliteration of the vessels of the neck, and obstruction of the esophagus and of the trachea.

Blades (18) classified thymomas as tumors of the anterior mediastinum. Benign tumors of the thymus were described by Heuer and Andrus (98) as casting a circumscribed shadow in the anterior mediastinum between the sternum and pericardium. Tumors and enlargements of the thymus are best found on the lateral x ray film according to Blalock (21). Apparently such disc shaped shadows immediately above the pericardium are malignant tumors of the thymus and such shadows are suggestive of these tumors according to Decker and Crosby. McEachern stated that roentgenological evidence of thymic enlargement of tumor was rare in myasthenia gravis and believed that roentgen therapy of the thymus in this condition gave inconclusive results. Clagett and Eaton wrote that of the last 55 cases of myasthenia gravis at the Mayo Clinic, 9 were found to

have tumor of the thymus on careful roentgenological examination. They believed that there was some experience at the Clinic showing that there was some improvement in myasthenia gravis following roentgen therapy. They described 2 cases in which it was thought that remissions had been induced by such therapy and which were operated on with good results. Blalock (22) in his discussion advised against the use of x-ray therapy in this connection as there were reports of poor results and several deaths. Both Decker and Haagensen pointed out that sarcoma of the thymus gland was radiosensitive but that carcinoma was not. Decker suggested x-ray therapy for palliation, particularly in lymphosarcoma.

The report of Kennedy and Moersch was cited by Blalock *et al* (24), 84 patients with myasthenia gravis were observed of whom 24 died of the disease, and in whom complete remissions varied from 1 month to 15 years with an average duration of 2 1/2 years. The figures of Viets were cited there were 100 cases of the disease of which 22 terminated fatally. In this series only medical treatment was given. Blalock (22) found that the results from surgery in myasthenia gravis were not uniform but they were encouraging and there seemed little doubt that thymectomy was indicated for thymic tumor in this disease. He also believed that thymectomy was probably indicated when there was no demonstrable tumor if the patient was disabled with myasthenia gravis despite prostigmine therapy. The results were considered to be better in those not having suffered from the disease over long periods and he suggested that the operation be limited to patients with severe disease at least for the present. The indications in benign and malignant tumors of the thymus occurring in those not suffering from myasthenia gravis would appear to be the same as for mediastinal tumors in general, as noted later in the review.

Blalock (22) noted that in patients with myasthenia gravis the preoperative determination of the quantity of prostigmine which produced maximum improvement was important in the later management. Blalock *et al* (23) pointed out that it was most important to prevent respiratory infections as they cause exacerbation and some of the effect of prostigmine is lost. Prostigmine in doses of from 15 to 25 mgm. and atropine were administered preoperatively and these writers observed that the dosage may need to be increased the first few days. They found the major complications of operation to be pneumonia and atelectasis. Clagett and Eaton (36) also stressed that infections, trauma exertion, and nervous

strain be avoided preoperatively. They administered sulfadiazine and controlled the patient with prostigmine preoperatively. Oxygen, prostigmine, chemotherapy, and bronchoscopy with aspiration of secretions, if necessary were used.

Blalock (21, 22) operated through an upper median sternotomy and remarked about the small amount of ether necessary for adequate anesthesia (intratracheal technique was used). The operative technique was described as starting with a longitudinal incision from the cricoid to the level of the fourth costal cartilage with separation of the sternohyoid muscles. A finger was inserted under the manubrium and both pleural reflections were pushed aside. The sternum was split to the fourth cartilage and divided transversely. The muscle and fascia at the base of the sternohyoid muscles were divided. Thymic tissue was usually found below the level of the left innominate vein, although the gland may extend to the inferior pole of the thyroid gland, and there was usually a lateral lobe extending under the pleura. The vessels communicated mostly with the thyroid or internal mammary vessels. The thymic mass was removed by dissection from the attachments to the pericardium and fascia over the aorta and great vessels. No drainage was used, the sternal flaps were approximated with braided silk, and then the remainder of the incision was closed. Clagett (36, 38) preferred the sternal splitting approach, similar to the one described, for the usual case as it gave a good view and was extrapleural. He mentioned the use of a posterior approach with division of the costal cartilages and the posterolateral incision which gave good exposure but was transpleural.

Sauerbruch, whose cases were reported by others (4, 135, 154) was credited with the first attempt to cure myasthenia gravis (21, 35). He attempted the removal of the thymic mass in 3 cases with death in the 2 later cases of tumor and failure to cure in the original case (enlarged gland) although improvement was noted. Haberer was cited for the second attempt and apparently here only involution of the thymus was present. The excision of the large tumor reported by Andrus and Foot (10) apparently was the first successful removal of a thymoma, and this was considered essentially nonmalignant. Myasthenia gravis apparently was not diagnosed in the case although fatigability was noted (36). Blalock *et al* (21) first reported the removal of a cystic, necrotic, thymic tumor in a case of myasthenia gravis in 1939 the patient was followed up for some time and appeared to be essentially well. Blalock and his colleagues (23) later reported operation on 6

cases of myasthenia gravis with no roentgenological evidence of tumor but in which a persistent thymus was found in every case. Poer in 1942 believed his successful removal of a malignant thymic tumor in a case with myasthenia gravis was the first instance of such a circumstance. Turnbull also removed such a tumor but failed to influence the course of the disease. The other surgical reports were noted in the first paragraph with the exception of the thymectomy of Leriche and Jung following which there was no early improvement. It is of interest to note that in at least 2 cases operated on there was an associated hyperthyroidism (17, 34).

Clagett and Eaton (36) collected 8 cases of thymic tumor in myasthenia gravis in which operation was carried out (cases of Blalock *et al* and Campbell Fradkin, and Lipetz Poer Turnbull and Sauerbruch) and they classified the results as 2 of benefit, 2 remissions, 1 of no benefit, and 3 more such cases of tumor in which the results of their disease uninfluenced 1 case was operated on too recently for classification. Blalock (22) recently reported 2 cases in which a tumor was removed and classified the results as 1 patient considerably benefited and 1 essentially well. Hardyman and Bradshaw recorded 1 case in which removal of a benign thymoma gave benefit. Thus, excluding the first case of Sauerbruch (154) there were at least 15 benign and malignant tumors of the thymus that occurred in myasthenia gravis for which operation was carried out, and the results were described as remissions or of benefit in 8 cases too early for classification in 1 case of no benefit or influence on the disease in 3 cases, and death in 3 cases.

Blalock (22) reported 20 cases in which thymectomy was performed in the treatment of myasthenia gravis, which included the 6 cases of a previous publication (23). In this series the duration of illness was from 7 months to 12 years and the follow-up period was from 6 months to 2 years and 9 months. The results were given as 4 deaths (3 early), 3 of little if any benefit, 5 of moderate benefit, 5 of considerable benefit, and 3 essential cures. If the 2 cases of thymoma are excluded in Blalock's series and the cases of Sauerbruch (154) Clagett and Eaton (36) Hardyman and Bradshaw Leriche and Jung and Haber are added, the total results in 23 cases without tumor but in which thymectomy was performed are 4 deaths, 5 results of no or little benefit, 13 of benefit in various degrees and 1 result which is too recent for evaluation.

If the results reported in the letter of Viets (which included 3 tumors not reported separately as to results) read by Blalock (22) are added to the combined figures for both the tumor and non tumor groups in which thymectomy was performed in myasthenia gravis, the total of the results for both groups becomes 11 deaths, 9 of no or little benefit, 28 of benefit in various degrees and 4 too recent for classification in a total of 52 cases.

#### LYMPHOMAS LYMPHOCYTOMAS LYMPHOSARCOMAS LEUCOSARCOMAS HODGKIN'S DISEASE

Heuer and Andrus (98) stated that there was no set classification of these tumors and that it was difficult to classify them with accuracy. These authors cited a classification of Ewing according to cell origin, namely from lymphocytes, reticulum cells, or endothelial cells of lymphoid tissue. It was considered that simple lymphomas malignant lymphocytoma, and leucemias arose from lymphocytes and that myeloid leucemia, malignant granulomas Hodgkin's disease and large cell lymphosarcomas were derived from reticulum cells. Endotheliomas were considered as developing from endothelial cells.

Heuer and Andrus discussed simple lymphomas (of which type none was noted by them) malignant lymphocytomas, lymphosarcomas, and Hodgkin's disease. Malignant lymphocytomas were considered as a clinical rather than a pathological group of tumors and included malignant lymphocytomas not otherwise designated by them, malignant lymphadenomas and possibly small cell leucemia. The basis for the group was lymphatic small cells resembling lymphocytes. Lymphocytomas were considered as moderately large tumors arising in the anterior mediastinum, extending up and through the mediastinum, surrounding the mediastinal structures, invading the organs, and metastasizing distally. The tumors were described as hard nodules resembling sarcoma of the small lymphocytic type. The third group or lymphosarcomas, was considered fairly common and the writers found 18 cases in a series of 145 mediastinal tumors. These tumors were said to arise from the mediastinal lymph glands or thymus, usually in the anterior mediastinum surrounding and compressing the mediastinal structures. Lymphosarcomas were not considered as being very invasive, although they may extend into the retroperitoneal region below the diaphragm and may metastasize. The tumors were described as hard with little necrosis and made up of mulitized lymphoid cells with hyperchromatic

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Sauerbruch, whose cases were reported by others (4, 135, 154) was credited with the first attempt to cure myasthenia gravis (21, 35). He attempted the removal of the thymic mass in 2 cases with death in the 2 later cases of tumor and failure to cure in the original case (enlarged gland) although improvement was noted. Haberer was cited for the second attempt and apparently later only involution of the thymus was present. The excision of the large tumor reported by Andreu and Foot (10) apparently was the first successful removal of a thymoma, and this was considered essentially nonmalignant. Myasthenia gravis apparently was not diagnosed in the case although fatigability was noted (36). Blalock *et al* (24) first reported the removal of a cystic, necrotic, thymic tumor in a case of myasthenia gravis in 1939 the patient was followed up for some time and appeared to be essentially well. Blalock and his colleagues (23) later reported operation on 6

cases of myasthenia gravis with no roentgenological evidence of tumor but in which a persistent thymus was found in every case. Poer in 1942 believed his successful removal of a malignant thymic tumor in a case with myasthenia gravis was the first instance of such a circumstance. Turnbull also removed such a tumor but failed to influence the course of the disease. The other surgical reports were noted in the first paragraph with the exception of the thymectomy of Leriche and Jung following which there was no early improvement. It is of interest to note that in at least 2 cases operated on there was an associated hyperthyroidism (17, 34).

Clagett and Eaton (36) collected 8 cases of thymic tumor in myasthenia gravis in which operation was carried out (cases of Blalock *et al*, Campbell, Fradkin and Lipetz, Poer, Turnbull and Sauerbruch) and they classed the results as 2 of benefit, 2 remissions, 1 of no benefit, and 3 early deaths. The writers reported, in addition 5 more such cases of tumor in which the results were 2 patients made well, and 2 with the course of their disease uninfluenced. 1 case was operated on too recently for classification. Blalock (22) recently reported 2 cases in which a tumor was removed and classed the results as 1 patient considerably benefited and 1 essentially well. Hardyman and Bradshaw recorded 1 case in which removal of a benign thymoma gave benefit. Thus, excluding the first case of Sauerbruch (154) there were at least 15 benign and malignant tumors of the thymus that occurred in myasthenia gravis for which operation was carried out, and the results were described as remissions or of benefit in 8 cases, too early for classification in 1 case, of no benefit or influence on the disease in 3 cases, and death in 3 cases.

Blalock (22) reported 20 cases in which thymectomy was performed in the treatment of myasthenia gravis, which included the 6 cases of a previous publication (23). In this series the duration of illness was from 7 months to 12 years and the follow-up period was from 6 months to 2 years and 9 months. The results were given as 4 deaths (3 early), 3 of little if any benefit, 5 of moderate benefit, 5 of considerable benefit, and 3 essential cures. If the 2 cases of thymoma are excluded in Blalock's series and the cases of Sauerbruch (154), Clagett and Eaton (36), Hardyman and Bradshaw, Leriche and Jung and Haberer are added the total results in 23 cases without tumor but in which thymectomy was performed are 4 deaths, 5 results of no or little benefit, 13 of benefit in various degrees, and 1 result which is too recent for evaluation.

If the results reported in the letter of Viets (which included 3 tumors not reported separately as to results), read by Blalock (22), are added to the combined figures for both the tumor and non tumor groups in which thymectomy was performed in myasthenia gravis, the total of the results for both groups becomes 11 deaths, 9 of no or little benefit, 28 of benefit in various degrees, and 4 too recent for classification in a total of 52 cases.

#### LYMPHOMAS LYMPHOCYTOMAS LYMPHOSARCOMAS LEUCOSARCOMAS HODGKIN'S DISEASE

Heuer and Andrus (98) stated that there was no set classification of these tumors and that it was difficult to classify them with accuracy. These authors cited a classification of Ewing according to cell origin, namely, from lymphocytes, reticulum cells, or endothelial cells of lymphoid tissue. It was considered that simple lymphomas, malignant lymphocytoma and leucemias arose from lymphocytes and that myeloid leucemia, malignant granulomas, Hodgkin's disease and large cell lymphosarcomas were derived from reticulum cells. Endotheliomas were considered as developing from endothelial cells.

Heuer and Andrus discussed simple lymphomas (of which type none was noted by them), malignant lymphocytomas, lymphosarcomas, and Hodgkin's disease. Malignant lymphocytomas were considered as a clinical rather than a pathological group of tumors and included malignant lymphocytomas not otherwise designated by them, malignant lymphadenomas, and possibly small cell tumors of the thymus associated with lymphatic leucemia. The basis for the group was tumors of small cells resembling lymphocytes. Lymphocytomas were considered as moderately large tumors arising in the anterior mediastinum extending up and through the mediastinum surrounding the mediastinal structures invading the organs, and metastasizing distally. The tumors were described as hard nodules resembling sarcoma of the small lymphocytic type. The third group or lymphosarcomas was considered fairly common and the writers found 18 cases in a series of 145 mediastinal tumors. These tumors were said to arise from the mediastinal lymph glands or thymus, usually in the anterior mediastinum surrounding and compressing the mediastinal structures. Lymphosarcomas were not considered as being very invasive, although they may extend into the retroperitoneal region below the diaphragm and may metastasize. The tumors were described as hard with little necrosis and made up of multilayered lymphoid cells with hyperchromatic

nuclei in reticular tissue and with destruction of the node architecture. Heuer and Andrus observed that in a few cases of Hodgkin's disease the mediastinum may appear as the seat of the disease, although it was usually involved later and they emphasized that the involvement was only a part of the general picture. These writers noted that the glands may remain discrete or demonstrate invasive qualities as a mass surrounding mediastinal structures and extending to other organs. The microscopic picture was described as a diffuse cellular hyperplasia with endothelial cells, giant cells, plasma cells, eosinophile leucocytes, and Dorothy Reed cells. Twenty nine cases of Hodgkin's disease were found in a series of 145 mediastinal tumors.

Haagensen discussed these tumors and described the small round cell lymphosarcoma (malignant lymphocytoma) as rare and as occurring in the thymic area with wide metastasis. Large round cell lymphosarcoma (reticulum cell) was considered frequent and he expressed the view that its origin was unknown—whether from the thymus, lymph nodes, or both. He stated that lymphatic leucemia involved the mediastinal nodes and that the thymus for the most part was not involved. Leucosarcomatosis was characterized according to him, by leucemic and lymphosarcomatous features. A blood picture with predominant large mononuclear cells and usually involvement of the anterior mediastinal nodes and other tissues with an overgrowth of the large mononuclear cells in the lymphatic tissues was noted. Infiltration of the adjacent organs in the mediastinum as in sarcoma was considered as differentiating this type from the lymphatic leucemia group. Hodgkin's disease was described by Haagensen as usually originating in the lymph nodes and infiltrating widely. He gave some evidence to suggest a possible thymic origin as distinct from Hodgkin's disease of other organs.

MacCallum commented on the regional character of lymphosarcoma and Boyd (27) also distinguished the small cell lymphocytic and the large cell reticuloendothelial types of lymphosarcoma.

Haagensen gave the age incidence of the large round cell lymphosarcoma and Hodgkin's disease as most often from 20 to 30 years, while small round cell types were usually found in infants. Heuer and Andrus (98) found the age incidence to be somewhat older with a frequency of 2 to 1 in males for lymphocytoma and lymphosarcoma.

Heuer and Andrus (98) found the symptoms and signs of lymphocytoma and lymphosarcoma to be similar in that there were signs of mediastinal

compression and of involvement of the organs with pain, progressive hemoptysis, occasional low grade leucocytosis, and pleural effusions. They noted that these tumors were rapidly fatal, with an average of 32 weeks from the onset of symptoms to death. The signs and symptoms of Hodgkin's disease were considered similar to those of lymphosarcoma although not so fulminating.

Blades (18) considered the lymphomas as usually occurring in the anterior mediastinum. Reby (151) suggested that mediastinal adenopathies were more centrally located in the mediastinum.

Heuer and Andrus (98) observed that the roentgenological appearance of lymphocytoma and lymphosarcoma was of a sharp or diffuse mediastinal mass. They described the appearance of Hodgkin's disease as more sharply defined and lobulated, the mass extending from the cardiac shadow up toward the neck. It was believed that in Hodgkin's disease, good palliative relief could be obtained from roentgen therapy while in the other lymphomas a temporary reduction in size might be expected.

Haagensen pointed out that secondary compressive and inflammatory changes adjacent to the tumor may confuse the roentgen picture. He stated that malignant tumors of lymphatic origin frequently have irregular hazy borders and cited Lenk's observations that lymphosarcoma was most often irregular and hazy. Hodgkin's disease was more clear cut with less evidence of infiltrative growth and the leucemic picture was usually clear cut with polycyclical outline. Haagensen found that lymphosarcomas, Hodgkin's disease, leucosarcomas, and leucemic lymphomas were often very radiosensitive although there was an occasional resistant case. He further noted that small round cell lymphosarcomas and lymphatic leucemia were not very radiosensitive, but that large round cell lymphosarcomas were quite radiosensitive, as was Hodgkin's disease for the most part, while leucosarcomatosis was moderately radiosensitive.

Heuer and Andrus (98) stated that surgery had been of no value as yet in malignant lymphocytoma and lymphosarcoma.

#### NEUROGENOUS TUMORS

Heuer and Andrus (98) analyzed 108 cases of these tumors in 1940. Blades (18) was able to collect 135 and considered primary nerve tumors the most important group of tumors in the posterior mediastinum. Kent, Blades, Valle, and Graham (108) recently reviewed 105 cases from the literature and 18 proved intrathoracic cases from the Barnes Hospital. Harrington (83) in 1934, re-

ported 14 surgically treated cases of mediastinal or intrathoracic tumors termed perineural fibroblastomas, from the Mayo Clinic.

Foot reviewed and classified the tumors of peripheral nerves to indicate the histogenic position of each as follows:

#### Neuroma

1 Cellular (a) primitive and undifferentiated sympathogonioma (neuroepithelioma, neurocytoma) (b) incompletely differentiated sympathoblastoma (sympathicoblastoma, neuroblastoma) (metastasize on right to liver—Pepper and on left to skeleton—Hutchinson) medulloblastic—sympathetic neuroblastoma and sympathetic spongioblastoma pheochromoblastic pheochromoblastoma (c) well differentiated ganglioneuroma—some congenital—may arise from cells in lymph nodes, and some may become malignant—sympathetic neuroblastoma pheochromocytoma (chromaffinoma, paraganglioma, argentaffinoma)

2 Fibrillary (a) true fibrillary neuroma—growth of peripheral nerve fibers (b) false traumatic neuroma—only shell overgrowth with probably no axones appendicular neuroma—Auerbach's and Messner's plexuses—inflammatory?

#### Tumors of the Nerve Sheath

1 Simple or specific (a) poorly or incompletely differentiated neurilemmosarcoma (malignant schwannoma) (b) well differentiated neurilemmoma of Stout (perineural fibroblastoma, neurinoma, schwannoma peripheral glioma) A type with whorls or Verocay bodies—palisading B type myxomatous with fusicellular component.

2 Compound (a) poorly or incompletely differentiated neurogenous sarcoma (b) well differentiated subterminal (cutaneous neuroma) sheath neurofibroma plexiform neurofibroma, neurofibroma (Ranke-neuron elephantiasis neurotoides) neurofibromatosis (von Recklinghausen's disease) associated tumors of neurofibromatosis Pringle's—lipoma—fibroma.

#### 3. Terminal neurogenous tumors.

In Foot's discussion it was noted that in non-myelinated fibers there were sheaths of cells similar to those of Schwann but termed Remak's fibers. Foot also commented that the sheath of Schwann has a limiting Schwann membrane, outside of which is the endoneurium which contains various structures. (Special stains are needed for identification of the structures.) It was thought that there was considerable basis for the common origin of the sheath and nerve. Foot noted that there was no reason why a pure fibroma of the nerve sheath could not occur. Concerning neurogenic sarcoma it was considered that a neurilemmosarcoma and a fibrosarcoma or reticulum cell

sarcoma occurred. Ewing's belief that most of the spindle celled sarcomas of skin and deeper tissues of the limb and trunk arose from peripheral nerves was cited as was a quotation from another source that 53 of 600 neurofibromas were found to have become malignant.

Geschikter believed that the axon myelin, and Schwann sheath were all of neurogenic origin and the endoneurium perineurium and epineurium were from connective tissue. He, as did Ewing cited Virchow as dividing peripheral nerve tumors into false neuromas arising from nerve sheaths and true neuromas arising from nerve fibers and cells. Examples of true neuromas were given as ganglioneuromas, whether occurring in peripheral spinal or sympathetic nerves as well as amputation neuromas and peripheral neuroepitheliomas. False neuromas were considered more common and as occurring in spinal or sympathetic nerves—motor or sensory—centrally or peripherally. Geschikter also commented that one school thought the false type was derived from the sheath of Schwann (neuroectodermal) and the other school from connective tissue sheaths.

Geschikter classified 2 varieties of solitary benign nerve sheath tumors

1 Differentiated—with collagen and fibrous tissue featured and areas of palisade formation of nuclei all enclosed by perineurium except at attachment. These types were considered as rarely becoming malignant and as having been termed perineural fibroblastomas, neurinomas schwannomas, neurilemmomas, and lemmomas. They were considered to be most frequent along the roots of nerves centrally particularly the roots of the cranial and spinal nerves or in subcutaneous tissue, and as occurring mostly in myelinated nerves.

2 Undifferentiated—composed of myxomatous reticulated tissue often in bundles and quite cellular. These types were considered as benign either encapsulated or not, and prone to recur or become malignant. They were considered as more frequent in deep nerves of the extremities or under the epidermis (they may be associated with von Recklinghausen's disease) and as occurring primarily in unmyelinated nerves such as the sympathetic. They have been termed fibromyxomas, fibroneuromas, and myxoid neurinomas and are seen in children or adults. Sarcomas were described as occurring in either type, but usually in the second, and as consisting of groups of plump spindle cells with large nuclei mitotic figures, and giant cells.

Apparently Verocay was usually cited for the theory of origin of certain nerve sheath tumors



from the Schwann cells, which was supported by Masson and by Stout, while von Recklinghausen was sometimes credited for the theory of origin from connective tissue which was advocated by Penfield.

In Trueblood's discussion of neurogenic sarcoma it was pointed out that extension along the nerve may be present for some distance and yet this area may appear grossly normal. It was also stressed that malignant change may occur in von Recklinghausen's disease particularly when of deep nerve origin and, also when apparently benign, the growths may recur as pathological diagnosis is difficult. An incidence of from 10 to 15 per cent of malignant change is cited in this disease. The progressiveness of the disease from childhood to adult was mentioned.

Andrus (9) traced the cells and elements of nerves in the chest from their embryologic origin. He described the origin of both the intercostal nerve fibers from cells in the gray matter and ganglions of the posterior roots as medullary epithelium. The autonomic system was considered to be derived from medullary epithelium by way of the neural crests. The Schwann sheath was also thought to be of medullary origin and the myelin of the same origin as the axis cylinder.

Andrus (9) distinguished between *neurinoma* (*Schwannoma*) and *neurofibroma* with the former arising from cells of Schwann rather than perineural connective tissue and described 2 types: (1) a group consisting of elongated fusiform cells similar to neuroglia of the central nervous system with vacuolated cytoplasm palisading nuclei, and perhaps whorls (Verocay bodies) and (2) the Antoni type with mucoid degeneration mistaken for myxoma and usually reported in peripheral nerves. Malignant tumors of sympathetic origin were described as varying in the degree of immature types of cells and numbers present with a tendency to pseudorosette formation in the more undifferentiated types. Neuroepithelioma was discussed as being characterized by irregular columnar cells with deep staining nuclei arranged in rosettes and lined by an internal membrane. It was thought to be a primitive form of spongioblast. Neurofibromas containing ganglion cells were termed ganglioneurofibromas. No pure neuroma of axis cylinders and sheaths in the chest was observed by Andrus. He apparently believed that 90 per cent of the tumors in the area discussed were benign.

Scott and Palmer outlined the embryonic development of the cells of the sympathetic system as being derived from the neural crests and ventral roots. First in the series is the sympathogonia

which is completely undifferentiated (Kuntz) and later the sympathoblast which is multipotential (Bailey). Pheochromoblasts may develop from sympathoblasts and form the pheochromocytes of the adrenals and paraganglionic bodies; sympathoblasts may develop from them and form mature astrocytes (supportive tissue) or neuroblasts may develop and form the adult ganglion cells of the sympathetics. These authors classified the tumors of the sympathetic system, modified after von Fischer (170) on the basis of embryologic development with tumor types corresponding to the dominant cell types. They pointed out that tumors may contain cells of varying maturity making classification difficult. Their classification follows: (A) completely undifferentiated—sympatheticoblastoma (1) tumors of migratory cells and sympathogonia and (2) sympathoblastoma, (B) incompletely differentiated (1) sympathetico-neuroblastoma (2) pheochromoblastoma, (3) sympathetico-blastoma and (C) completely differentiated, (1) ganglioneuroma (2) pheochromocytoma, and (3) astrocytoma.

These writers described a tumor containing sympathogonia (rounded, small, deep staining nuclei) and sympathoblasts (larger vesicular nuclei) arranged in lobules and sometimes in rosettes.

Schaffner Smith and Taylor described a ganglioneuroma immaturum and 2 other ganglioneuromas of the mediastinum and while the cells were not mature they were thought not to be as undifferentiated as sympathoblasts or neuroblasts. These authors stated that the majority of such tumors arose from the sympathetic chain, or anlage, and emphasized that multiple sections from different areas may show variability and even one small malignant region. Two sympathetico-blastomas were cited from the literature.

Bohrer and Lincoln collected 9 cases of ganglioneuroma and other such types of tumor in the chest of children and added 1. They apparently thought that neuroblastoma was usually found in children and cited instances of both malignant and benign tumors in the same person.

James and Curtis collected 33 cases of mediastinal ganglioneuroma and added 1 in 1941. They considered the neuroblastoma the most common type found in children particularly in the adrenal gland, and thought that true ganglioneuroma was rare in children and benign in its early development. It was believed that there was a low tendency toward malignancy in these tumors and the older the patient the more apt they were to be benign.

Heuer and Andrus (98) pointed out that tumors may arise from any of the nerve elements occur-

ring in the thorax as well as from their intimate connective tissue elements. They also considered the hypothesis that in embryologic development cell rests may be left during early migration or carried outside of the central nervous system to explain the origin of some of the tumors such as those of sympathetic type and neuroepitheliomas.

They (98) considered that neurofibromas arose from connective tissue with degenerative or sarcomatous changes in some and that they usually occurred singly in the chest. These tumors were noted to be of all sizes in all ages and 77 per cent were found in females in a series of 20 collected cases, to which these authors added 1. The ganglioneuromas were considered as originating in sympathetic ganglia, frequently in the upper posterior mediastinum. They were described as encapsulated and firm, but they may have a dense shell with a soft center and be relatively vascular with lobulation on the cut surface. Microscopically fibrous tissue and medullated and non-medullated fibers were noted and ganglion cells spersed. Among 68 cases the age of the patient was stated in 36 and 74 per cent of the cases occurred in children under 10 years of age—females predominated 3.2. Neurinomas (schwannomas) were differentiated microscopically from fibromas and considered of ectodermal origin. They were described as nodular enlargements of a nerve or nodules of various sizes projecting from a nerve, and of 2 microscopic types as noted in the discussion by Andrus (9). Neurinomas were noted as occurring more often in peripheral nerves and the spinal canal than in the thorax. 19 cases were reviewed.

Kent, Blades, Valle, and Graham stated that the differentiated tumors described by Geschikter (neurilemmomas) were the principal type found in the thorax and originated most frequently in the intercostal nerves. The ganglioneuromas were the next most frequent type and if these contained considerable fibrous tissue they believed that these might be termed ganglioneurofibromas. It was also observed that certain of the tumors presenting the picture of neurilemmomas may on other sections demonstrate ganglion cells.

In a series of 105 cases of intrathoracic neurogenic tumors collected from the literature by these authors (108) the tumors in 39 cases, or 37 per cent, were malignant. The authors noted that the neurogenic tumors arising within or close to the mediastinum were less malignant than those occurring in the chest away from the mediastinum. Examination of the data concerning their collection of neurogenic tumors in the mediasti-

nium showed that of 74 there were 59 (79.7%) benign and 15 (20.3%) malignant, whereas of the 27 apparent chest wall tumors 11 (40.7%) were benign and 88.8 per cent malignant. Further analysis of the paper revealed that in the collected cases of mediastinal tumor in which the age and sex were given there were 37 males and 29 females. The average age in the 55 benign cases was approximately 26 and in the 15 malignant cases it was about 17 years.

These authors (108) noted that neurogenic tumors are the most common ones arising in the posterior mediastinum or posterior part of the superior mediastinum and found only 2 (?) in the anterior mediastinum in the literature. Blades found that practically all of these tumors occurred in the posterior mediastinum. His collected neurogenic mediastinal tumors were classed as neurofibromas in 22 cases, ganglioneuromas in 70, neurinomas in 19, and perineural fibroblastomas (all primary nerve tumors) in 24 cases.

Apparently most authors (9, 98, 108, 152) thought that in the majority of cases of neurogenic tumors the onset occurred with various signs of neurological involvement, and that signs of mediastinal pressure occurred late but were not too common. Heuer and Andrus (98) pointed out that the benign tumors may be asymptomatic or the symptoms may begin during a respiratory infection and they may even be those of a respiratory infection. They previously noted (11) that intercostal pain possibly suggested a neurofibroma, whereas when a Horner's syndrome was present early a ganglioneuroma might be considered although the various types of mature tumors can not be distinguished clinically (9). Schaffner Smith, and Taylor believed the most characteristic symptom to be a dull intercostal pain and noted that these tumors may be of the Pancoast type, with or without the syndrome. Harrington (83) believed that a clinical characteristic was the relatively few symptoms for such large benign tumors, but that severe intercostal pain was a distinguishing feature if they became malignant. He found that the average duration of symptoms in his cases was 4 years and that the most common symptom was dyspnea. These tumors have occurred as hourglass tumors of the spine arising in or adjacent to the intervertebral foramina and extending through it with signs of spinal cord compression (71, 98, 108).

Harrington (83, 85) described the roentgenological findings in nerve tumors as consisting of sharp borders even if lobulated and located in the posterior mediastinum with or without pressure erosion of the ribs. Those in the foramina may

demonstrate erosion of the pedicles. Later erosion of the lamina, enlargement of the foramina, and possible widening of the intercostal spaces. He distinguished the destruction of the infiltrative type with irregular bony damage in the malignant lesions from the erosion of the atrophic type in benign lesions. Heuer and Andrus (98) pointed out that such densities were suggestive but not proof of the type present. Kent, Blades, Valle, and Graham were of the opinion that the tumors were usually single in the thorax and that a lobulated appearance suggested rapid growth and malignancy. They also stated that effusion was not proof of malignancy, and that neither benign nor malignant tumors of this group responded to x-ray therapy.

Schaffner, Smith, and Taylor described the intrapleural thoracoscopic appearance of neurogenic tumors as a thin, loose pleura without inflammatory reaction covering a smooth gray spherical mass.

James and Curtis, writing about mediastinal ganglioneuromas in particular, expressed the view that the prognosis was good in operable tumors but depended to some extent on the degree of differentiation of the tumor. Kent, Blades, Valle, and Graham thought that intrathoracic neurogenic tumors should be removed because of the high incidence of malignant change if for no other reason. Harrington (83) believed that the high incidence of benign tumors in his operative series was due to early removal and stressed early removal because of the danger of malignancy or increased size. The only malignant case in his series recurred in 2 years with death.

This author (83) used an approach directly over the tumor, as also advocated by others (98-108) which was usually of the posterolateral periscapular type with subperiosteal rib resection and division under the erector spinae muscles. He found that the tumors were usually surrounded by a vascular capsule. The mass was separated from the lung and adjacent structures. Attention to intercostal vessels and suture of the damaged lung were stressed. Hourglass types were best removed in one stage, and if possible the intraspinal portion was removed first to relieve the pressure symptoms. A laminectomy approach was frequently used (98-108). Wide removal of nerve roots entering or attached to a neurogenic sarcoma was advocated by Trueblood because of the microscopic extension along an apparently grossly normal nerve. Blades and Dugan (19) reported a case of a neurofibroma on the left vagus nerve with 2 likewise located on the thoracic sympathetic chain in a case of neurofibromatosis. All

were resected with no ill effects and the recurrent laryngeal nerve was spared.

Heuer and Andrus (98) collected the results in 108 cases. They found 21 neurofibromas of which 4 were noted at autopsy, 17 were operated on and 29.4 per cent of the patients died while 76 per cent recovered. Of 68 cases of ganglioneuroma 14 were found at autopsy, 51 were operated on and 31 per cent of the patients died while 69 per cent recovered. (The incidence of hemorrhage and shock in the latter group of deaths was noted and more attention to the pedicle is suggested.) Of 19 cases of neurinoma (schwannoma) there were 4 found at autopsy, 15 were operated on and 1 of the patients died while 14 recovered. Among the many cases of intrathoracic neurogenic tumors analyzed by Kent, Blades, Valle, and Graham, there was a mortality of apparently 30 per cent, which was about equally divided between operative and nonoperative deaths.

#### DERMOID CYSTS AND TERATOMAS

Gordon in 1815 apparently was the first to describe dermoid cysts and teratomas. At autopsy Boyd (28) stated that teratoid tumors and lymphomas occurred in about equal numbers in the anterior mediastinum. According to Blades these tumors were twice as frequent as any other in the mediastinum except lymphomas which were noted more often.

Hertzler collected 72 cases plus 1 of his own in 1916. Kerr and Warfield increased the number to 138 in 1928. Hedblom's notable paper written in 1933 consisted of an analysis of 185 reported intrathoracic cases to which he added 6 personal ones. Houghton later added 24 cases to Hedblom's series. Heuer and Andrus (98) including their own cases, brought together 217. The latest review was that of Rusby, of 1944, in which he considered a total of 251 cases. There have been numerous reports of which some of the more recent ones were of particular interest. (48) Harrington (87) has reported one of the largest series from a single clinic, consisting of 16 cases.

Hedblom stated that the consensus of opinion at that time was that congenital cystic tumors which contained epidermal derivatives were usually termed epidermoids or dermoids, those demonstrating derivatives of mesoderm were called dermoids or teratomas, and those that consisted of elements of all 3 germinal layers were usually labeled teratomas. Hertzler was able to collect 18 reports of those he considered the epidermoid type, and 25 with two or more germ layers represented. Phenilster, Steen, and Voldersauer added 22 cases to Hedblom's group, and found that in 3

series of 206, 162 were of the dermoid variety and 46 were of the teratomatous type. Smith and Mills differentiated between dermoid and teratomatous groups, more or less on the above basis. MacCallum denoted dermoids as simpler forms of teratomas containing essentially derivatives of ectoderm, and discussed epidermoid wens at the extreme end of the scale. Boyd (27) apparently regarded dermoids as derived of ectoderm and teratomas as derived of more than one germinal layer. Harrington (82) apparently favored grouping all the tumors of the group derived in various degrees from all three germ layers under the term *teratoma*, with a subclassification. The latter derivation of the group was also considered by Rusby (151) who subdivided the tumors into *teratomas of the dermoid type* (simple cystic variety) and *solid teratomas*.

A number of cases were reported as apparently originating in the thymus, according to Heuer and Andrus (98). A probable origin was given by Hedblom as in the region of the branchial clefts, and this author noted cases with the tumor pedicle attached to the thyroid and thymus glands as well as to other areas of the mediastinum. He also cited these two theories (1) development from the same host embryo and (2) origination from an independent embryonal anlage such as a parasitic fetus occurring as a fertilized polar body or independent blastomere. He noted that some believed that only teratomas developed according to the second theory. Rusby stated that earlier authors tended to consider dermoids as of different origin than teratomas. They considered some as inclusions that resulted from embryonic fissure closure. This was thought to be an explanation for the occurrence of presternal dermoids with no connection to the mediastinum although some occurred as hourglass tumors through the sternum. Because there were so many borderline cases between pure dermoid (ectodermal?) types and teratomas of 3 germ layers in the literature, Rusby believed that both have a common origin. Boyd (27) apparently subscribed to the theory of inclusions of dermal tissue in the case of congenital dermoids as distinct from teratomas. He considered the premise that the latter were a product of the parthogenetic development of a segregated early germ cell. A similar view was held by MacCallum. The conception was extended further—the first segments of the blastomere were totipotent (develop near fetus) while the latter segments were multipotent and did not result in such a complete development (27). Ewing apparently gave credence to many of the different theories of origin, according to the loca-

tion and structure of the tumors. He noted that the conception of specificity of cells in germ layers was undergoing reconsideration and that the theory of a budding process was being given more consideration (budding or pinching off from early embryonic structures). The influence of organizer substances upon the development of cells in this connection, as summarized by Schwarz and Williams will be given later.

Hedblom described the structure of his class of epidermoid cysts as consisting of a cyst wall lined with stratified squamous epithelium with a stratum corneum with or without glandular tissue of ectodermal origin and containing products of ectoderm in which there may be various degrees of degeneration. He considered dermoids as demonstrating lobulation or being multicystic and presenting areas of thickening plus mesodermal elements such as cartilage, bone, teeth, and muscle. Teratomas were defined as being more or less solid and also containing derivatives of ectoderm—some of the more complex tissues resembling the pancreas, intestines, and thyroid gland with occasional organized arrangements of tissues suggesting coils of intestine, the above formations, and appendages being present. In a total of 184 cases analyzed by Hedblom there were 96 of epidermoid type, 50 of dermoid type and 38 of the teratomatous variety. Harrington (80) reported an unusually well differentiated organoid fetallike tumor. This writer (82, 87) also suggested that if enough sections were made derivatives of more than one germ layer would be found in this group of tumors. Rusby pointed out the frequent presence of a ridge or protuberance from which hair grew and which often contained cartilage in the simpler dermoid variety. He believed that this type was normally enclosed in a fibrous capsule with a pedicle and noted that there may be clusters of cysts. MacCallum mentioned the hairbearing thickened patch and also pointed out that such complicated ectodermal elements as derivatives of the eye and central nervous system may be present. Also the thick, often brownish fluid containing fat and cholesterol crystals was noted by Phemister and his colleagues. The size of the tumors varied from that of a pigeon's egg to a size weighing 6,000 gm. or a capacity of 4 quarts or more, according to Hedblom. Heuer and Andrus (98) noted that the solid types were less frequent than the more cystic variety.

Rusby found in his review of the literature that the solid teratomas differed from the cystic dermoid types in their tendency toward malignancy. In the extensive group studied 70 per cent of the malignant tumors arose in the solid types and 30

per cent in the dermoid types. There were 27 malignant tumors among the 209 cases analyzed, or 12.9 per cent. In Hedblom's collection (185 plus 6 personal cases) there was malignant degeneration into carcinoma, sarcoma, chorioepithelioma, and other types in 17 cases, with metastasis in 8 cases.

Doran and Lester cited an incidence of 80 per cent for the benign types of these tumors and considered that those possibly malignant from the start occurred mostly in children, whereas those appearing late occurred in the cancer age. Three of Harrington's (87) 16 cases were malignant, of which 2 were squamous cell carcinomas occurring in dermoid types and the other case was an adenocarcinoma in a teratoid type. There were 5 of 13 cases of Heuer and Andrus (98) which had become malignant at the time of operation. Graham (67) stated that the incidence of malignancy in his series of 12 cases was 41.6 per cent. Chorioepitheliomatous proliferation in a teratoma was described by Frank, although the case did not rest on too secure a footing in that account. Rusby called attention to the significance of the Asheim-Zondek test in this connection, in the absence of pregnancy and of testicular teratoma.

In a series of 233 collected cases, Blades noted that only 3 of these tumors were in the posterior mediastinum, while the others were apparently located in the anterior mediastinum. This was about the same distribution as described by others (90, 98, 109). Schwarz and Williams expressed doubt that any dermoid tumor has been proved as originating in the posterior mediastinum. Harrington (87) described the usual origin of these tumors as in the region of the base of the great vessels and pericardium. They frequently were noted adjacent to the anterior pericardium (98). Hedblom observed that in 176 cases, 13 tumors were between the mediastinal pleura and behind the sternum (retrosternal), 19 presented in the suprasternal notch or from behind the sternoclavicular joint (cervicosternal) and the remainder originated in the anterior thorax generally and extended into either thoracic cavity (anterolateral thoracic). Rusby called attention to those situated preternally with no connection to the mediastinum and to those with hourglass connections through the sternum. Intrapericardial teratomas were described and some as probably originating in the diaphragm were noted (15, 62, 87, 90).

Rusby noted no particular sex predilection. Among the 171 cases of Hedblom's collection in which the sex was stated, there were 79 males and 92 females. Hedblom also found that the majority of cases were observed operated on or noted at

autopsy before the age of 30, and, among 171 cases, there was only 1 patient in the sixth decade. There were 26 cases in his series in which the patient was under 12 years and some cases were found in patients as young as 3 to 4 months. Among 174 cases analyzed by Rusby there were 68 patients between 20 and 29 years of age, 7 between 10 and 19, and 37 between 30 and 39. Heuer and Andrus (98) found that in most cases the patients were observed in the third decade and only 5.5 per cent of the tumors were noted in patients under the age of 12.

Heuer and Andrus (98) described the tumor as growing slowly with symptoms appearing rarely before puberty. They also commented that the majority of cysts causing symptoms were of the lateral thoracic variety and that symptoms implicating involvement of local structures were less frequent than the general ones due to increased pressure in the mediastinum. Carlson stated that a feature of teratoid tumors was the absence of symptoms for a long period. Hedblom noted that the onset of symptoms was insidious in about 15 per cent of the cases and abrupt in many of the remainder, some cases being symptomless and discovered by examination. He observed that the duration of symptoms to autopsy or operation in 100 cases was under 6 months in 37, from 6 months to a year in 22, from 1 to 3 years in 34, and from 5 to 10 years in 18. In the same analysis, hair was expectorated by at least 26 patients, with fatty or sebaceous material and cholesterol crystals noted in several. Bulging of the chest wall in 33 patients and tumor of the neck in 19 were also mentioned in this analysis of the older case reports. Harrington (87) thought the most common features of these tumors were the intermittent symptoms with gradual progression and the association with respiratory infections. He also noted that this type of tumor was the only one in the thorax which may have a pathognomonic clinical symptom—the expectoration of hair in dermoids. Rusby believed that a palpable mass occurred late although other signs or symptoms may be mild, and described the other physical findings, when present, as signs of a mass in the chest and its complications.

Episodes and complications occurring in the course of these tumors were described by Rusby as growth with subsequent pressure effects, bronchocystic fistula (with or without infection), rupture into adjacent structures, adherence to adjacent structures, and the development of malignancy. Adhesions in some instances were considered to be due to the irritation of constant pulsation from vascular structures. Rusby suggested

that vigorous anterior pulsation of the chest, persistent tachycardia, and a right axis deviation of the electrocardiogram might indicate adherence of the tumor to the pericardium. Infected cysts may enlarge with pressure effects or rupture into the pleural cavity (empyema) or bronchus with the expectoration of foul sputum, hair and blood and thus simulate the picture of abscess or another suppurative process. It was also emphasized by Rusby that the cysts may be infected, in the absence of fistula, via the blood and lymph streams. Heuer and Andrus (98) pointed out that infection was the most common complication. One explanation of the enlargement was offered by Hertzler—an irritation of chemical nature. Hedblom noted that some of the complications may even obscure the picture of tumor. The pain was considered more prominent progressive and severe in malignant cases (82).

Rusby cited authoritative sources for the statement that an irregular, lobulated, defined mass in the anterior mediastinum on the roentgenogram was suggestive of teratoma in contrast to a rounded dermoid. He noted that a pedicle was seen on an occasional film and emphasized the use of lateral and oblique films in identifying calcified areas. Also an air fluid level in the case denoted a fistula to an air passage. Fluoroscopy is of aid in this connection and in identifying the relationship to adjacent structures, according to Rusby. Others have noted that lobulation was suggestive of the more solid teratomas (46, 141). Harrington (87) pointed out that one of the difficulties in x-ray diagnosis was interfering inflammatory changes. Phemister, Steen and Volderauer observed a shifting fluid level (line) without air in the cystic types, due to a layer of fat floating on aqueous fluid, which was confirmed by examination and analysis of a surgical specimen. Evidence was cited (151) that roentgen therapy did not affect even the malignant teratomas.

In a group of 209 deaths analyzed by Rusby there were only 9 or 4.3 per cent, in which the tumor did not contribute to the death and in 8 of these 9 the tumors were of the dermoid variety. For 47 patients who had had no previous active treatment and who died, the history varied from 14 years to 2 weeks, with an average of 1.8 years, and included both benign and malignant tumors. Heuer and Andrus (98) noted in a review of 217 cases that the 47 untreated patients all died of the disease. They mentioned 1 patient followed up for 44 years from whom the tumor was not removed.

Surgical treatment was required for the prevention or relief of complications (90, 151) and the presence of same adversely affected the results of

treatment according to Hedblom (90). Harrington (82) stressed the removal of these tumors. Hedblom cautioned against simple drainage in the apparently noninfected cysts because of the added risk from the consequent infection and adhesions as well as the poor results obtained. Heuer (1195) advised a 2 stage operation for infected tumors with drainage to clear up the infection before removal as it was better than risking the infection that might follow primary removal. He warned against drainage of defects left by the excision of noninfected dermoids. Rusby pointed out that partial removal and marsupialization could be used if the tumor were too adherent for removal or the patient a condition poor and perhaps later removal could be completed with the benefits of reduced size and infection even though there are possibilities of sinus formation or malignant change in the remaining portion. He thought the transpleural approach was best if infection were feared or if the neoplasm were of a large size. For upper retrosternal tumors he suggested a transverse cervical collar incision with splitting of the sternum as recommended by others (82, 90) whereas the trapdoor incision was considered of value for the thoracic substernal location except for the lateral thoracic type. Harrington (82) preferred the posterior approach in most instances because of better exposure and Graham (67) suggested the inframammary approach especially in women for cosmetic reasons.

Bastianelli was credited with the first surgical removal of a dermoid cyst with cure. Hedblom noted that of 99 patients operated on there were 47.4 per cent cured, 32.3 per cent improved although with a complicating sinus, and 16.1 per cent died. The greatest cause of poor results and death in these cases was infection such as empyema and pericarditis.

Heuer and Andrus (98) reviewed the results in a total of 217 cases of which 32 were discovered at autopsy, 47 of the patients were untreated and died and in 8 the results were not known. The other 130 patients were subjected to various operations. One child died at operation in which drainage was attempted of an empyema resulting from a ruptured cyst. In 2 cases the cysts were exposed and aspirated with 1 death and 1 failure. Five patients were inoperable, 3 with malignancy, 1 died 13 days after exploration and 1 patient recovered from operation but died of the disease. Drainage or marsupialization was done in 34 cases with 9 deaths but only 5 cures. Partial resection was carried out in 12 cases with 2 deaths and 5 cures. Total excision was done in 76 cases with 8 deaths (10.7%) and 68 cures (89.3%) in con-

trast to a mortality of 26.5 per cent and cure in 15 per cent following drainage operations, and a mortality of 16.6 per cent and cure in 41 per cent following partial resection.

In the recent analysis of Rusby there were 31 patients subjected to rib resection and drainage as the only procedure. 13 were benefited, 14 died and for 4 the results were not stated. Rusby thought a number of cases in this group were collected from the older literature and mistaken for empyema. There were 15 patients treated only by partial removal and marsupialization, 9 were benefited, 4 died, 1 had an unsatisfactory result and for 1 the result was not stated. Complete removal in one or more stages was performed in 60 instances, 53 patients were cured although some small tags were left, 4 were benefited but had fistulas, and 3 died. There was no case of malignancy which was cured that was known to Rusby.

In Harrington's (87) published series of 16 cases, of which 3 were malignant, 13 patients were living but 2 did not recover from the operation. There was a complicating empyema in 5 cases, mediastinal abscess, osteomyelitis of the ribs, pneumonia, and embolism were also mentioned. Graham (67) removed 7 benign tumors without mortality.

#### BRONCHOGENIC CYSTS—CILIATED EPITHELIAL CYSTS

Hare was cited as not finding any cysts of this type in 600 mediastinal tumors reviewed prior to 1899. Alford collected 10 cases (2 described as in the pericardium) and added 1 in 1937. Heuer and Andrus (98) were able to collect 25 cases of ciliated epithelial cysts of the mediastinum and added 1 in 1940. Brown and Robbins (31) discussed 12 cases in which operation was performed between 1934 and 1943 at the Massachusetts General Hospital. Thornton and Adams (3) published 3 surgical cases. A few other isolated cases were reported recently (35, 69).

Brown and Robbins believed such cysts were congenital malformations of tracheobronchial origin but doubted if all were of pure bronchogenic origin. The theories of development as given by Carlson were diverticula of the endoderm and mesoderm from the foregut, secondary budding of the tracheal anlage or later abnormal division of the respiratory buds, or imperfect closure of the communication between the trachea and esophagus. Heuer and Andrus (98) held a somewhat similar conception. Freedlander and Gebauer, among other premises, commented on the potency of a given germ layer—entodermal cells of the foregut may become separated which might pro-

duce cysts even if not included in the respiratory bud—and mentioned that the early foregut was lined with ciliated epithelium. Tracheobronchial diverticula have been discussed as examples of similar forms of abnormal development in this connection (3, 12, 58). These cysts are derived of mesoderm and endoderm, according to Carlson.

This writer (35) described the cysts as containing any of the bronchial elements. A ciliated epithelial lining with a wall which may contain such elements as mucous glands, fibrous tissue, elastic fibers, smooth muscle, cartilage, nerves, and vessels may compose the structure of these cysts, and frequently a milky fluid is found in them (3, 21, 35, 98). Adams and Thornton (3) noted that in some the epithelium may be absent or atrophic and the fluid contained under pressure. Greenfield and Touroff described a case of a thin walled cyst lined by columnar epithelium and containing crystal clear water, possibly of a different origin. Freedlander and Gebauer noted the theory that if cysts were developed before the fifth generation of respiratory budding fluid was contained, but if formed later air was present. These authors also differentiated between an accessory bronchogenic form with a tracheobronchial communication and an aberrant closed bronchial form. Brown and Robbins noted that some of the simpler cysts might be of pleural or pericardial origin.

Carlson found that these cysts were usually less than 5 cm. in size and apparently originated in the posterior superior mediastinum. Other authors described them as commonly located in the region of the trachea and major bronchi, usually on the right side (3, 58, 98). Blades classified bronchogenic cysts with other cysts in the anterior mediastinum. Heuer and Andrus (98) pointed out that such cysts may be found along the esophagus, particularly its lower portion. Brown and Robbins described several cysts intimately associated with the esophageal musculature and noted that they may be anywhere in the mediastinum.

Carlson expressed the opinion that bronchial cysts produced symptoms early in life before becoming large, by their effect on the respiratory passages. Heuer and Andrus (98) indicated that a number were asymptomatic but the presence of others was suggested by signs of mediastinal pressure or the development of infection. Adams and Thornton pointed out the incidental finding of these cysts on x-ray films and stated that their course depended on their size and location. In 1 of their surgical cases the cyst was infected by coccidioid-like organisms. Freedlander and Gebauer noted that accessory types of congenital

malformations with tracheobronchial communications were more apt to produce clinical signs than the aberrant types, although the latter may become infected through the blood and lymph channels. Brown and Robbins observed that the presenting symptom was usually pain followed later by the other signs of a mediastinal tumor and that expectoration of foul sputum may occur in those infected cysts which communicate with the tracheobronchial tree. They found that the duration of symptoms in their review was from 1 to 25 years.

Robbins described the most important roentgenological sign as a smooth round or ovoid shadow anywhere in the mediastinum without evidence of bony erosion or calcification. He believed that if the density was beneath the carina and there was evidence of tracheal attachment, or of intramural extramucosal involvement of the esophagus, this supported the impression. In addition to the use of conventional x ray films, fluoroscopy and contrast media he suggested the use of laminograms in locating the cysts and demonstrating changes in adjacent tissues. It was further stated by him that there was less inflammatory reaction around infected cysts than in the picture of lung abscess although a fluid level may be present.

Freedlander and Gebauer believed it was impossible to predict the risk incurred by the presence of these cysts. Because of the difficulty in differentiation from other tumors and cysts Heuer and Andrus (98) thought that the cysts should be removed. In addition Adams and Thornton (3) thought exploration and excision were indicated because of the dangers of complications such as enlargement with pressure symptoms and infection. They also noted that partial excision with destruction of the remainder was indicated if complete removal was dangerous, but they avoided drainage unless infection was present, because of sinus formation. Brown and Robbins believed that, as the frequent cause of symptoms was infection which increased the technical difficulties, delay until its appearance increased the risk. They likewise favored removal when possible as the diagnosis was made with the tumor out and the operation was usually technically easy and safe.

In the series that Brown and Robbins analyzed there were 10 clean cases of cysts 7 cysts were removed with cure of the patients, 1 cyst was partially excised with cure and 1 was aspirated with complicating empyema. The last patient was cured after a thoracoscopy. There were 2 infected cases, 1 of the patients being well after drainage

and removal of the cyst, and the other still draining 6 years after marsupialization. In the collected cases of Heuer and Andrus (98), many of the cysts were found at autopsy and in 12 cases operation was performed. In 8 of the 12 cases the cysts were removed—5 were excised in one stage and 3 were taken out after preliminary drainage but in the other 4 cases only drainage or partial removal was carried out. All 12 patients recovered although 1 had a fistula.

Freedlander and Gebauer pointed out that *accessory and aberrant pulmonary lobes* may occur in the mediastinum or be attached to its structure by a stalk, although the aberrant types were frequently located on the left between the lower lobe and the diaphragm. Most aberrant lobes and cysts were found at autopsy in infants, according to the writers. Accessory lobes were considered as behaving as other lobes but possibly being more susceptible to pathological processes. Aberrant lobes were described as containing dilated bronchial radicals, epithelial lined cysts, cartilage, smooth muscle, and little alveolar structure with the blood supply from the thoracic aorta and the return to the azygos vein along the stalk. Their origin was suggested as similar to that of the cysts just discussed and they may have a similar course. Accessory types were considered to be more amenable to roentgenological and other means of diagnosis than aberrant types which present no typical picture. The writers noted that such malformations may cause symptoms because of location size pressure from growth and resultant pleural effusions, or because of becoming infected like cysts. They described 2 cases of aberrant lobe in the region of the mediastinum, one of which was surgically removed. Harrington (81) discussed the removal of a cystic azygos lobe from the posterior mediastinum.

#### GASTROENTEROGENOUS CYSTS

Roth was credited with reporting a case of cyst lined with intestinal epithelium in the thorax and another in the abdomen in 1881 and as quoting 2 similar cases. Mixer and Clifford reported 2 cases of gastrogenic cyst in 1929 Poncher and Miles described in 1933 a case of multiple gastroenterogenous cysts in the mediastinum and abdomen with intestinal diverticulum and ulcer. Brass was cited as reporting 1 case and having collected 3 cases of cysts lined with intestinal mucosa with associated intra-abdominal cysts. Black and Benjamin reported a case in which it could not be determined whether the thoracic cyst was of gastrogenous or enterogenous makeup and there was an accessory intestinal pouch in the mesen-



tery, containing an ulcer and communicating with the jejunum. Boess and Seydel are credited with cases of peptic ulcer in gastrogenic cysts with perforation into the lung and hemorrhage. Ladd and Gross described 2 cases of intrathoracic gastrogenic cysts. Nichols reported a case of gastric cyst in the mediastinum previously treated for empyema by mistake. He analyzed 10 cases of gastrogenic cyst of which 1 contained both gastric and esophageal mucosa and another with ciliated respiratory epithelium in addition to gastric mucosa. In addition to these 10 cases in his collection there was 1 intestinal cyst (Brass) and 1 cyst composed of tracheal and esophageal elements. Schwarz and Williams observed 3 cases of thoracic gastric cyst 1 of which contained functional mucosa and including their own, were able to analyze 5 collected cases with evidence of secretory function in the cyst, and 7 with no activity some of which contained respiratory as well as intestinal lining. Carlson recently reported the excision of a gastric or gastroenteric cyst in this location.

A gastric mucosa containing parietal, chief, and goblet cells surrounded by 3 layers of muscle with the outer and inner strata running in the same direction was described in gastrogenic cysts, and even Brunner's glands were noted (155). Calcification in the wall and pedicle attachment to the mediastinum were also observed. Varying degrees of destruction of the mucosa and wall from pressure, inflammation or perhaps from digestive juice were pointed out (144). Vagal nerve elements were found in the case of Brass.

The pinching off of buds or diverticula from the foregut, intrathoracic vestiges of the omphalo-mesenteric duct, specific entodermal germ cells of esophagus capable of further development, and fetal inclusions were offered by various authors as explanations of the origin of these cysts (17, 35, 133, 144). Schwarz and Williams believed that the mechanism of origin of gastrogenic cysts was

with all others on the right, when position was mentioned in the reports (133, 155). Carlson commented that the onset of symptoms occurred early in life and that all the reported enteric cysts were found in early infancy. Schwarz and Williams also found that these cysts were manifested early although one of their gastric cysts was in a patient 23 years of age. In the 12 cases analyzed by Nichols, there were only 2 patients over the age of 3 years.

Schwarz and Williams felt rather certain that gastric cysts with functional secretory activity could be distinguished more readily and differentiated from gastroenterogenous cysts of mixed make-up by the more pronounced symptomatology such as pain and pressure symptoms in the former. They noted the presence of skin excoriation in the group with secretory activity when they were drained and the relatively frequent presence of ulcers with perforative complications, and pointed out the use of laboratory analysis of the contained fluid, including the test for acidity as has Nichols. They found that in 2 of 9 cases reviewed there were other developmental abnormalities which were factors in the cause of death. Poncher and Millies called attention to the frequent association of mediastinal enterogenous cysts with abdominal cysts and the presence of marked abdominal symptoms such as pain and tarry stools. In the case of Black and Benjamin the cyst extended through the diaphragm, and also of interest in this case was the history of a grandmother who gave birth to 13 children of whom 10 died before the age of 6 months from

"intestinal trouble." Carlson stated that such entodermal cysts often cause symptoms, complications, or death in early infancy and that many are discovered in poorly nourished, ill infants who may die of complications before surgical interference is possible. The 4 or 5 cases of enteric cyst that he found all occurred in infants and were

## PERICARDIAL COELOMIC CYSTS

In 1940 Lambert (115) reported 2 cysts lying on the anterior pericardium which were removed by Berry and cited 4 other cases, some of which were previously thought to be of other origin. Blades later noted that 5 cases of mediastinal cyst from the Barnes Hospital were reclassified into this group and he included them under his classification of anterior mediastinal tumors.

Freedlander and Gebauer suggested that pericardial defects might be produced by failure of fusion of the embryonic transverse septum with the pleuropericardial or pleuroperitoneal membranes. Lambert attributed the origin of pericardial cysts to failure of primitive mesenchymal lacunae which form the pericardium to fuse with others and instead form independent cavities. He described these cysts as being lined by vascular endothelial cells upon loose fibrous tissue containing capillaries and noted that it was difficult to distinguish between mesothelial and endothelial linings. This author further observed that other cysts have characteristics to distinguish them but these cysts do not have such features. The roentgenological picture was given as a rounded defined translucent mass.

## ECHINOCOCCAL CYSTS

Heuer and Andrus (98) stated that these parasitic cysts were rare and cited a case of a dumb-bell cyst presenting on the anterior chest wall. Seven cysts of the hourglass type in the posterior mediastinum were mentioned by them. The finding of scolices and daughter cysts, if perforation occurred, was diagnostic. Signs of spinal cord compression occurred, as in tumors of this location, and would demand similar management. Fluid levels in cysts perforating into respiratory passages, signs of liver involvement eosinophilia (particularly in a foreigner or traveler) together with such reactions as that of Casoni or any of the indicative precipitation and complement fixation procedures were considered of diagnostic aid in echinococcal cysts. Drainage marsupialization destruction of the lining and excision were used in the management of echinococcal cysts, but drainage alone although occasionally apparently necessary in complicated cases was of little curative value in itself and contamination from the contents must be avoided (44 123).

## LYMPHANGIOMAS

Michaelis in 1934 was credited with the only recorded cases in the 10 years prior to 1936. He apparently collected 7 cases and reported 1 in which an attempted excision was impossible and

the patient died later (98 159). Lemon in 1931 mentioned a case of cystic hygroma of the left neck and anterior mediastinum followed to autopsy which consisted of endothelial lined cysts in connective tissue and was poorly demarcated from the surrounding tissue. Eloesser in the same year described a case of Bruns of lymphangioma in the supraclavicular area, extending down internally which was excised. Skinner and Hobbs later reported a lymphangioma in a 7 year old boy with symptoms of 3 years duration which was adherent to the pericardium attached by a pedicle in the mediastinum to the region of the thymus, and poorly defined. In this case there were a few other associated small cysts. The tumor was successfully resected in 2 stages and consisted of multiple endothelial lined cysts filled by fluid or gelatinous material with septae containing fat smooth muscle cholesterol crystals lymphocytes, and blood vessels. Arnheim recently reported 2 cases.

Skinner and Hobbs thought that these tumors were probably congenital due to the isolation of somewhat mature cells and that perhaps hygroma of the neck descended with the pericardium from the region of the branchial clefts, although the possibility of thymic origin was considered. Lambert considered lymphangiomas as congenital maldevelopments of the lymphatic vessels and as being composed of loose fibrous tissue lined by mesothelium (which cannot be differentiated from endothelium microscopically). He stated that they were intimately adherent to the adjacent structures and have a profuse blood supply. He was of the opinion that they could occur anywhere. Heuer and Andrus (98) stated that these tumors were found near the hilum or in connection with the pericardium. Blades and Clagett (37) classified them as anterior mediastinal tumors. Carlson expressed the opinion that the onset of symptoms of mediastinal tumor in lymphangiomas occurred somewhat earlier than in such tumors as dermoids and teratomas.

## HEMANGIOMAS

Adams and Block recently reported a hemangioma of the mediastinum in a man 34 years of age. The mass was found on roentgenological examination after a cough persisted following respiratory infection. The roentgenological findings were described as several rounded shadows in an opaque density which was less penetrable at the periphery. There was a history of 2 earlier removals of masses from the left side of the neck and there was an irregular movable mass presenting in the left side of the neck which revealed the

characteristics of hemangioma on biopsy. A soft mass was found attached to the mediastinum at operation and it was necessary to leave a portion anteriorly. There was a somewhat stormy post-operative course with laryngeal cord paralysis but the patient recovered. There was no follow up recorded in the account. A thin capsule was noted on the mass which showed fibrous trabeculae, and cavernous and calcified areas on examination. There were many endothelial lined sinuses containing blood with scattered areas of areolar tissue infiltrated with lymphocytes, and bone with marrow was noted. The authors were able to discover only 1 other case, which was that of a malignant hemangioendothelioma in a man. In that case the tumor was removed but the man died of extension and metastasis.

Hosoi and Stewart described a case of malignant endothelioma, probably of vascular origin seen at autopsy. The tumor was located in the posterior mediastinum behind the trachea and was about the size of a lemon. The tumor was encapsulated and was featured by numerous capillary channels with tumor cells arranged in a perithelial manner around them. No metastasis was noted although the symptoms had existed 1½ years. The authors cited another case of hemangioendothelioma situated in the anterior mediastinum.

Clagett and Hausmann (37) classified benign hemangiomas as anterior mediastinal tumors.

#### FIBROMAS

Heuer and Andrus (98) were able to find 32 cases of fibromas in this region, in some of which sarcomatous changes may have occurred. Blades (18) was not certain of the diagnosis in all of 32 collected cases. Clagett and Hausmann (37) recently reported a huge intrathoracic fibroma, though it was not certain whether the tumor arose from the mediastinum. Harrington's (76-81) previous reports were of interest, particularly the presence of a bloody pleural effusion with a benign intrathoracic fibroma in one case.

Clagett and Hausmann cited the opinion of Tudor Edwards that fibromas frequently originate from tissues other than the pleura which may be pushed ahead of the growth. Heuer and Andrus (11-98) stated that these tumors may arise from the pericardium, vertebrae, or sternum, and noted 1 on the arch of the aorta. They described the tumors as hard, firm, of varying size, adherent, and as occurring for the most part in the anterior mediastinum, although an occasional fibroma was found in the posterior division. In most of the cases other connective tissue elements were found

to be present. Clagett and Hausmann closed fibromas as benign tumors of the posterior mediastinum. In their case the tumor consisted of mature fibroblasts and collagen. They mentioned the danger of confusion with neurofibromas and it was their belief that fibromas were more apt to undergo sarcomatous change than tumors of nerves.

The symptoms were noted by Heuer and Andrus (98) as appearing late, usually after the age of 40, and with a duration of from a few months to 15 years. The symptoms were found to be much those of mediastinal compression, including venous engorgement. The authors remarked about the clinical silence of such tumors.

These authors considered the prognosis as good with surgery but otherwise hopeless. In their collection of 32 cases, 13 of 14 patients subjected to operation recovered and 1 died, while all of the 18 unoperated patients died. Clagett and Hausmann felt that thoracotomy was indicated for benign lesions not only because of the possibility of malignancy but because the lesions, irrespective of size, may jeopardize the patient by interference with the function of the intrathoracic organs and the risk of later extirpation may be increased. They emphasized the marked physiological change gradually compensated for during the growth of large tumors and the severe disturbance on sudden removal of the mass. This was illustrated by the postoperative hypotension in their case, due to the release of pressure on the vascular system.

#### FIBROLEIOMYOMAS, FIBROMYOMAS, MYXOMAS

Heuer and Andrus (98) mentioned this group of tumors in their discussion of mediastinal tumors. The 2 cases of fibroleiomyoma of Jacobson and Einar Key that were situated in the posterior mediastinum and cast a circumscribed shadow on the x-ray film were cited. The tumors were attached to the vertebrae and ribs (periosteum) and were successfully removed. The masses were edematous and smooth muscle was present. The benign encapsulated pure myxoma of Graham (68) was mentioned; this was situated in the anterior mediastinum, was attached to the pleura, presented in the right chest wall, and was successfully removed. Also Heuer and Andrus described their case of myxoma in a 41 year old patient located in the posterior mediastinum and filling the hemithorax, which was successfully removed. Lemon mentioned a case of intrathoracic myxoma and observed that these tumors were characterized by widely separated cells in a mucinous matrix.

LIPOMAS

Fathergil in 1783 was credited by McCorkle *et al* with the first case described. These authors added the reports, since Heuer's (95) earlier paper up to 1940 and collected a total of 34 intrathoracic lipomas. In the monograph of Heuer and Andrus (98) 42 cases were reviewed and all but 1 or 2 were in the mediastinum. Walker discussed the subject and recently Watson and Urban described a huge mediastinal lipoma which was removed. Blades stated that only 2 were found at the Barnes Hospital.

Heuer and Andrus (98) found that it was difficult to determine the origin of these tumors and thought that many were congenital. The tumors apparently vary in character from a pure type some contain fetal fat tissue capillary sinuses, monocytes, and many are made up of lobules as noted in the table of Yater and Lyddane. Heuer and Andrus divided the tumors into those protruding through the chest wall of which they found 13 cases with the patients ages ranging from 6 months to 60 years tumors in the superior mediastinum extending into the neck of which type 5 cases were found and the intrathoracic type majority of these were noted. They noted that the tumors may attain a great size

These writers observed that the symptoms were the usual ones of a mediastinal mass with palpable tumors noted in the first and second groups. They noted that a long duration of symptoms, when present such as dyspnea from 12 to 20 years, was indicative of early slow growth. McCorkle *et al* found that among 34 cases, 14 of the tumors were palpable, cardiac symptoms were present in 3 cases and that 5 cases were asymptomatic.

Heuer and Andrus stated that a characteristic of lipomas was a decreased density near the periphery of the tumor on roentgenological examination. McCorkle *et al* noted that lipomas were most often mistaken for fluid in the x ray film but pointed out that on aspiration the sensation was buttery or boggy.

Walker stressed the difficulties of removal although the tumor was easily shelled. He noted that bleeding was troublesome because of the subatmospheric pressure after the chest wall was closed and that the physiological changes were rapid, whereas a previous gradual accommodation had occurred with the growth of the tumor. He suggested tight closure of the chest with gradual aspiration as a means of gradual decompression or the removal in stages of large tumors. Watson and Urban thought that removal was in

dicated for these tumors apparently because of the symptoms produced. They placed the patient with his good side down to avoid a rapid mediastinal shift during the postoperative period. Andrus (8) discussed a recurrent lipoma of massive size recorded in the chest tumor registry which could have been removed again.

The results in 13 cases of hourglass tumor were given by Heuer and Andrus (98) as follows in 1 case the tumor was found at autopsy and in 12 cases the patients were operated on the whole tumor being removed in 9 with cure in 7. Among 5 cases of the superior mediastinal type there was 1 case in which the tumor was found at autopsy and 1 in which the patient died despite x ray therapy and 3 cases in which the patients were operated on successfully. In 24 cases of intrathoracic tumor 16 of the patients died untreated (found at autopsy) and 8 were operated on, with recovery in 5 and death in 3. It was pointed out that most of the entire collection were old cases that were operated on before the advent of aseptic surgery.

XANTHOMAS

Phillips in 1937 was able to collect 5 cases of intrathoracic xanthomatous new growth, including 2 of his own and stated that some of the growths were in the mediastinum. Heuer and Andrus (98) in 1940 collected 10 including 1 of their own all of the growths were successfully removed with no mortality. Phillips described these tumors as characterized by the presence of doubly refractile lipid material or a pigment the tumor being of a yellow color. He thought these tumors were apparently of fatty or reticuloendothelial origin but noted that the origin was unknown. He stated that such neoplasms usually arose in tendon sheaths, and those in the chest were located in the costovertebral gutter as a rule but unlike such tumors in other regions those in the thorax were encapsulated—and therefore easily freed. The microscopic picture was described as consisting of doubly refractile lipid (or fatty acid) globules in large polyhedral and small spindle shaped cells with the central cells more distended. He considered xanthomas as apparently non-malignant and believed the term sarcoma should be dropped. Heuer and Andrus (98) noted that in all cases reviewed the ages were between 21 and 50. They observed that the symptoms were the usual ones of mediastinal compression.

OSTEOCHONDROMAS CHONDROMAS CHONDROMYXOMAS CHONDROMYXOSARCOMAS

Heuer and Andrus (98) observed 4 such tumors and found 14 in the literature between 1926 and

1940 Harrington (86) reported 1 chondrosteosarcomas in a group of 35 posterior mediastinal tumors. Other reports of interest are those of Heuer (94) Harrington (77) Lemon (117) Graham, Singer and Ballon (68).

Heuer and Andrus (11 98) stated that such tumors were derived from cartilage of the bony thorax and they encroached upon the mediastinum. Lemon believed that they may also arise from the tracheobronchial tree during body development. Harper considered that the origin was uncertain but noted the possibility from fetal rests, from rachitic islands of cartilages, and as a result of trauma. He suggested that osteochondromas apparently arose from tendinous attachments and chondromas from joint cartilage. Blades found that chondromas, although rare, most commonly arose from costal cartilage and occurred in the anterior mediastinum while the others were more common in the posterior mediastinum.

Heuer and Andrus (11 98) described chondromas as solid and cartilaginous while chondromyxomas were considered as partly solid and cystic, containing fluid or gelatinous material. These tumors were noted to be circumscribed, nodular and encapsulated. They crowd but do not usually invade or become adherent to the mediastinal structures. These writers observed that the tendency to recur or metastasize although the tumors were benign microscopically was present as elsewhere. Harper described osteochondromas as exostosis which arose as bony tumors with cartilaginous caps. He described chondromas as containing adult cartilage primarily which may ossify or undergo myxomatous degeneration. He also stated that chondromas were prone to recur and become malignant.

Heuer and Andrus (11 98) further observed that these tumors may become very large and that symptoms occurred in adult life, as growth was slow. The symptoms were those of mediastinal compression with pain usually occurring first, and hourglass types of the spine were noted with signs of cord involvement. Deformity of the thoracic cage may be produced and in the majority of cases of tumor of rib, sternum, or clavicle, the tumor is obvious with pain, swelling palpable mass, and physical signs suggesting its presence according to the authors (98 99). The tumors were usually well circumscribed on roentgenological examination and connection with the bones was suggestive. Such tumors were considered as apparently not amenable to x ray therapy. Because of the tendency toward recurrence and malignancy Harper preferred early removal.

Heuer and Andrus (98) stated that the tumors were easily freed but their size made removal difficult. The results of operative treatment in their 4 cases were apparently successful in 2; there was 1 operative death, and 1 case developed metastases in a year. In the 14 collected cases, 7 patients were operated on with 5 recoveries and 2 deaths in the 7 others the tumors were found at autopsy.

#### SARCOMAS

Heuer and Andrus (98) stated that the primary sarcomas arose for the most part from connective tissue or benign tumors of the same origin as described before. There were 7 sarcomas among 145 mediastinal tumors in the New York Hospital series, of which 3 were malignant degeneration of benign tumors, 2 were liposarcomas, and 1 arose from the subclavian artery. These authors were able to collect 32 cases between 1906 and 1920, of which 17 were classed as fibrosarcomas or fibroblastomas, 13 as sarcomas, 1 as hemangiosarcoma, and 1 as liporhabdomyosarcoma. Cases of interest were described by Eggers (49) and by Harrington (77 79 81). Blades stated that many believe that a high proportion of intrathoracic sarcomas begin as benign chondromas or neurofibromas.

Heuer and Andrus (98) found that these sarcomas usually occurred apically and in both the anterior and posterior mediastinum with encroachment on the contents, but they may when arising in nerves, develop into hourglass tumors. They stated that the symptoms were those of compression or involvement of the mediastinal structures and the symptoms were progressive with pain, although less rapidly so than those of some malignant conditions. It was the authors opinion that the masses were well demarcated and rounded on the x-ray film as also observed in benign tumors. The presence of metastases suggested the condition and aspiration biopsy was suggested to aid diagnosis.

Andrus (8) observed that sarcomas were particularly fatal. Of the 32 cases collected by Heuer and Andrus (98) there were 19 in which operation was carried out with the removal of the tumor in 18 with 10 recoveries and 8 deaths the late results were not stated. However in 7 cases of fibrosarcoma in which the tumor was removed with recovery there were 3 deaths in 6 months.

Secondary or metastatic sarcomas of the mediastinum is rare and usually seated in the lungs (95).

#### CARCINOMAS

Adams observed that almost all carcinomas were due to metastasis to the mediastinal glands.

or direct extension from primary lesions of the esophagus or bronchial tree. Blades stated that the thymus was the most common source of primary carcinoma of the mediastinum although often the source of the tumor could not be determined, and the most frequent secondary invader was the bronchogenic variety. Heuer and Andrus (98) also considered that carcinomas arose primarily from the thymus, as described and secondarily from carcinoma of the lung or tracheobronchial tree, esophagus, breast or metastasis from elsewhere. Also they noted that primary carcinoma was less frequent than sarcoma. They stated that the symptomatology and progress in carcinoma were like those in sarcoma, but that carcinoma was not so prone to compression symptoms, which were usually of secondary importance to the symptoms of a primary lesion elsewhere in the case of metastasis. The picture of a Pancoast tumor may be present. Harrington (81) described a case of adenocarcinoma of an intrathoracic goiter and mentioned 2 cases of metastatic carcinoma which could not be distinguished preoperatively (77).

#### TUBERCULOMA

Grace reported a case of tuberculoma of the mediastinum which he believed to be the only one of the mediastinum recorded. He recognized the question of the classification by stating that the mass was composed of unusual tissue formation in response to the tubercle bacillus, but considered that tumor formations may result from certain chronic inflammatory or other process. He distinguished this condition from tuberculous adenitis and mediastinitis and stated that the difficulty was in differentiating the type of process present before operation is performed. The patient, after a long involved history presented himself with complaints of pain, dyspnea, cough and a low grade, elevated temperature. The tuberculin test was positive and an orange sized, sharply demarcated mass under the arch of the aorta was noted in the left hilar area on the roentgenogram. The mass failed to respond to roentgen therapy and the patient was operated on with the finding of a mass adherent to the pericardium above the lung root.

There was marked relief of the symptoms following excision. There was a thick capsule which contained cream cheese, and microscopically there appeared to be remnants of lymph gland structure with central necrosis surrounded by fibroblastic tissue infiltrated with inflammatory cells suggestive of epithelioid reaction but no definite tubercles.

#### HOURLASS TUMORS OF THE SPINE

This group of tumors in the mediastinum was described by Heuer and Andrus (98) as tumors of various types arising from tissues intraspinally from the vertebrae and from paravertebral tissues with extension into the intervertebral foramina or between the lamina. The foramina were usually enlarged, apparently in most instances from pressure atrophy rather than from destructive invasion according to Heuer (93). He also found that both the intraspinal and paravertebral portions were, as a rule well encapsulated and separable. Apparently many were of neurogenic origin. Heuer and Andrus (98) noted that the majority appeared to be benign although some were malignant, and some echinococcal cysts were also observed to be of this configuration. According to these writers the symptoms were predominately those of involvement of the spinal cord—of extramedullary spinal cord tumor. Thoracic signs were usually late even in large types. Apparently some of the tumors may present externally (93). Surgical treatment was primarily concerned with the tumor portions compressing the cord and they usually were approached through a laminectomy. The paravertebral portions could also be removed at the same time as a rule by resection of the transverse processes and extrapleural dissection (93). Harrington (86) preferred a one stage combined mediastinotomy and laminectomy unless there was danger of leaving a portion of the tumor.

#### PANCOAST TUMORS AND OTHER TYPES

Pancoast described a type of tumor characterized by the clinical phenomena of pain in the eighth cervical and upper two thoracic nerve trunk distributions with wasting of the muscles of the hand. Horner's syndrome, defined roentgenological shadow in the apex of the pulmonary sulcus, and destruction of the posterior aspects of one or all of the upper 3 ribs with adjacent transverse processes and sometimes of the vertebral bodies. He considered the tumors thus characterized as of epithelial origin although the exact origin was not definitely determined. Ray apparently showed that various types of tumors of several origins may produce such a picture, of which mediastinal tumors may be the basis, although bronchogenic carcinoma was probably more frequent. He pointed out the degree of inoperability and poor results from surgical treatment in malignant tumors of this type. Heuer and Andrus (98) also stressed that the picture may be caused by even small tumors, pressing on the structures in the region of the sulcus.

*Pulsating tumors* of the anterior mediastinum were discussed by Horsley who stated that they erode through the sternum by transmitted aortic pulsations. He considered that the most common pulsating mass in the sternum was aneurysm of the aorta. He noted the occurrence of aneurysm of the internal mammary artery plus bone aneurysm as well as sarcoma of the sternum. The observations of Crile, that the majority were malignant and metastatic from adenocarcinoma of the kidney or malignant adenoma of the thyroid were cited. Horsley considered his case as similar to the type Pancoast described, that is, of epithelial origin, and speculated on an origin from a branchial groove rest.

#### MEDIASTINAL GOITERS

Clute and Lawrence credited A. Haller in 1749 with first anatomically describing intrathoracic goiter. These authors stated that if substernal, "retrosternal" and "subclavicular" goiters are included under the term intrathoracic, from 12 to 30 per cent of all goiters would be so classified but if intrathoracic is applied to only those goiters extending down to or below the arch of the aorta, the incidence is less than from 1 to 10 per cent of all goiters operated upon. They thought that low cervical goiter should not be included under the term. They further believed that goiter arising from ectopic thyroid tissue in the mediastinum was rare. Wakeley and Mulvany found an incidence of 1.34 per cent for partial and 0.23 per cent for total intrathoracic goiter and suggested that the term "intrathoracic" be reserved for those goiters in which the majority or all of the swelling was within the thorax. They also cited Kocher's definition—a portion of swelling remained permanently retrosternal.

According to Clute and Lawrence, the present day experience is that "the thyroid gland in typical exophthalmic goiter rarely if ever extends deeply into the thorax." They stated that intrathoracic goiters were from a single adenoma or more frequently from nodules of multiple adenomatous goiter which descended into the thorax. It was considered that the nodules were usually located at the lower poles or inferior portion of the thyroid isthmus and, because the rate of growth was slow the descent was slow. Growth in the line of least resistance (toward the loose areolar tissue inferiorly) action of the overlying muscles, movements of respiration and swallowing together with gravity were given as the factors aiding descent. These writers found that hyperplasia often occurred with the picture of toxic adenomatous goiter and that there may be degenerative

changes with necrosis, hemorrhage, cyst formation which may enlarge, and calcification. There may be malignant degeneration varying from the localized to the diffuse invading type, or any type of thyroid malignancy may be present. Wakeley and Mulvany agreed that the goiters were usually of the nodular cystic variety and as to the mode of descent. They found them usually to be the seat of degenerative processes, and thought there was an incidence of from 2 to 3 per cent malignant change. Mora Insua, and Spencer re-emphasized that practically all cases of intrathoracic goiter were of the adenomatous variety and that Lahey as never having seen a diffuse exophthalmic goiter in the thorax.

Clute and Lawrence observed that the mass may be found on the front, back, or either side of the trachea. They stated that, although it was unusual, goiters did occur behind the trachea as they grew back between the branches of the thyroïd artery and descended there. The blood supply was noted to be the same as for the remainder of the gland. Intrathoracic goiter arising from ectopic thyroid tissue, on the basis of embryology should be in relationship to the aortic arch or tracheal bifurcation and may be connected with the thyroid gland by a fibrous band, according to the authors. They found that in most cases the recurrent laryngeal nerve was pushed backward, although it may be anterior at times in a case posterior to the trachea. Paralysis of the nerve may occur in both benign and malignant conditions, but was rarely found in intrathoracic goiter.

Wakeley and Mulvany observed that the usual signs and symptoms of hyperthyroidism were frequently present but believed that the toxicity was of the milder type and might be overshadowed by the effects of mediastinal pressure. They noted that exophthalmos, loss of weight, and thirst were less apparent, and that the average basal metabolic rate was plus 30. There was evidence of toxicity in 7 of their 20 collected cases. These writers stated that the mediastinal pressure effects were first noted on the respiratory mechanism, then on the esophagus, and finally on the venous return. The majority of these goiters occurred in middle aged women, in their experience. Clute and Lawrence also said that there may be changes from hyperthyroidism, from the presence of a mediastinal mass, and from invasion of the organs by malignant growth. The trachea was first to show signs and effects of pressure, which occasionally could be observed by tracheoscopy. Intrathoracic goiters frequently disappear or not in the neck on cough, or the lower pole on one side of adenomatous goiters may be difficult to

palpate. Movement of the mass up and down with deglutition on fluoroscopy as well as the use of barium visualization of the esophagus, and other roentgenological study (with a well defined high anterior midline, wedge shaped mass 151) were mentioned as suggestive aids in diagnosis by the authors.

Early operation facilitated the removal of such goiters in the opinion of Clute and Lawrence and they thought that this could be carried out with out enlarging the thorax cutting the sternum, or separating the sternoclavicular joint. The usual incision was made and the strap muscles were divided as indicated. A finger was swept behind the capsule of the substernal mass and the veins to the intrathoracic mass were lifted up and ligated at times the superior thyroid artery was also ligated at this point for better mobilization. If the mass could be displaced forward the inferior thyroid artery was ligated, otherwise this was deferred until the mass was delivered. The authors stressed the necessity of staying in the right plane of cleavage to avoid bleeding and entering the pleura. After delivery of the mass, gauze was packed in the defect for hemostasis and to avoid rapid physiological changes. Then the location of the recurrent laryngeal nerve and the parathyroid glands was checked if present they were left behind, and the mass was dissected from the trachea. Drainage was carried out for a few days to prevent fluid accumulation. It was usually found that it was unnecessary to decompress the mass by rupturing the capsule in order to remove it. Mora, Issacs, and Spencer collected 6 cases, plus their own of posterior mediastinal goiter. They stated that such a goiter could be removed as other intrathoracic goiters, without disturbing the bony thorax. The complications were listed by Wakeley and Mulvaney as hemorrhage, collapse of the trachea, infection, tracheal fistula, laryngeal nerve paralysis, and crisis. There were no deaths in their series. Apparently preoperative and postoperative care is the same as for other thyroid surgery of similar nature.

#### MEDIASTINAL PARATHYROID ADENOMAS

The clinical diagnosis of hyperparathyroidism was discussed by Lahey and Haggart. They distinguished the osteitis fibrosa cystica of von Recklinghausen from the osteitis of Paget by the presence of large cysts, generalized skeletal involvement, and hyperparathyroidism with adenoma in the former but with only mild hyperparathyroidism occasionally in a parosis form in the latter. A clinical osteitis fibrosa cystica with diffuse granular osteoporosis and multiple cysts,

hyperparathyroidism with osteoporosis as an earlier stage, and a renal type due to precipitation of calcium phosphate in the kidney (in which type there may be no abnormal skeletal picture) were differentiated as classes by them. It was believed that the renal picture indicated the severity and the bony picture the duration of the condition. According to these authorities the disease was predominant in females from the ages of 30 to 50 and the onset was usually with pain in the back or extremities. The disease was characterized by arthritic pains which were worse on motion and the presence of pathological fractures in some. They noted that where cysts were formed there was expansion of the bony cortex with no periosteal proliferation. Subperiosteal rarefactions and small cysts were best seen at the metaphyses of the long bones or margins of the ribs. Kyphosis and crushing of the vertebrae were also observed on roentgenological examination. These writers commented on the diagnostic significance of the elevated calcium and low phosphorus blood levels with increased phosphatase activity as well as the increased ratio of calcium in the urine.

The following discussion was abstracted from the article of Cope

At the Massachusetts General Hospital there were 60 cases of hyperparathyroidism 54 cases of adenoma and 6 cases of hyperplasia of the parathyroid gland. In 4 cases there were 2 adenomas in each case and this was possibly true of 2 others. Eleven adenomas were found in the anterior mediastinum and 5 were noted in the posterior division, with the remainder in the neck. In the 6 cases with hyperplasias, there were 23 glands in the neck and only 1 gland in the posterior mediastinum. After excluding the cases explored previously by others, there was an incidence of 18 per cent of the glands discovered in the mediastinum 10 per cent anteriorly and 8 per cent posteriorly.

Cope believed that parathyroid glands occurred in the mediastinum following embryologic descent. He encountered them from above the superior pole of the thyroid gland to the level of the pericardium. It was stated that the upper parathyroid glands arose from the fourth branchial cleft in relation to a thyroid portion and descended with it. They usually were found above the main inferior thyroid artery but occasionally they were noted anterior to the superior thyroid artery above the thyroid and were usually easier to locate than the inferior glands. The lower glands were considered as arising in the third branchial cleft near the thymus, descending with it laterally to the thyroid gland, and dropping off opposite the



lower pole of the thyroid gland. Some, however descend on down with the thymus to a position low in the neck or to the mediastinum, or they remain in the thymic capsule others may go behind the innominate vein but anterior to the arteries, or occasionally lateral to the aorta. Cope also thought that enlarged glands could be displaced into the mediastinum by their weight, by the negative intrathoracic pressure, or by muscle action. It was considered embryologically impossible for the glands to develop into the posterior mediastinum. It was pointed out that those found there had vascular pedicles leading to the thyroid vessels and that parathyroid glands receive their blood supply from the artery nearest to the place where they are deposited, and are held in place by their vascular pedicle.

Cope thought that the treatment of hyperparathyroidism was surgical, that roentgen therapy was of no benefit, and that dietetic therapy was injurious to the kidneys and bone. He stressed the difficulty in locating the tumor (not usually visualized on the roentgenogram) the special training necessary to recognize the diseased tissue, and bloodless surgery as bleeding confuses the picture. At the first stage, exploration of the neck and posterior mediastinum was carried out through a transverse collar incision with division of the strap muscles and elevation of the lateral thyroid lobe. The upper parathyroid glands were looked for first and, if necessary the search was carried up to the upper border of the larynx or even to the carotid sheath. Inspection was also made behind and in front of the esophagus next the dissection was extended into the posterior mediastinum, avoiding the thoracic duct, and also into the anterior division as far as visible. Aid was obtained by the finding of a vascular pedicle leading away from the thyroid arteries. The capsule of the upper thymus and the sulci of the thyroid capsule were observed closely. If all the offending glands were not located, the anterior mediastinum was explored at a second stage through a longitudinal incision with a trapdoor division of the sternum down to the level of the third interspace. Search was made from the neck to the pericardium as well as on both sides of the aorta. It was found that the region of the thymic capsule was the most likely location for normal or abnormal glands.

This authority stated that there were many variations of the normal parathyroid glands, but that they were usually soft, surrounded by a thin capsule, and covered with a network of fine vessels leading to a vascular hilus. The glands were molded into the shape of the compressing struc-

ture but were globular when free in fat or the thymus, and their color depended on the amount of contained fat, which increased to the age of 40 and then decreased. Cope believed that in the presence of an active tumor there was an atrophy of disease in the normal gland cells with a relative increase in fat. Both adenomatous and hyperplastic glands were considered as containing little fat and thus they were browner than normal, while hyperplastic glands were possibly darker and more uneven. The size of an adenoma was noted to be proportional to the elevation of the blood calcium and the depression of the phosphorus readings. With a level of 15 mgm. of calcium the tumor was usually large enough to palpate. If an adenoma was smaller than expected on this basis, Cope suggested looking for another. It was mentioned that the surest way not to overlook another abnormal gland was to isolate all 4, as 80 per cent were symmetrical, although the possibility of supernumerary glands must be remembered. Apparently the finding of 1 normal gland excluded hyperplasia in this author's experience and if a gland were larger than expected the possibility of hyperplasia was to be considered. He suggested the partial removal of the gland for biopsy if in doubt. Subtotal resection was recommended for primary hyperplasia and occasionally for adenoma (but not if carcinoma were present). If for example other glands had been removed previously or if postoperative tetany were anticipated, as in extensive bone disease, he also advised subtotal resection, as there may be rapid absorption of calcium by bone. The latter may be predicted by a preoperative phosphatase level of 10 Bodansky units or more. It was noted that the postoperative phosphorus level was lower in this type of tetany in contrast to the hypoparathyroid types, while the phosphatase level was higher, and it sometimes took nearly a year for these levels to become normal. Cope observed that in the literature no hyperfunction was noted in the cases of carcinoma.

In the discussion of Cope's paper Lacey mentioned some successful experience with the transplantation of parathyroid glands. Freedlander stated that in 10 per cent of the cases of hyperparathyroidism, the tumor was located in the posterior mediastinum.

H. B. Alexander, J. de J. Pemberton, E. J. Kippler and A. C. Broders recently discussed the clinical and pathological considerations of functional parathyroid tumors and hyperparathyroidism in the *American Journal of Surgery* of August, 1944. They studied 14 cases of hyperparathyroidism due to the formation of tumor in the parathyroid

glands. It was noted that 4 parathyroid tumors were in the mediastinum (28.6%) of which 3 were located in the posterior mediastinum and 1 tumor was in the anterior division. The outlines of 2 of the tumors were visible on roentgenological examination. These writers observed that in 13 of the 14 cases, the tumor showed evidence of malignancy. They found no correlation between the weight of the tumor and the degree of hyperparathyroidism as measured by the concentration of the calcium in the blood before operation. The results of operative treatment were considered excellent in 12 cases of the series while in 2 cases there was a fatal termination.

E. H. Norris recently reported a study of 322 collected cases of parathyroid adenoma in SURGICAL GYNECOLOGY AND OBSTETRICS (INTERNATIONAL ABSTRACTS OF SURGERY 1947 84 1). He found that these tumors originated at practically any time in life with the maximum incidence being in the fifth decade. He also observed that the tumors occurred more frequently in females than in males. This writer concluded that in the majority of cases, parathyroid adenoma is a single noma involving only 1 gland. He noted that adenomas were found in an aberrant position in 10.7 per cent of the cases of which group 63.3 per cent were located in the mediastinum. The author also observed that only a few patients have symptoms for less than 2 years and that the average duration of symptoms was probably from 5 to 7 years prior to the diagnosis of the adenoma.

# REFERENCES

1. ADAMS, H. D. Surg. Clin. N. America, 1938, 18 3 629.
2. ADAMS, W. E., and BLOCK, R. G. Arch. Surg. 1944, 48 126.
3. ADAMS, W. E. and THORNTON, T. F. J. Thorac. Surg., 1943 12 503.
4. ANTLER, H. Arch. Clin. Chir. 1937 189 539. Cited by Clagett and Eaton (36).
5. ALEXANDER, J. Ann. Surg., 1941 114 734.
6. Idem. J. Am. M. Ass., 1942, 119 395.
7. ALFORD, J. E. J. Pediat., St. Louis, 1937 11 550.
8. ANDRUS, W. DeW. J. Thorac. Surg. 1935 4 236.
9. Idem, 1937 6 381.
10. ANDRUS, W. DeW. and FOOT, N. C. J. Thorac. Surg., 1937 6 648.
11. ANDRUS, W. DeW., and HEUER, G. J. Surg. Gyn. Obst., 1936 63 469.
12. ARCE, J. J. Thorac. Surg., 1943, 13 638.
13. ARNDT, E. E. J. Mount Sinai Hosp. N. York, 1943, 10 405.
14. BASTIENZI, Riforma med., May 20, 1893. Cited by Hedblom (90).
15. BACK, C. S. Ann. Surg., 1943, 116 161.
16. BELL, E. T. J. Nerv. Ment. Dis., 1917 45 130.
17. BLACK, R. A., and BENJAMIN, E. L. Am. J. Dis. Child., 1936, 51 1126.
18. BLADES, B. Am. J. Surg., 1941, 54 139.
19. BLADES, B. and DEGAN, D. J. J. Am. M. Ass., 1943 123 409.
20. BLAKEMORE, H. H. and KING, B. G. J. Am. M. Ass., 1938, 111 1821. Cited by Mackler and Graham (122).
21. BLALOCK, A. Am. J. Surg., 1941 54 149.
22. Idem. J. Thorac. Surg. 1944, 13 316.
23. BLALOCK, A., HARVEY, A. M., FORD, F. R., and LILIENTHAL, J. L., Jr. J. Am. M. Ass., 1941 117 1539.
24. BLALOCK, A., MASON, M. F., MORGAN, H. J., and RIVIN, S. S. Ann. Surg. 1939, 110 544.
25. BOHRER, J. V., and LINCOLN, E. M. J. Thorac. Surg. 1934 3 365.
26. BOSS, C. Virchow's Arch., 1937 300 166. Cited by Carlson (35).
27. BOYD W. Text Book of Pathology 3rd ed. Philadelphia Lea and Febiger 1939.
28. Idem. Surgical Pathology 5th ed. Philadelphia and London W. B. Saunders Co. 1942 p. 797.
29. BRASS, K. Zach. Path., 1936 50 26. Cited by Carlson (35) and Nichols (123).
30. BRILL, N. Q. and SILVERMAN, D. E. J. Am. M. Ass., 1938, 110 2001.
31. BROWN, R. K. and Robbins, L. L. J. Thorac. Surg. 1944, 13 84.
32. BRUNN, H. and GOLDSMAN, A. Am. J. Surg. 1941 54 179.
33. BURNETT, E. W. Am. J. Surg., 1941 54 90.
34. CAMPBELL, E., FRADKIN, N. and LIFETZ, B. Arch. Neurol. Psychiat., 1943 47 645.
35. CARLSON, H. A. J. Thorac. Surg., 1943, 12 376.
36. CLAGETT, O. T. and EATON, L. M. Surg. Clin. N. America, 1943, 23 1076.
37. CLAGETT, O. T. and HAUSMANN, P. F. J. Thorac. Surg. 1944, 13 6.
38. CLAGETT, O. T., and ROOT, G. J. Surg. Gyn. Obst., 1944, 78 397.
39. CLAGETT, O. T., and SHEPARD, V. D. J. Thorac. Surg., 1943 12 464.
40. CLUTE, H. M., and LAWRENCE, K. B. Am. J. Surg., 1941 54 151.
41. COPE, O. Ann. Surg., 1941 114 706.
42. CROSBY, E. H. Am. J. Cancer 1939, 26 461.
43. CUTLER, E. C. Tumors and Cysts of the Heart. In Lewis' Practice of Surgery. Vol. 4, chap. 13, p. 59. Hagerstown, Md. W. F. Prior Co. Inc., 1944.
44. DAVIDSON, L. R. Hydatid Disease of the Lung. Read before 25th Annual Meeting of Am. Ass. of Thorac. Surg., Chicago, May 5, 6 1944.
45. DECKER, R. H. J. Thorac. Surg. 1935 4 445.
46. DORAN, W. T., and LESTER, C. W. J. Thorac. Surg. 1939, 8 309.
47. EGGERS, C. J. Thorac. Surg., 1931 1 41.
48. Idem. Ann. Surg. 1933 97 135.
49. Idem. Am. J. Surg., 1935, 27 52.
50. ELOSHER, L. Surg. Gyn. Obst., 1931, 52 747.
51. ERGANTON, J. and WADZ, L. J. J. Thorac. Surg., 1943, 13 275.
52. EWING, J. Neoplastic Diseases, 4th ed. Philadelphia and London W. B. Saunders Co. 1940.
53. FISHER, R. C. J. Thorac. Surg., 1937 6 212.
54. FOOT, N. C. Arch. Path., 1940, 50 773.
55. FOX, J. P., and HOFFER, C. A. Am. J. Cancer 1930 28 373. Cited by Doran and Lester (46).
56. FRANK, R. T. J. Am. M. Ass., 1906, 46 343.
57. FRIEDLANDER, S. O. Ohio M. J., 1942 38 919.
58. FRIEDLANDER, S. O., and GERBAUER, P. W. J. Thorac. Surg. 1939, 8 581.

59. GALE, J. W., and EDWARDS, S. R. J. Thorac. Surg. 1939, 9, 185.
60. GARLAND, L. H. Radiology 1943, 41, 89.
61. GRAUBER, P. W. J. Thorac. Surg., 1941, 10, 4.
62. *Ibid.*, 1943, 12, 458.
63. GERSCHWITZ, C. F. Am. J. Cancer 1935, 25, 377.
64. GORDON, J. A. Med. Chir. Tr. London 1825, 13, 12. Cited by Hedblom (90).
65. GRACE, A. J. J. Thorac. Surg., 1942, 12, 131.
66. GRAHAM, E. A. Year Book of Surgery Chicago Year Book Publishers Inc., 1943, p. 273.
67. *Idem.* Discussion of Harrington's Paper (87).
68. GRAHAM, E. A., SCHUTZ, J. J. and BALLON, H. C. Surgical Diseases of the Chest. Philadelphia Lea and Febiger, 1935.
69. GREENFIELD, J. and TOUROFF, A. S. J. Thorac. Surg., 1943, 12, 495.
70. HAGGREN, C. D. Am. J. Cancer 193, 16, 783.
71. HARKER, H. Arch. klin. Chir. 1917, 99, 193. Cited by Blalock, et al. (24).
72. HARTMAN, P. B. and BRADSHAW, H. H. Surg. Gyn. Obst., 1944, 78, 402.
73. HARR, Mediastinal Disease. Philadelphia Blakiston Co., 1890. Cited by Alford (7).
74. HARPER, F. R. J. Thorac. Surg., 1939, 9, 39.
75. HARRINGTON, S. W. Arch. Surg., 1927, 14, 406.
76. *Ibid.*, 1930, 19, 1670.
77. *Idem.* Surg. Gyn. Obst., 1930, 5, 647.
78. *Idem.* J. Thorac. Surg., 1931, 1, 24.
79. *Idem.* Surg. Gyn. Obst., 1931, 53, 417.
80. *Idem.* J. Thorac. Surg., 93, 1, 663.
81. *Idem.* Ann. Surg., 1932, 96, 843.
82. *Idem.* J. Thorac. Surg., 1933, 2, 50.
83. *Ibid.*, 1934, 3, 590.
84. *Idem.* Surg. Clin. N. America, 1934, 4, 68.
85. *Idem.* Am. J. Roentg., 1935, 33, 340.
86. *Idem.* N. York State J. M., 1935, 35, 973.
87. *Idem.* J. Thorac. Surg. 1938, 7, 191.
88. *Ibid.*, 1938, 8, 127.
89. HARRINGTON, S. W. and MORTIMER, H. J. J. Thorac. Surg., 1944, 31, 394.
90. HEDBLOM, C. A. J. Thorac. Surg. 1933, 3, 22.
91. HERTZLER, A. E. Am. J. M. Sc., 9, 6, 152, 165.
92. HEUSER, G. J. Ann. Surg., 1920, 90, 692.
93. *Idem.* Arch. Surg., 1920, 18, 935.
94. *Idem.* Ann. Surg., 1922, 96, 830.
95. *Ibid.*, 1923, 98, 801.
96. *Idem.* Surg. Gyn. Obst., 1920, 70, 2.
97. *Idem.* Ann. Surg. 1941, 1, 3, 357.
98. HEUSER, G. J. and ANDRUS, W. D. W. Am. J. Surg., 1940, 50, 143.
99. *Idem.* Tumors and Cysts of the Thorax. In Lewis' Practice of Surgery Vol. 5 chap. 5, Hagerstown, Md. W. F. Prior Co. Inc., 1944.
100. HORSLEY, J. S. Surg. Gyn. Obst., 1912, 75, 49.
101. HOSOT, K., and STEWART, F. C. Arch. Int. M., 1931, 47, 290.
102. HOUTCROFT, J. D. Am. J. Path., 1936, 2, 349.
103. JACKSON, C., and JACKSON, C. L. Benign and Malignant Tumors of the Trachea and Bronchi. In Lewis' Practice of Surgery vol. 4 chap. 7 p. 180, Hagerstown, Md. W. F. Prior Co. Inc., 1944.
104. JAMES, A. G., and CURTIS, G. M. Ann. Surg., 94, 131, 767.
105. JAMES, R. M. J. Thorac. Surg., 1939, 9, 145.
106. KERRICK, C. S. Arch. Int. M., 1938, 62, 99.
107. KIRKPATRICK, F. S., and MORSE, F. R. Canad. M. Ass. J. 1937, 37, 216. Cited by Blalock et al. (24).
108. KENT, E. M., BLAIR, B., VALLI, A. R. and GRAM, E. A. J. Thorac. Surg., 1944, 12, 125.
109. KIRK, H. H., and WARFIELD, J. O. Jr. Am. J. 1928, 58, 607.
110. KIRKILL, B. R. Am. J. Roentg. 1936, 36, 1.
111. KIRKPATRICK, T. J. Benign Fibromas of the Diaphragm. Case Presented in the Discussion of the Paper of Gale and Edwards (50).
112. KORNBLUTH, K., and BRADSHAW, H. H. Radiology 1941, 37, 301.
113. LADD, W. E., and GROSS, R. E. Surg. Gyn. Obst., 1910, 70, 295.
114. LAHEY, F. H., and HAGGART, G. E. Surg. Gyn. Obst., 1935, 60, 1073.
115. LAMBERT, A. V. S. J. Thorac. Surg., 1939, 9, 1.
116. LAVENDER, H., and PRITCHETT, H. R. Arch. Surg. 1940, 40, 973.
117. LEWIS, W. S. Med. Clin. N. America, 1931, 15, 7.
118. LEWIS, R. Die Röntgendiagnostik der mäsigen kühlen Tumoren und ihre differentialdiagnose. Wien: Julius Springer 1929. Cited by Haggart (70).
119. LERCHER, R., and JUCH, A. Med. Acad. Chir., Pr., 1939, 65, 334. Cited by Blalock et al. (24).
120. LEEVER, J. A. Presse med., 1936, 44, 991. Cited by Blalock et al. (24).
121. MACCALLUM, W. G. A Text Book of Pathology, 6th ed. Philadelphia and London: W. B. Saunders Co., 1937.
122. MACHLER, S., and GRAHAM, E. A. J. Thorac. Surg. 1943, 12, 719.
123. MAIER, H. C. Am. J. Surg., 1941, 54, 92.
124. MAMBOY, P. Am. J. Path., 92, 8, 367.
125. MCCORMICK, R. G., HORTON, C. J. and DOUGLAS, J. M., Jr. J. Thorac. Surg., 1940, 9, 368.
126. McEACHRAN, D. Medicine, Balt. 1943, 22, 1.
127. MICHAELIS, O. Deut. Zsch. Chir. 1914, 241, 27. Cited by Skinner and Hobbs (190) Hest and Andrus (88).
128. MITCHELL, C. G., and CLIFFORD, S. H. Am. Surg. 1920, 90, 714.
129. MORF, J. M., ISAACS, H. J. and SPENCER, S. H. Surg. Gyn. Obst., 1944, 79, 314.
130. NEUMOFF, H. J. Thorac. Surg., 1937, 6, 124.
131. NEUMOFF, H., and COVIELMAN, R. Am. J. Surg. 1941, 54, 4.
132. NEUMOFF, H., and WENGLER, H. J. Thorac. Surg. 1934, 1, 637.
133. NICHOLS, M. F. Brit. J. Surg., 1940, 28, 37.
134. NORMAN, E. H. Am. J. Cancer 1924, 27, 421.
135. OBERMAYER, R. A. Virchows Arch., 1937, 300, 379. Cited by Clagett and Eaton (56).
136. OCHSNER, A., and DIXON, J. L. J. Thorac. Surg. 1936, 5, 642.
137. OGDEN, Z. N. Radiology 1941, 37, 454.
138. OVERHOLT, R. H., and SOUTHWELL, C. R. Surg. Clin. N. America, 1937, 17, 905.
139. PAINCOFF, H. K. J. Am. M. Ass. 1932, 99, 198.
140. PIERFIELD, W. Tumors of the Sheaths of the Nervous System, in Cytology and Cellular Pathology of the Nervous System, New York Paul B. Hoeber Inc., 1932. Cited by Foot (54) Lavender and Pridett (16).
141. PRITCHETT, D. B., STEWART, W. B., and VANDERLIND, J. C. Am. J. Roentg., 1936, 36, 14.
142. PHILLIPS, E. W. J. Thorac. Surg., 1937, 7, 14.
143. POSE, D. H. Ann. Surg., 1942, 5, 580.
144. POWERS, H. G., and MINER, G. Am. J. Dis. Child. 1933, 43, 1064.
145. RAY, H. S. Surg. Gyn. Obst., 1928, 67, 377.

146. REYNOLDS, L., and LEUCUTIA, T. *Am. J. Roentg.* 1942 48 440. Cited by Brown and Robbins (32)
147. ROSS, G. P. and STEINBERG, L. *J. Clin. Invest.* 1938, 17 507
148. ROWEN, L. A. *Am. J. Roentg.* 1943, 50 381
149. ROBERTSON, H. E. *J. Cancer Res.* 1924 8 317 Cited by Blades (18)
150. ROTH, M. *Virchows Arch.*, 1881 86 371 Cited by Black and Benjamin (17)
151. RUSBY, L. N. *J. Thorac. Surg.* 1944, 13 169.
152. SCHAFFNER, V. D., SMITH, R. P. and TAYLOR, H. E. *J. Thorac. Surg.* 1943, 12 247
153. SCHATZKI, R. and HAWES, L. E. *Am. J. Roentg.*, 1942, 48 1
154. SCHUMAKER and ROTH. *Mitt. Grenzgeb. Med. Chir.* 1913 25 746 Cited by Clagett and Eaton (36)
155. SCHWAB, H., and WILLIAMS, C. S. *J. Thorac. Surg.*, 1942, 12 117
156. SCOTT, E., and PALMER, D. M. *Am. J. Cancer* 1932, 16 903.
157. SEYDEL, G. H. *Zachr. Path.*, 1938 52 346 Cited by Carlson (35)
158. SHAMAMIAN, A. *Am. Rev. Tuberc.*, 1941 44 310.
159. SKINNER, G. F. and HOBBS, M. E. *J. Thorac. Surg.* 1937 6 98.
160. SMITH, E. V., and MILLS, R. G. *J. Thorac. Surg.*, 1938, 7 328.
161. SEIDENBERG, M. F. GRISHMAN, A., and SUBSHAW, M. L. *Surg. Gyn. Obst.*, 1942 75 93
162. STOUT, A. P. *Am. J. Cancer* 1935 24 741 Cited by Foot (54) Kent et al (108)
163. SYMMERS, O. *Ann. Surg.* 1932 96 544 Cited by Decker (45)
164. TRUEBLOOD, D. V. *Surg. Gyn. Obst.*, 1941 72 363
165. TURNBULL, F. *Arch. Neur. Psychiat.*, Chicago, 1942 42 938.
166. VAN HANDEL, W. *J. Thorac. Surg.* 1940 9 495
167. VEROCAY, J. *Beitr. path. Anat.*, 1910 48 1 Cited by Kent et al (108)
168. VIETS, H. R. *Lancet, Lond.* 1944, 1 33 Cited by Blalock (22)
169. VINCOW, P. P. *The Diagnosis and Treatment of Diseases of the Esophagus*, Springfield, Ill. Charles C. Thomas, 1940.
170. VON FISCHER, R. F. *Zachr. Path.* 1922 28 603 Cited by Scott and Palmer (156)
171. VON RECKLINGHAUSEN, F. *Festschr. Virchow Berlin* A. Hirschwald, 1882 Cited by Kent et al (108)
172. WAGENSTEIN, O. H. *J. Thorac. Surg.*, 1932, 1 612
173. WAKELEY, C. P. G. and MULVANY, J. H. *Surg. Gyn. Obst.* 1940, 70 702
174. WALKER, R. M. *J. Thorac. Surg.* 1937, 6 89
175. WATSON, W. L. and URBAN, J. A. *J. Thorac. Surg.* 1944, 13 1
176. WIGGIM, S. C., and SCHULTZ, P. E. *Am. J. Surg.* 1941 54 4.
177. WOMACK, N. A., and GRAHAM, E. A. *Arch. Path. Chic.*, 1938, 26 165.
178. YATNER, W. M., and LYDDANE, E. S. *Am. J. M. Sc.*, 1930, 180 79. Cited by Graham, Singer and Ballou (68)

## EAR

Conley J J: Atresia of the External Auditory Canal Occurring in Military Service: A Report on the Correction of the Condition in 10 Cases. *Arch. Otol.* Chic., 1946, 43: 613

Until the advent of the war atresia of the external auditory meatus resulting from wounds about the ear was strikingly uncommon. In atresia secondary to tumor growth the therapy of the tumor is of first importance.

The author presents 10 cases to illustrate the various types and degrees of atresia secondary to gunshot wounds and other traumas. The cases are divided into four groups, according to the type of the atresia: (1) web type, (2) solid fibrous healed type, (3) solid fibrous and bony healed type, and (4) infected fibrous and bony type.

All subjects were combat soldiers and their average age was 26 years. None had had a previous history of aural disease. Eight of the men had been injured in battle by shrapnel or mortar or machine gun fire, 1 had sustained a fracture of the skull in falling from a truck, and another had been injured in an airplane accident. The points of entrance of the missiles varied from the immediate area of the ear to the middle and posterior portions of the neck, and from a point posterior to the pinna to one anteriorly located in the region of the cheek. In 4 patients there was mild to moderate deformity of the pinna. Eight patients were standing and 2 were prone at the time of injury. Right and left ears were involved in equal numbers. Atresia was complete in all but the 2 infected canals, where fistulas, granulation tissue and pus were present in the scarred mass.

The author's method of treatment of the various types of atresia is as follows:

1. Web type. Corrective measures in the simple, uncomplicated type are accomplished by excising the web and adjacent scar tissue through the endaural approach and implanting a thin, split, free skin graft over the denuded areas.

2. Solid fibrous healed type. Patients with this type of atresia were treated similarly but more extensively. When the newly created flap was not ample, the skin and periosteum were reflected inward the tunnel was enlarged by removing some of the bone on the inferior posterior and superior walls of the canal and then the tissue was replaced in its new bed.

3. Solid fibrous and bony healed type. In this group there was the added factor of fractured bones. The wounds were deeper there was more scarring and considerably more damage to the surrounding structures. In the treatment of these cases radical mastoidectomy was frequently necessary and it was always necessary to do some bone work.

4. Infected fibrous and bony type. Treatment of this type of atresia was essentially the same as in the previous group except that suppuration was present. These cases practically always require a radical

mastoidectomy and chemotherapy and both should always be employed to prevent complications. *JOHN F. DUFFY, M.D.*

Greeley P W: Reconstructive Otoplasty: Further Observations; Utilization of Testatum We Mesh Support. *Arch. Surg.*, 1946, 51: 34

The reproduction of an auricular cartilage remains the greatest problem in the construction of a new ear. In an earlier paper personal experience with Gillies' method utilizing a maternal or or tilage as the architectural support around which to build a new ear was described in detail. Subsequently a total of 15 ears were constructed by this procedure.

At first, it appeared that the method, as originally presented by Gillies, was a great step in the successful performance of this persistently difficult plastic operation. However as time progressed, it became apparent that these transplanted auricular cartilages were not going to remain in their original condition permanently. In each case, the individual cartilage underwent aseptic necrosis and was replaced by fibrous tissue. By and large, this transition developed in from 1 1/2 to 2 years in small children and in from 6 months to 1 year in patients of adolescent age. Consequently with the fibrous tissue replacement, the inevitable contracture typical of all scar tissue ensued and the resulting ear shrank to a small irregular structure. This resulted in an ear which was unsatisfactory to both the patient and the surgeon.

Through the co-operation of an engineer various models of ear cartilages were constructed of testatum. The author eventually selected a fine wire mesh model, which was not only lighter but would permit development of circulation between the open spaces. These reproductions were made from a model of the normal ear.

A case is presented in which a mold of wire testatum was buried beneath the skin in a patient who had suffered the loss of an ear some months previously. The mold was untouched for 7 months, after which the skin flap was reopened and the posterior surface of the new ear and the temporomastoid bed were covered with a stent graft.

Twenty-five months after operation the mold was still in place without apparent tissue reaction.

*JOHN F. DUFFY, M.D.*

## NOSE AND SINUSES

Karanjian, V H., and Holmes, E. M.: Stenosis of the Nasopharynx and Its Correction. *Arch. Otol.* Chic., 1946, 44: 86

An analysis of the literature indicates that a congenital atresia of the nasopharynx is rare and that the majority of cases occur following an operative procedure sometimes complicated by sepsis. In a smaller group of postoperative cases there may also be an atresia of the oral pharynx because the tongue is drawn upward into the tonsillar fossa. Infections such as syphilis, tuberculosis, diphtheria, and rheumatism may also produce scarring and stenosis.

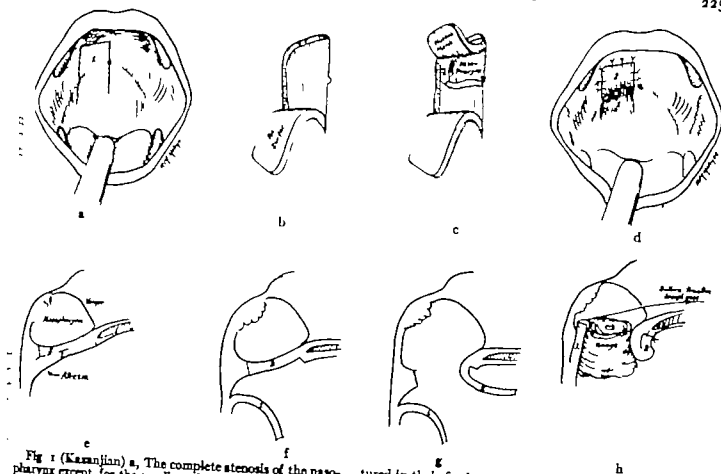


Fig. 1 (Kazanlian) a, The complete stenosis of the nasopharynx except for the small perforation. dotted line indicates the initial incision through the mucosa. b, diagrammatic illustration of flap 1 dissected free, leaving one half of the thickness of the tissues to form flap 2 which the dotted line indicates. c, the second flap created and the opening made into the nasopharynx. d, flaps 1 and 2 sutured in their final positions covering all raw surfaces and creating a nasopharyngeal opening. e, diagrammatic section to show the atresia and the dissecting incisions employed to create the flaps. f, flap 1 dissected free. g, flap 2 completed. h, method in which flap 1 was made to come in contact with raw surface of the posterior part of the pharyngeal wall.

Syphilis produced the thickest scarring and the most difficult type to treat. If the patient with syphilis has sufficient opening to care for nasal secretions it is recommended not to disturb the nasopharynx.

The common surgical methods of using a plug in the nasopharynx following removal of scar tissue, or the application of a skin graft to a denuded area has not been satisfactory. Failure has been due to the impossibility of immobilizing a skin graft in the nasopharynx, the poor vascular supply and ever present sepsis. The author describes three methods of creating flaps of the neighboring tissues so that denuded areas resulting from excision or correction of the stenosis are covered by mucous membrane. The advisability of determining the extent of the fibrosis and scarring preoperatively is stressed. This can be done by palpation with a probe through the nose and a finger in the mouth and by nasopharyngoscopic and roentgenographic examinations. In most cases a diaphragm had been created by the scar tissue, which closes off the nasopharynx from the oral pharynx.

Three cases are reported in which hinged flaps of mucosa were prepared and sutured in position after correction of the stenosis so that the denuded sur-

faces were prevented from growing together again. Because the extent of mucosa is likely to be inadequate after correction of the stenosis which allows the tissues to fall back to their normal position a third method was devised in which a pedicled flap from the cheek was swung into position to cover a denuded surface which could not be adequately covered by the hinged flap. The flaps are clearly illustrated by diagrams.

JOHN R. LINDSEY M.D.

Wright, R. W.: Round Shadows in the Maxillary Sinuses. *Laryngoscope*, 1946 56 455

A great many interesting problems arise as to the nature and clinical significance of cystic or polypoid structures in the maxillary sinuses. Among these are the question of their symptomatology, the possibility of their acting as a focus of infection, and the mechanism of their production. These are the questions which the rhinologist would like answered when he examines an x-ray picture showing one or more round shadows in the maxillary sinuses.

Cysts are classified as follows:

1. Benign cysts arising from the jaw or teeth
  - (a) follicular or dentigerous cysts (b) radicular or dental cysts (c) median anterior maxillary cysts

2. Benign cysts arising from the sinus mucosa. (a) secreting cysts, including gland cysts and mucocoele (b) nonsecreting cysts of the sinus mucosa.

The symptomatology of antral cysts is divided into several groups for clarity and convenience: (1) symptoms arising directly from the cyst (2) those arising indirectly from the cyst and (3) cysts producing no symptoms. In the first group there were 9 cases in which the patients had pain and soreness in the face pain in the teeth and (in one) numbness of the upper lip. All of the patients were relieved by puncture of the cyst.

Joint pains vague pains and headache, fatigue, low grade fever and dizziness are other conditions suggesting a focus of infection.

The treatment of cysts of the antrum in civilian life depends upon the symptoms presented. In aviation practice the presence of a cyst is considered evidence of sinus disease and its removal is a necessity for qualification, which accounts for the high percentage of surgical procedures.

In the author's cases many of the asymptomatic cysts were discovered on routine x ray examination of the sinuses.

Seventy-eight cases are presented. Forty-two of the patients were operated upon by means of the Caldwell-Luc technique, and in all but a few of the cases no opening was made in the nose. The pathological structure most frequently found was the non secreting or mesothelial cyst and in 38 patients the cysts were of this type.

In a summation, the author states that round shadows seen in x rays may represent a cyst or a polyp and positive x ray findings do not represent a definite pathological entity.

JOHN F. DILLON, M.D.

Lillis, H. I.: Osteomyelitis of the Maxilla Secondary to Suppurative Maxillary Sinusitis. *Ann. Otol. Rhinol.*, 1946 55 495.

The mechanism of the occurrence of osteomyelitis of the maxilla following operations on the maxillary sinus is suggested, as the sequence of symptoms and signs seems to be explained on anatomic and pathological bases.

The pathological characteristics of osteomyelitis of the maxilla that occurs secondarily to suppuration of the maxillary sinus differ greatly from the pathological characteristics of osteomyelitis of the frontal bone that occurs secondarily to suppuration of the frontal sinus largely because of the difference in the character of the bone involved. The latter is largely because of the difference in the arrangement

It is emphasized that accurate classification of the infecting organism is essential if penicillin is to be an adjuvant in treatment is to be employed effectively. It is also stated that in the presence of penicillin chemotherapy nor penicillin can be relied on as curative agents. The use of chemotherapy and penicillin should be continued for several days following apparent resolution of the infective process.

## MOUTH

Bernier, J. L.: Mixed Tumors of the Lip. *J. Otol. Surg.* 1946, 4 93.

A review of slightly less than 600 mixed tumors of the salivary glands at the Army Institute of Pathology revealed 38 of the lips. Of these, 35 occurred in the upper lip. The greatest number occurred between the ages of 30 and 40 years. The embryonic embryologic background of the upper arch is probably a factor in the histogenesis as encavement of epithelial remnants. The theory of origin on the basis of metaplasia of the epithelial cells of the striated excretory ducts (Stuart, Foote, and Becker) may also account for a number of these tumors. The lesions were extremely variable. Epithelioid tendencies on the part of the epithelial component was striking in some cases, manifesting either a typical basal cell character or squamous features. In some, the epithelium appeared to be of the transitional type. Cartilage or chondroid stroma was present in about one-half of all tumors. A mucopapillary tendency was evidenced in some by numbers of excretory and striated ducts. No evidence of malignancy was found in any of the group. Most of the tumors were well circumscribed, with a well-developed capsule. The myxoid or chondroid stroma is distinctive of these so called mixed tumors.

JOHN R. LINDSAY, M.D.

Slaughter D. P.: Multicentric Origin of Intraoral Carcinoma. *Surgery* 1946, 30: 133.

The final outlook in the present day treatment of intraoral cancer is so discouraging that an evaluation of the reasons for therapeutic failure is indicated. Many failures are due to cervical node metastases, but not enough attention has been given to the reason for recurrence at the primary site after adequate treatment has apparently been given. These poor results are universal in spite of recent therapeutic developments.

It is generally accepted that a malignant tumor is a collection of pre-existing cells which destroy the surrounding tissue. However, the author does not believe that such a simple view covers all of the aspects of the growth and development of these tumors.

# SURGERY OF THE HEAD AND NECK

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metaplasia refers to transformation into cancer of the benign epithelium at the edge of the tumor because of some carcinogenic effect of the cancer cells. This theory is an old one that has been condemned as false in the past, but which is again being considered as a possibility in the growth and recurrence of cancer.

A study of 80 cases is given which offers some support to the idea of 'multicentric origin' and 'lateral cancerization.' These cases were treated in the last 25 years at the tumor clinics of the Illinois Research and Presbyterian Hospitals. The cases are classified as to the distribution and size of the tumors. Table I shows the distribution, while Table II gives the locations of multiple tumors.

In favor of the lateral cancerization theory is the fact that many of the tumors show a greater spread laterally than in depth. Microscopic study of biopsy specimens, and especially of whole tumors which had been surgically removed gives some evidence to support the idea of multicentric origin. Several cases are discussed in more detail and 9 microscopic photographs are included to illustrate the discussion.

Although this is a small series of cases Slaughter states that these three factors—lateral spread multiple tumors, and microscopic evidence of multicentric origin—seem to suggest that more than one mechanism exists which leads to the growth and

spread of intraoral cancer. More studies are needed on this subject before any definite conclusion can be made.

WILLIAM A. ABRONY, M.D.

## PHARYNX

McClure G.: Odontoma of the Nasopharynx. *Arch Otolaryng.* 1946 44 51

Odontoma of the nasopharynx with a deciduous tooth puts the growth in the classification of osteofibroma of dentigerous origin. The location of the growth was unusual, rare for this type of tumor. Careful search of the literature did not reveal a single case of odontoma of the nasopharynx. The origin of the growth could not be determined but apparently the tumor sprang from the posterior ramus of the mandible. A tumor of this type when situated within the mandible or the maxilla appears to be completely separated from the surrounding bone by its capsule therefore one may assume that it had no attachment. The audiogram revealed a typical conductive hearing loss in the left ear due either to complete obstruction or to absence of the eustachian tube.

The recurrence of the tumor was definitely due to a small portion of the capsule which remained in the extreme lateral part and contained tooth remnants in the bony structure with the power of regrowth. This regrowth is typical of odontoma, the second tooth presenting itself to the surface, in this case the nasopharynx.

The recurrence of the growth and the formation of a second deciduous tooth definitely put the tumor in the classification of a compound composite odontoma.

NOAH D. FABRICANT, M.D.

## NECK

Magnusson P. and Sørensen G.: The Treatment of Hyperthyroidism with Methylthiouracil. *Acta med. scand.*, 1946 125 163.

The authors review the literature on the treatment of hyperthyroidism with methylthiouracil with emphasis on (1) the discovery of antithyroid substances (2) the effect of these substances on experimental animals and (3) the effect and by-effect of these substances when employed for therapy in the human being.

A résumé covering the treatment of 46 patients with methylthiouracil is presented. In 3 cases methylthiouracil was used for preoperative treatment. One patient died with a severe degree of thyrotoxicosis. Thirty-eight patients tolerated the methylthiouracil and a normal metabolism was obtained. The suggested dosage is 40 cgm. daily. The maintenance dose is about 10 cgm. every other day but many patients are maintained on a smaller dose. The treatment was discontinued in 10 cases. Three of these patients are still symptom free 5 have had a relapse 1 patient died of an intercurrent disease and 1 has not been followed up. The untoward reactions from this treatment were 1 case of granulocytopenia

TABLE I.—TUMORS IN EIGHTY PATIENTS

Anatomic distribution	Microscopic evidence of multiple origin	Gross evidence of lateral spread greater than depth
Base of tongue	7	7
Extensive disease	3	3
Soft palate	14	14
Central palate	3	3
Gingiva	13	13
Floor of mouth	5	5
Buccal mucosa	5	5
Tongue	18	18
Multiple	14	14
Total	80	72

TABLE II.—ANATOMIC LOCATION OF MULTIPLE TUMORS

Case number	Location of tumors
1	Tonsil and gingiva
2	Tonsil and gingiva
3	Floor of mouth and tongue
4	Bilateral buccal mucosa
5	Antrum and opposite gingiva
6	Lip and tonsil
7	Floor of mouth and tonsil
8	Tongue and esophagus
9	Lip and buccal mucosa
10	Lip and buccal mucosa
11	Tongue and floor of mouth
12	Bilateral buccal mucosa, tongue and floor of mouth
13	Tongue anterior and posterolateral
14	Tongue anterior and posterolateral



12, 3 cases of drug fever 1 case in which there was drug fever and swelling of the salivary glands 1 case of thrombopenic purpura and granulocytopenia and 1 case of polyneuritis

It is strongly recommended that treatment with methylthiouracil be given only in hospitals where frequent laboratory control examinations may be carried out

RICHARD J BENNETT JR., M.D

Parnley G. C. and Hellwig, G. A.: Lymphadenoid Goiter: Its Differentiation from Chronic Thyroiditis. *Arch. Surg.* 1946, 53 90

In recent articles lymphadenoid goiter has been recognized as a pathological and clinical entity but its causes, histogenesis and clinical significance are little understood. The author's report is based on 14 cases of this condition.

The clinical findings in the 14 cases were as follows: all 14 cases were in women the average age being 44.7 years. Thirteen complained of enlargement of the thyroid gland 11 had noticed nervousness, and 3 had rapid heart rates. Only 3 of the 14 patients had regular menses. The preoperative diagnosis was nontoxic goiter in 8 cases, fetal adenoma in 2 and toxic goiter in 4 cases.

The pathology of the condition is described in detail. While the abundance of lymphoid tissue is a most conspicuous feature the authors state they found by actual measurement that only one third of the enlargement of the thyroid gland is due to the lymphoid tissue while two-thirds consisted of epithelial tissue.

The thyroid epithelium was of two types: a high cuboidal epithelium arranged in small acini, and a large pale polygonal epithelium arranged either in acini or in solid cell strands. The authors regard the latter to be identical with the cells of Hurthle.

The authors believe that the lymphadenoid goiter has lost its ability to manufacture colloid and that this is due to hyperactivity of the hypophysis following loss of ovarian function.

F J LEIDENHOFF, JR., M.D

Auerbach, O.: Laryngeal Tuberculosis. *J. Otolaryng. Chic.*, 1946, 44, 91.

Although there are many studies of laryngeal tuberculosis, most of these are based on clinical observations. The pathogenesis of laryngeal tuberculosis, over which there has been much controversy, should not be studied from clinical findings alone, but cause organs other than the larynx must also be examined. The clinical findings should be combined with pathological studies. In the course of study by Auerbach and his colleagues, the larynx is routinely examined for gross and microscopic pathological changes. An opportunity was thus afforded to study the mode of development and the progression of laryngeal tuberculosis as well as its relationship to tuberculosis occurring in other parts of the body.

Laryngeal tuberculosis was present in 304 (5.1 per cent) cases of tuberculosis which came to autopsy. In all but 2 instances it developed as a direct infection from positive sputum in chronic pulmonary tuberculosis. The age, sex, and race distribution in this series parallel those in chronic pulmonary tuberculosis. Tuberculous foci, with and without central zones of caseation, form in the walls of the larynx as a result of tubercle bacilli which enter through the ducts of the mucous glands. Ulcers develop either through pressure atrophy of the mucous membrane by the tuberculous foci or by caseous necrosis of the overlying epithelium as the tuberculous areas enlarge. The further progression of the ulcerative process is similar to that in other parts of the body. Ulcers were found most frequently on the true vocal cords.

Healing may occur in any stage of anatomic development, usually in cases in which underlying chronic pulmonary tuberculosis undergoes spontaneous healing. In some instances healing and progression keep pace in the same larynx, resulting in a pronounced thickening of the wall, nodular protrusions into the lumen, and narrowing of the canal.

NOAH D. FARRAR, M.D

# SURGERY OF THE NERVOUS SYSTEM

## BRAIN AND ITS COVERINGS CRANIAL NERVES

Jegel E. A., Spiegel Adolf, M., and Wycis H T :  
Cerebral Concussion; Histochemical Demonstration of Nucleases in the Cerebrospinal Fluid *Arch Path. Chlc.*, 1946, 42 175

By spectrophotometric examination of the cerebrospinal fluid in patients, following concussion, it had been noted previously by these authors that substances were present which were interpreted as nucleic acids or their derivatives. These gradually disappeared as the fluid was allowed to stand and this enzymatic action. Cerebrospinal fluid from both normal patients and those who had suffered cerebral concussion was incubated with nucleic acids. The quantity of these acids decreased in the concussion samples but no decrease was noted in the normal fluids or in nucleic acids mixed and incubated with alkaline solution. This work substantiates the assumption that enzymatic substances acting on nucleic acids or their derivatives appear in the cerebrospinal fluid after cerebral concussion.

Since spectrophotometry is such a specialized technique, a simpler method was sought to investigate this problem. It was decided to utilize the nucleic acids found in the anterior horn cells of the spinal cords of cats. Cerebrospinal fluid was incubated with paraffin sections of spinal cords and this was followed by microscopic examination of the nerve cells with reference to the Nissl bodies.

Preliminary experiments reiterated the importance of the relation between the degree of tigrolysis and the pH. Ringer's solution as well as the cerebrospinal fluids produced tigrolysis when incubated with spinal cord sections. A difference was noted when the pH was lowered. With the pH between 2.0 and 4.1 no effect of Ringer's solution or the cerebrospinal fluids following incubation was significant. With a pH of 4.6 or above, the Nissl bodies became finer. The authors conclude that "at the normal cellular concentrations of the body fluids or kept in solution and only when postmortem changes cause an accumulation of acids in the central nervous system are the nucleoproteins precipitated and the results are Nissl bodies."

In the final experiments paraffin sections of feline spinal cords fixed in alcohol were used. These were separated and different sections were incubated with cerebrospinal fluids and Ringer's solution, in the absence of fluid. All fluids were acidified with an acetate buffer solution of 4.05 pH before incubation at 37° C. for 4 hours. The sections were then washed and stained with thionine solution. The following

1 Sections incubated with cerebrospinal fluid from patients who had undergone cerebral concussion showed tigrolysis of the anterior horn cells.

2 Similar procedures with normal cerebrospinal fluid and Ringer's solution failed to exhibit such an effect.

3 Histochemical findings correlated with spectrophotometric examination of the cerebrospinal fluids those fluids producing tigrolysis decreased the absorption bands characteristic of nucleic acids while those fluids not affecting the anterior horn cells did not result in such spectrophotometry.

The authors hypothesize the significance of enzymes (probably nucleases and deaminases) as the cause of chromatolysis following cerebral concussion  
C. FREDERICK KITTLE, M D

Heinbecker P : Cushing's Syndrome *Ann Surg*  
1946, 124 252

Cushing's syndrome is characterized by painful adiposity confined to the face neck, and trunk of the face neck and trunk in females and preadolescence in males dusky plethoric skin with purplish lineae atrophicae on the abdomen and thighs hypertension backaches abdominal pains and weakness and dryness of the skin with acne and sometimes skin infections. Occasionally there are hyperglycemia glycosuria diminished sugar tolerance polyphagia and polydipsia.

Cushing was aware that similar clinical findings were found associated with tumors of other glands such as the adrenals but hypothesized that the primary cause was a basophil adenoma of the hypophysis which belief is considered erroneous because basophil adenomas are found without the syndrome and the syndrome is found without an associated basophil adenoma.

The author states that the primary cause of the condition may be a tumor of the adrenal cortex, the ovary or the thymus. In a group of cases without a primary tumor there was atrophy of the paraventricular nuclei of the hypothalamus.

The neural hypophysis of dogs was denervated by separating it from suprapituitary and paraventricular nuclei which resulted in loss of basophilic cells in the glandular hypophysis. A comparison of the histological sections of the other endocrine glands in a dog without basophilic cells with the endocrine glands of a totally hypophysectomized dog show what organs are affected by the eosinophil and basophilic cells. They indicate that the eosinophils are trophic to the adrenals prostate interstitial cells of the testis and corpus luteum while the basophils are trophic to the thyroid and ovarian follicle and are essential for germ cell maturation.

Desoxycorticosterone is an antagonist of the hormone of the neural hypophysis. A state of diabetes

insipidus results when it is given to dogs. The author believes that adrenal cortical tumors causing Cushing's syndrome secrete enough desoxycorticosterone to neutralize the hormone of the neural hypophysis and result in degeneration of the basophils. The chemical structural similarity between desoxycorticosterone and progesterone is cited. With that in mind one might expect ovarian tumors secreting a progesteronelike substance to bring about degeneration of the basophils.

DANIEL ROOK, M.D.

Sparling, H. J. Jr., and Adams, R. D.: Primary Hodgkin's Sarcoma of the Brain. *Arch. Path., Chlc.*, 1946 43: 338.

A case of primary Hodgkin's sarcoma involving the left frontal lobe of the brain is reported.

The patient presented a progressive intracranial lesion of rapid course involving the left hemisphere without evidence of any other neoplasm involving other parts of the body.

At operation, a tumor was resected and microscopic studies revealed a Hodgkin's sarcoma.

The patient succumbed a few days later and it was possible to obtain a complete autopsy. However this failed to reveal any other evidence of tumor involving other portions of the body.

The authors state that this is the only reported case of primary Hodgkin's sarcoma originating in the brain.

HOWARD A. BROWN, M.D.

Kettell E. Neurinoma of the Facial Nerve. *Arch. Otol. Chlc.* 1946, 44: 353.

This article reviews the case history of a 32 year old woman who 7 years previous to operation, suffered a severe pain behind the right ear followed by sudden complete right facial paralysis and gustatory changes. The paralysis cleared up partially under conservative care, but the pain persisted. Once again, the paralysis suddenly became complete, this time without improvement. The condition was diagnosed as relapsing Bell's palsy, and the decompression operation of Ballance and Duell was carried out, during which operation a neurinoma the size of a hazelnut and arising from the descending portion of the facial nerve was discovered. Although there was considerable bone destruction, roentgenograms of the involved bone gave no hint as to the presence of the tumor.

Neurinomas are tumors arising specifically from the cells of the sheath of Schwann, and therefore they are ectodermal in origin. They are probably best known so far as the cranial nerves are concerned in the form of the acoustic neurinoma. They characteristically occur on the sensory roots or in the pure sensory cranial nerves (the olfactory and optic nerves, not being true peripheral nerves, being excepted). They may however occur in mixed motor and sensory nerves, arising from the sensory portion thereof. Several cases of neurinomas forming in the facial nerve are on record, and histologically so proved, and this brings up the question of whether

or not the facial nerve is a pure motor or a mixed nerve. The author apparently is first aware of the fact that the facial nerve is, indeed, a mixed nerve; the presence of the tumor in his patient.

The treatment of these tumors, if they can be diagnosed is strictly surgical, and after they remove the gap in the badly damaged nerve must be repaired with a nerve graft, upon which procedure the author looks with considerable optimism. A point of practical importance is the differential diagnosis between a simple Bell's palsy which also frequently shows relapses and is accompanied by pain, and an intracranial neurinoma such as the author has described. Perhaps the main point of differentiation between the two conditions, requiring such different treatment, is the continuous pain which is likely to be present when a tumor exists, whereas in Bell's palsy the pain is usually transient.

JOHN MARSH, M.D.

Cairns, H., Duthrie, E. S., and Smith, H. V.: Intrathecal Streptomycin in Meningitis: Clinical Trial in Tuberculous, Coliform, and Other Infections. *Lancet*, Lond., 1946, 1: 153.

The authors state that supplies of streptomycin are scarce and many medical centers are trying to obtain the drug. This urgency may be somewhat dampened by the report that the results thus far are not nearly as dramatic as are those obtained with penicillin, and that in the use of streptomycin certain special safeguards may be necessary.

Streptomycin was used in cases of meningitis due to organisms shown to be sensitive in vitro and in laboratory animals. Seven patients with meningitis were treated and all but 1 died. There were 1 case of *Pseudomonas pyocyanea*, 1 case of *Haemophilus influenzae*, 2 cases of *Mycobacterium tuberculosis*, and 1 case of *Achromobacterium*. The patient with *Achromobacterium* infection was the one who survived.

Reactions to intrathecal injection of the drug believed to be due to impurities, were observed in 3 cases. Reaction to injection by the lumbar route was mild in 1 case, severe in 2 cases, and fatal in 1 case. In one of the patients with very severe reaction, streptomycin was given also into the ventricle. The ventricular use of the drug produced a reaction in a patient in another with an indwelling catheter no reaction occurred. Streptomycin, compared with penicillin, spreads slowly through the subarachnoid space and the bactericidal effect in vivo is not nearly as great as in vitro experiments would indicate. It is suggested that the acid reaction of pus may account for this.

A dosage of from 80,000 to 100,000 units once or twice daily is probably necessary, but in the severely ill patient this dosage is not free from danger. The injection should be given slowly—5,000 to 10,000 units a minute—and a safety valve indwelling intracatheter should be employed to keep the intraventricular pressure below 300 mm. of water.

ANDREW VEE BROCKMAN, M.D.

Hortensu W W: Invasion of Paranasal Sinuses by Tumors of Meningeal Origin. *Am. J. Orthodont.*, 1946, 32: 556.

The author presents two case reports of meningioma infiltrating into the paranasal sinuses. Although the extension of meningiomas through the calvarium is of frequent occurrence their penetration through the base is unusual.

In the first case an olfactory groove meningioma was removed. Three years later the patient was treated for a nasal recurrence. Six years after the craniotomy the neoplasm was thought to extend into the left nasal chamber, the left frontal and ethmoid sinuses and the left orbit. When last seen 8 years after the initial surgery there was no evidence of further intracranial growth despite extension into the nasal passage. The histopathological diagnosis was meningotheliomatous meningioma.

The second case revealed extension of the neoplasm into the left ethmoid sinus and antrum the tumor filling the left nasal passage when the patient was first seen. The patient expired after an emuculation copy the intracranial tumor was found to occupy the left frontal fossa, with extension into the left ethmoid and ethmoid sinuses. Histological study revealed a fibroblastic meningioma with transition into a greater fibroblastic stromal element as the tumor spread to the nasal cavity.

Both tumors were regarded as benign despite their rather extensive spread.  
Jack L. Woods M.D.

## SPINAL CORD AND ITS COVERINGS

Diaz, J: Persistent Sciatica Due to Hernia of the Intervertebral Disc; 14 Further Observations (Clínic rebelde por hernia de disco Intervertebral. Resultado alejado de otras catorce observaciones). *Rev. Acad. Argent. cir.* 1945, 30: 439.

Sixty-one patients with sciatica due to hernia of the intervertebral disc have now been operated upon. Of these the cases of 21 were previously reported during the period from August, 1944 to April, 1945. The present series comprises 14 patients observed during the period from August, 1944 to April, 1945. The remaining cases will be reported later.

Contrast radiography has not been abandoned in these cases. The author admits one instance in which the contrast substance apparently caused a postoperative sciatica however without this method of examination he would never have been certain that there was a hernia of the intervertebral disc and would not have persisted so far in demonstrating its presence. He is still not sorry that he used minimal incision advocated by Love, since the former method permits section of the sensory root, or laminectomy rather than the more extensive laminectomy advocated by Love, since the former method permits section of the sensory root, or laminectomy rather than the more extensive laminectomy. Laminectomy is also the only method of procedure in the presence of the so-called concealed disc of Dandy. Love's recommendations were made in the

day when it was thought that a laminectomy would require a coincident ankylosing operation for support of the spinal column at the level of operation. However of the author's 61 patients not one patient was given a fusion or other bracing of the spine, not one had to wear a corset or other support and not a weakness in the spine.

The herniated disc sequestrum may reduce it self spontaneously during the operation but may usually be demonstrated by placing the patient in the position of exaggerated lordosis on the operating table. The author believes that the condition designated by Dandy as a concealed disc, and ascribed by him to a primary degeneration of the substance of the disc, is in reality this type of self reducing hernia. The section of the sensory root at the level of pressure is not harmful. The patient does not notice the sensory fibers of the compressed or irritated root, and the method seems to prevent recurrence of the disc if the method is used. Section of the sensory fibers of the root constitutes the best treatment yet devised for the concealed disc of Dandy.

In the 14 cases here reported the operation in all but two instances was performed entirely under rachis anesthesia (0.007 gm. of percaine). In the one patient the operation was started and finished under local anesthesia and in the other patient, this method was instituted after the rachis anesthesia. In all instances, except one, the discal sequestrum was removed in this case a concealed disc of Dandy was diagnosed and no sequestrum could be located. Nevertheless even in this patient, with cutting of the sensory fibers of the fifth root, the result was immediate definitive and excellent. In every case removal of the sequestrum, and section of the sensory root affected has given uniformly successful results. The patient has been up in a few days has returned to work (often heavy work) the pain has not returned, and the strength and mobility of the spine has remained unaffected. In only one instance was there even a partial failure. This consisted in the development of a sciatica on the right side a year after the pressure on the left side had been removed.

JOHN W. BRIDGEMAN M.D.

## SYMPATHETIC NERVES

Goodman, E. N. Messenger W. J., and White J. C.: Indications and Results of Surgery of the Autonomic Nervous System in Naval Personnel. *Ann. Surg.*, 1946, 124: 504.

In Naval personnel, surgery of the sympathetic nervous system has been performed for causalgia, hyperhidrosis, hypertension and angina pectoris. The authors accept the theory of Doupe, Cullen and Chance. The qualities of causalgic pain are due

to direct cross-stimulation of sensory fibers by afferent sympathetic impulses at the point where the nerve trunk is injured. They have successfully done preganglionic sympathectomies upon patients whose symptoms were relieved by paravertebral procaine block. Among their 13 cases of causalgia there were 7 of the median nerve, 3 of the median and ulnar nerves combined, and 1 each of the ulnar, common peroneal, and posterior tibial nerves. Ten patients obtained complete relief, the other 3 retained slight residual aches.

When there is pain in an extremity following amputation of a part of the extremity and this pain is not due to a neuroma or phantom limb, the authors have done sympathectomies when relief was obtained by paravertebral procaine block. Their 6 patients had traumatic amputations of either the fingers or toes. These patients were then bothered with deep aching pains and hyperesthesias. Four obtained complete relief and 2 patients were definitely benefited.

The extremities of patients with peripheral vascular diseases are observed for color and rapidity of color change with position changes, temperature differences, absence of peripheral pulse, oscillometric readings, degree of sweating, and x-ray evidence of arterial calcification. Either peripheral nerve block or paravertebral block are done to study changes in the temperature and color. In Raynaud's disease there are good results in the group that has not progressed to the cold white hand with endarteritic changes; therefore early diagnosis and operation are important. The authors cite 4 cases in which the circulation improved and there was no sensitivity to

cold. They have operated upon 7 patients with thrombo-angiitis obliterans. Five of these had claudication and were relieved of it after operation. Three had ulcers which healed promptly after surgery. All were told not to use tobacco in any form and to use alcohol prophylactically. Sympathectomies were done upon 2 patients who had arteriosclerosis with vasospasm. Both had pain in a lower extremity which decreased following surgery. The authors believe that success will result in only three cases with excessive sympathetic tone. One patient whose popliteal artery was severed by a scapula had to undergo arterial ligation, which left the leg cold and painful. This was relieved by sympathectomy. Two patients with hyperhidrosis were subjected to sympathectomies and warm dry extremities resulted.

Radical bilateral thoracolumbar sympathectomy for hypertension were done on 14 people, mostly between 32 and 55 years of age. Renal function was evaluated by PSP, urea clearance, creatinine tests, frequent urinalysis, and pyelogram. The lability of the blood pressure was studied by all pressor tests and sodium amytal sedation tests. Funduscopic examinations were done by competent ophthalmologists. The operation failed to produce a significant lowering of the blood pressure in only 1 case. The authors are very optimistic for the hypertensive patients who have surgery before the age of 50, but admit that they have not followed up their patients very long.

Two patients with angina pectoris not relieved by nitroglycerine were subjected to resection of the upper thoracic ganglia on the side of most severe pain. Both were relieved. DAVIES REED, M.D.

# SURGERY OF THE THORAX

## TRACHEA LUNGS, AND PLEURA

**Recueil II: The Pulmonary Artery Its Ramifications and Relations (Arteria pulmonar Sus ramificaciones. Sus relaciones) *Revista med. argent* 1946 33 1463**

This is an exhaustive anatomical description of the pulmonary artery based on a specimen studied by corrosion, roentgen ray examination, and dissection. The description of the arborization is carried out to branches of the fifth and sixth order. Variations in the manner of branching are pointed out but the standard or common types alone are emphasized in the present article.

The right pulmonary artery is used as the sample artery the author considering the left main trunk to give off the same branches as the right. One standard deviation which he makes note of is the manner of branching of the artery after it branches off to the dorsal segment of the lower lobe on the left, he considers the artery to end in the lower lobe by bifurcation into anterior and posterior trunks of equal length, whereas on the right the pulmonary artery continues into the lower lobe as such gradually diminishing in caliber as it gives off numerous branches to that lobe.

The points of more practical interest concern the branches given off to supply the various pulmonary segments. The first branch from the right pulmonary artery arises therefrom to supply the upper lobe before the artery actually enters the lung substance. Another separate branch is also almost constantly present to supply the upper lobe. The left upper lobe is supplied by two or three branches. When it is supplied by two branches it is similar in disposition to the right side. When there are three branches they generally follow the main bronchial distribution.

The artery to the middle lobe is again described as a branch from the main trunk. There may be one or two branches arising independently a third smaller branch is sometimes seen, although typically it is a single artery which promptly divides. The lingular branch, according to the author's designation, is a branch from the inferior division of the middle lobe artery.

The branch to the dorsal segment of the lower lobe is typically single but may be double. It usually arises slightly above the middle lobe artery on the left and at this level on the right. The terminal branching to the lower lobe has been described. The manner of branching of all these vessels is given generally in relation to bronchial and venous patterns and the areas of lung substance supplied are beamingly well worked up.

Numerous diagrams photographs of the specimen prepared by corrosion, and a roentgenogram of an injected subject are appended for illustration.

HIRSH T. LAKSTON M.D.

**Leriche, R.: Large Emboli of the Pulmonary Artery (Les grandes embolies de l'artère pulmonaire) *Lyon chir* 1946 41 143**

The author has attempted to correlate the recent investigative work of his associates and others, which adds light to the problem of pulmonary embolus.

Of 222 patients who exhibited pulmonary emboli at autopsy 154 died with the clinical diagnosis of pulmonary embolus. In 132 cases the clinical diagnosis was correct. Thus in 22 instances the clinical diagnosis was not substantiated by the autopsy findings. However in 90 cases pulmonary emboli which had not been suspected clinically were found at autopsy.

The causes of death among 22 patients wrongly suspected of having pulmonary emboli were pulmonary edema, pulmonary tuberculosis malignant endocarditis, anemia with cardiac failure ruptured aneurysm, bronchopneumonia, pleurisy and valvular pathology mitral stenosis cardiac malformations or unknown causes.

Among the 90 patients who had pulmonary emboli which had not been recognized clinically death had been attributed to one of the following conditions cardiac failure pleurisy cachexia myocarditis uremia, generalized arteriosclerosis myocardial infarction mitral disease, gripe cerebral hemorrhage cardiorenal disease pulmonary tuberculosis bronchopneumonia, or paraplegia and pyelitis.

Thus it is apparent that massive emboli do not always exhibit the dramatic clinical picture with which they are commonly associated and further more many more unrecognized massive emboli occur than false embolic syndromes.

In 70 per cent of the patients who had a clinical diagnosis of pulmonary embolus substantiated by autopsy a complete obstruction of the pulmonary trunk or of the right and left branches was found. In these cases death was the result of a mechanical obstruction to the pulmonary artery. In the remaining 30 per cent of the patients the embolus involved only a portion of the pulmonary tree, and death can not be attributed solely to mechanical obstruction. It is conceivable that a violent vasomotor reflex modifies the coronary and cerebral circulation to complete the effect of the mechanical obstruction.

Operative attacks on pulmonary emboli usually reveal a very long nonadherent clot sometimes 40 to 60 cm. in length. Multiple statistics indicate that emboli are usually produced in the first 5 post operative days. Phlebitis seldom occurs before the end of the first week. In the author's opinion phlebotrombosis precedes thrombophlebitis and the danger of massive embolus exists during the early period when the clot is attached at a limited point, essentially floating in the blood stream. Once inflammation occurs and the clot becomes fixed the risk diminishes.

The most common source of the clot is in the common or external iliac veins or their tributaries and not the deep veins of the calf of the leg. Once detached the clot travels rapidly and if it is not completely obliterative in the first few moments the pressure of the blood soon forces it to occlude the pulmonary artery. Secondary coagulation then adds to and completes the obstructive process. Death results from pulmonary cardiac, and cerebral embarrassment.

The diversity of clinical forms and the rapidity of death are a result of the volume of the embolus the manner in which it obstructs the pulmonary artery and its location. Sudden death represents an obliteration of the pulmonary trunk or of its two branches. Survival for several hours signifies obstruction of a major branch of the pulmonary artery. The infarction type of pulmonary embolus results from small emboli.

EDWARD W. GRANT, M.D.

Törnelli, E.: Thresher's Lung. *Acta med. scand.*, 1946, 135 191

Inhalation of dust of various kinds may give rise to pathological lung changes. The nature of these changes is determined by the physical and chemical composition of the inhaled particles, by the amount of dust and the length of the exposure and by individual susceptibility. The pneumoconioses develop after the inhalation of inorganic dust. In silicosis, which is typical, the occupation, together with the characteristic symptoms and the lung changes, generally points to the diagnosis.

Organic dust is much less injurious to the lung since it is more easily resorbed. It does not cause pneumoconiosis, with its typical fibrotic nodules. A massive inhalation may cause an atelectasis with hemorrhages and inflammatory changes that cannot be distinguished from pneumonia, and which ultimately results in chronic induration and bronchiectasis. Organic dust can, however, give rise to disease by serving as a medium for the introduction of bacteria and fungi. If the fungus is pathogenetic, mold disease of the lung develops—pneumomycosis, bronchomycosis or the disease may be named after the species of fungus involved, such as aspergillosis, moniliasis, blastomycosis.

The primary form of bronchomycosis appears chiefly as an occupational disease in previously healthy persons. It is more common for the bronchomycosis to appear secondarily to other pulmonary disease. The fungus then covers the walls of existing cavities and may gradually spread, so that the mycosis predominates. It may even penetrate the vessels, and give rise to thromboses, infarcts, and hemorrhages.

"Tea tasters cough" is a primary bronchomycosis caused by the inhalation of tea dust containing *Monilia*. Isolated cases have been reported among dove breeders and wig makers. More frequently the disease is found among harvesters—bronchomycosis fenicislorum. This is a seasonal affection, and is due to the formation of mold on hay and grain. Some-

times the appearance of the disease coincides with threshing time.

There are 6 clearly delimited species of *Monilia*. Of these *Monilia albicans* is the only pathogen. It does not attack the mucous membranes of healthy animals or people. An increase in the degree of acidity of the membranes or their carbohydrate content is necessary for the growth of the fungus. Diabetes is a predisposing cause for fungal disease. The simultaneous inhalation of fungi and irritate containing dust as occurs in threshing, is probably of importance. The virulence of the fungus seems to vary considerably both in different areas and in the same culture on different occasions. The cause for this variation is unknown, but individual resistance appears to be of great importance for the development of moniliasis.

Nine cases of thresher's lung are described. The diagnosis is arrived at through the history, the findings characteristic of pneumoconiosis, and the finding of fungi in the sputum.

The prophylaxis is more important than the treatment of thresher's lung. A protective mask which always be worn when "burned" grain is threshed. Persons who have difficulty in breathing through the nose should not engage in this work. Fences, stables, and other places of work where damp hay, straw and grain are stored should be suspect. Workingmen who acquire thresher's lung should receive compensation for it as an occupational disease.

SARULL KURT, M.D.

Bartlett, J. P. and Adams, W. E.: Solitary Primary Neurogenic Tumor of the Lung. *J. Tra. Surg.* 1946, 13 251

What is believed to be the first case of solitary primary neurogenic tumor (neurinoma) of the lung removed surgically is reported. Primary neurogenic tumors of the lung are extremely rare, although neurogenic tumors are commonly found in the mediastinum. Kent and associates added 18 cases to a summary of 105 thoracic neurogenic tumors from available medical periodicals inclusive to 1941. None of these was located in the lung. In a further search, especially of readily available English periodicals inclusive to November 1945, no neurogenic tumors of the lung have been discovered. A letter from the Tumor Registry Washington, D.C. states that there was no report of primary neurogenic tumors of the lung in the files.

Only during the past 50 years have primary neoplasms of the thorax been observed, studied, and reported in any numbers. From a clinical standpoint circumscribed hilar lesions may be simulated by peripheral circumscribed tumors and are, for the most part, confused with metastatic tumors and infections which are in the minority in occurrence. Alexander stated that contrary to the prevailing impression, the majority of circumscribed intrathoracic neoplasms are intrapulmonary and malignant. Many of these tumors which are benign, undergo malignant changes, or cause disability.





was distal to the bifurcation of the main-stem bronchus giving the impression of a dermoid cyst of the lower anterior mediastinum. Bronchoscopic examination was entirely negative. The surgical chest service at first considered the possibility of the tumor being an aneurysm of the aorta, but practically ruled this out by fluoroscopic examination. Its position in the mid-anterior mediastinum protruding into the left side of the chest did not seem to put it into a category of smooth walled neurogenic tumors which occur mainly in the posterior mediastinum, but was more suggestive of a dermoid of the anterior mediastinum. The lack of calcification in the wall did not rule out a tuberculoma. Malignant lymphoma had to be considered but these lesions are usually less circumscribed and the margins are less sharp and are lobulated. One might expect more symptoms if this were such a lesion. By size, location, and bronchoscopy, as well as lack of obstructive signs, a bronchiogenic carcinoma could not be ruled out. On the basis of size, location, great possibility of malignancy and the inability to make definite diagnosis, exploratory thoracotomy was advised.

On March 1, 1935, through a fourth left interspace incision the pleural cavity was explored. A hard spherical tumor mass was found in front and distal to the left hilum, lying for the most part free in the pleural space between the upper and lower lobes of the left lung. After incision of the pleura overlying the tumor, the tumor was readily freed down to the division of the left main bronchus where it was found firmly attached distal to the bifurcation of the left primary bronchus. It was so intimately and firmly related to the bronchial wall that it was thought inadvisable to dissect the tumor free because of the danger of opening the bronchus or leaving the tumor behind. Biopsy was thought to offer more possibility of complications than assurance, therefore a left total pneumonectomy was performed in the usual manner.

The gross appearance of the tumor is illustrated in Figure 3. The tumor cut across through the bifurcation of the left main-stem bronchus and was firmly fixed to the outer layers of the bronchial wall. It was not possible to separate the tumor from the bronchus without destroying tissues of both. Within the tumor was a large irregular space partially surrounding a central mass. This space was filled with redish brown, old bloodlike substances. The central mass was glary light yellowish-brown color and of soft consistency. The outer shell of the tumor tissue was a light yellow pink color and of a rubbery-firm consistency similar to that of peripheral fibrous tumors. The bronchial mucosa showed no evidence of tumor extension, but the upper lobe bronchus was partially occluded by the compression effect of the tumor.

The tumor was microscopically intimately attached to the bronchus and in some areas tumor tissue was separated from bronchial cartilage by a pseudocapsule of connective tissue 100 to 300 microns across. No actual invasion of the cartilage or

mucosa was seen in the sections taken. The tumor tissue had many mature venules and nerves and capillary spaces throughout. Its cytoplasm hyalinized veinlike structure was unusual when seen, and in this case the loose cellular structure of collagenous strands could not be differentiated from an organizing thrombus. Most of the nodules of any size showed definite intimal and wall proliferation of their walls. The outer tumor mass was composed of masses of swirling cells, varying from dense collagenouslike spindle cells with elongated nuclei and showing a tendency to form small aggregates, with alternate spaces of random structure, to a very loose cellular structure of cells with clear or loose reticular vacuolation. Some of the cells resembled lipophages. Fat stain, with Sudan IV showed neutral lipid substances in these cells and very little in other parts of the tumor. Iron carmalum stains contributed no positive information. On the margin of the tumor surface pointed into the bronchus, beneath lymphoid tissue containing intrathoracic pigment granules, were areas of what appeared at first impression (with hematoxylin and eosin stains) to be sclerotic arterioles, similar to the structures seen in lesions of a sclerosing angiosarcoma type. Further study of Van Gieson, Bodan, and Perdrau stained slides proved these areas to be concentric and circularly elongated nuclei of proliferating Schwann cells about nerve fibrils. (The microscopic appearance of these areas was almost identical to those reported by Bailey in 1918.)

JAY P. BARTLEY, MD

Olsen, A. M.: Boeck's Sarcoid: A Brief Review of Report of a Case in Which Diagnosis Was Made by Bronchoscopic Examination and Biopsy. *Ann. Otol. Rhinol.* 1935, 55, 439.

In a case of Boeck's sarcoid, the history of the illness covers a period of 10 years. Lesions involved the lungs and the ninth and tenth cranial nerves. The diagnosis of sarcoidosis was established by bronchoscopic examination and biopsy of tissue taken from the bronchial mucosa. Roentgenograms of the thorax demonstrated the progression and regression of the pulmonary lesions in the course of 6 years. Gold sodium thiosulfate was administered after definite diagnosis had been established. It appeared to have been of benefit.

To the best of the author's knowledge, this is the only reported case of Boeck's sarcoid in which a diagnosis was made by bronchoscopic examination and biopsy of a bronchial lesion. Bronchial and tracheal lesions of this disease have been demonstrated at autopsy, and there are reports of 5 cases of sarcoidosis of the larynx. Bronchoscopic examination was carried out in several patients suspected of having Boeck's sarcoid, but in no other instance has a tissue diagnosis from the bronchial mucosa been obtained.

The case reported is of particular interest because of the lesions of the cranial nerves. Involvement of cranial nerves has been reported not infrequently

accompanying sarcomatosis, but usually occurs in association with the unepithelial form of the disease, and the seventh nerve is most commonly affected. The author feels justified in assuming that the lesions of the cranial nerves in this case were caused by sarcomatosis. The improvement in speech and deglutition is consistent with the course in many cases of sarcomatosis.

Boeck's sarcoma is a condition which must be kept constantly in mind by those interested in thoracic disease and bronchoscopy. Although this condition is most commonly confused with pulmonary tuberculosis and Hodgkin's disease, it also must be distinguished from primary or metastatic malignant disease of the lung, leukemia, pulmonary fibrosis, bronchiectasis, and fungous disease of the lung.

Leifer, L. H., and Herbst, P. A.: The Diagnosis of Bronchogenic Carcinoma by Examination of the Bronchial Secretions. *Ann. Otol. Rhinol.* 1946, 55: 646.

The authors present a diagnostic aid to supplement the procedures always employed in the diagnosis of bronchogenic carcinoma. This is the examination of the bronchial secretions and must not be confused with the study of sputum. It is of greatest value as an adjunct in cases which are completely inaccessible to bronchoscopic visualization. The authors believe that when more frequent roentgen examinations are made and all patients with questionable shadows are subjected to bronchoscopic examination so that secretion may be secured for cytologic study, the diagnosis of bronchogenic carcinoma will be made early, more patients will be found suitable for treatment, and the prognosis of bronchogenic carcinoma will become more hopeful.

Three cases are reported briefly. Fifty-seven scored cases were cited in 47 of which diagnosis was made by cytologic study.

EMIL C. ROSENTHAL, M.D.

Kauffman, K. E., and Neuhof, H.: Mucoepithelial Papillary Adenocarcinoma of the Lung and Lobectomy. *J. Thorac. Surg.* 1946 15: 472.

Because of the variations in the literature concerning terminology with regard to mucous cell cancer of the lung it is virtually impossible to ascertain the incidence of this lesion. According to Neuburger and Jeever who attempted a classification of the reported cases according to histology it is apparent that this type of tumor is not excessively rare. In fact, they believe that about 5 per cent of all primary cancers of the lung are of this variety. On the other hand it is also apparent that not a few of the cases in their collection are not sufficiently well documented to justify their being placed in this group. The difficulty becomes greater when an attempt is made to ascertain what, if any, distinctive features characterize this relatively rare form of cancer of the lung. Some cases are reported to be extremely malignant and of short duration and others are of comparatively long duration. There is no

other case reported with the topographical features of the authors' case and this is perhaps the reason that their case is the only one in which lobectomy rather than pneumonectomy was done.

In generalizing from the particular case, it would appear that a long standing unproductive cough, clubbing of the fingers, and a roentgenogram of the chest revealing a shadow with some suggestion of lobulation appear to comprise a triad pointing to a circumscribed type of cancer of the lung which may prove to be of the mucous cell type. Should bronchoscopy in such a case yield positive results it would be more in the nature of an accident of erosion of the tumor into one of the larger bronchi. The fact that the patient has responded well up to the present time to the relatively simple procedure of lobectomy emphasizes the fact that the tumor is circumscribed and well localized. The tumor involved almost the entire lobe in this case, but could nevertheless be eradicated by lobectomy with a satisfactory follow up 2 years after operation.

JOHN J. MALONEY, M.D.

Clagett, O. T., and Deterling, R. A., Jr.: A Technique for Segmental Pulmonary Resection with Particular Reference to Lingulectomy. *J. Thorac. Surg.*, 1946 15: 227.

Great advances in thoracic surgery in the past two decades have reduced the mortality rate in lobectomy for suppurative pulmonary disease to below 5 per cent. Because of the prevalence and seriousness of bronchiectasis, early diagnosis is of particular importance in augmenting the number of cases in which surgical treatment is applicable. Emphasis should be laid on the role played by the lingular division of the left upper lobe in bronchiectasis.

A surgical technique for segmental pulmonary resection, with particular applicability to the lingula, has been described. By using the divided lingular bronchus for traction dissection the diseased bronchus, its subdivisions, and adjacent parenchyma may be simply and completely removed. Early re-expansion of pulmonary tissue is facilitated by the use of interrupted sutures and avoidance of clamps on normal pulmonary tissue. A review of cases in which this technique was used was presented and the complications of pulmonary resection were discussed.

## HEART AND PERICARDIUM

Samson, P. C.: Two Unusual Cases of War Wounds of the Heart. *Surgery* 1946 20: 373.

Two unusual cases of cardiac trauma in soldiers, successfully treated, are presented.

The first case is that of a severe perforating wound of the heart by a shell fragment. The wound consisted of two 8 mm. lacerations of the left ventricle; the wound of entrance was at the apex and that of exit in the midportion of the posterior left ventricular wall. Clinically the patient showed signs of shock but no dyspnea, hemoptysis or signs pointing

particularly to cardiac trauma. Operation was performed because a thoracoabdominal wound could not be ruled out in the face of a tender and resistant abdomen, persistent nausea and vomiting, and the apparent course of the bullet.

It seems that a rare chain of circumstances are responsible for the patient's surviving the original wound. It is probable that the fragment struck end on and passed through the heart without revolving during the diastolic phase thus irreparable damage to the papillary muscle was avoided. Also it must have come from the left and missed the diaphragm. The nausea and vomiting were probably cardiac in origin; these are uncommon in pure thoracic injuries. The fragment was found lying free in the pleural cavity.

The second patient, a German sergeant was wounded in the right posterior chest wall by a bullet that apparently ricocheted before striking him. He was admitted to the hospital 5 days after being hit. He showed little discomfort except for hemoptysis and moderate dyspnea. There was no evidence of cardiac pathology. Roentgenograms and fluoroscopy showed a foreign body that was movable but always remained within the cardiac shadow. At operation 7 days after the wounding, no laceration of either the pericardium or myocardium could be demonstrated. The foreign body, a .45 caliber bullet, was removed from the right ventricle and the patient was discharged from the hospital 10 weeks after operation.

It is obvious that the bullet did not traverse the heart because resultant damage would have been evident within the time limit stated. The foreign body evidently entered the venous system just outside of the pericardium and was washed into the right ventricle.

The author states that cardiomy for the removal of foreign bodies is not without risk, but also mentions a number of delayed complications that may arise from their presence. It is stated that unless localizing cardiac symptoms persist in most instances operation should not be considered an emergency.

Conclusions regarding the indications for cardiomy must await further clarification and critical comparison of results from operation and from conservative management.

EDWIN W. PARRAKILL, M.D.

Vesell, H., and Kroes, I: Patent Ductus Arteriosus with Subacute Bacterial Endarteritis: Diagnosis and Indications for Operation. *Arch. Int. Med.*, 94: 77-89.

A case of patent ductus arteriosus, complicated by bacterial endarteritis, and successfully treated by means of both penicillin and surgery is reported in detail. The authors discuss the indications and contraindications for operation in cases of this type. A correct preoperative diagnosis involves consideration of the murmur, roentgenographic studies, the electrocardiogram, and blood pressure tests.

In the history it is usually found that the patient was not a "blue baby" but the child has had a history of cardiac murmur since infancy. Cyanosis does not occur except in the presence of pulmonary or cardiac complications.

The most helpful diagnostic sign was the type of a tunnel machinery murmur. It is loud, low pitched, rumbling and harsh, grows louder during systole, reaching its maximum intensity in late systole or early diastole, and continuing through most of diastole. It can best be heard in the left parasternal line in the second and third interspaces. The transmission of the murmur is quite uniform. Its quality component is well transmitted over most of the front and back of the chest, left and right; it can also be heard in the left axilla and in the neck. Its diastolic component and consequently the continuous murmur as a whole has been found by the authors to have a rectangular shaped area of transmission with the following borders: the midsternal line to the right, the midclavicular line on the left, the third at the top and the fourth intercostal space at the bottom. The striking difference in size of the area of transmission of the diastolic component from its very much larger area for the systolic component suggests a different source or origin for each component. The presence of a continuous machinery murmur is not necessarily found in all cases of patent ductus; in some instances the murmur is limited to systole. In one of the authors' adult patients in whom this was the type of murmur combined with operation revealed a very short, but not ductus. Rarely is a murmur lacking. A thrill is almost always felt over the pulmonary valve area. It can be felt better when the patient bends forward and holds his breath in deep expiration.

Frequently roentgenography is helpful in the diagnosis, particularly in the cases where the pathognomonic continuous murmur is absent. Enlargement of the pulmonary artery (roentgen-ray sign of Zinn) with increased hilar and pulmonary markings (together referred to as Asman's sign) occurs in more than 50 per cent of the cases. Fluoroscopy reveals increased pulsation of the pulmonary artery in contrast to the feeble pulsation of the proximal pulmonary artery in mitral stenosis. The cinegram reveals the great amplitude of the stroke produced by the increased pulsations of the pulmonary artery as well as some increase in the left ventricular border excursions. Angiocardiography brings out a characteristic and perhaps pathognomonic abnormality in the left outline position: a small but definite bulge has been found in the aortic shadow at the site of the aortic infundibulum of the ductus in 16 of 27 cases. The size of the cardiac chambers may be normal.

The electrocardiogram is usually normal and is sometimes helpful in establishing the diagnosis by ruling out other conditions in which diagnostic changes are expected. There may be slight or moderate left axis deviation. Pronounced right axis deviation is strong evidence against the presence of

patent ductus arteriosus as an isolated or primary defect.

There is a characteristic alteration of the arterial blood pressure in most cases (Bohn test). The brachial artery diastolic pressure is commonly from 30 to 40 mm. of mercury below normal as in patients with a large arteriovenous aneurysm. There is usually a low normal systolic pressure.

The Bohn test was found of aid especially in the differential diagnosis of patent ductus arteriosus from an interatrial septal defect. This test consists of a substantial reduction of the diastolic blood pressure following exercise. A control reading of the blood pressure is taken with the patient standing while the blood pressure cuff is left on the arm, the patient exercises by taking 10 knee bends (or their equivalents). A blood pressure reading is taken immediately after exercising. The diagnostic sign is: occurrence of a substantial reduction of the diastolic pressure following exercise, elevation of the systolic pressure occurs, as it does in normal subjects. More than a minute elapses after completion of exercise, the characteristic blood pressure response may be missed. The sign has been further modified by adding a second series of knee bends to exercise. In an 18 year old patient with patent ductus arteriosus and questionable cardiac decompensation the following blood pressure changes were obtained: control blood pressure in arm 125/50 after 10 knee bends, 165/0 and after 10 more knee bends, 205/0. Blood pressures in the legs (tibialis sticus) were control 162/90 after 10 knee bends 170/110, and after 10 more, 175/110. It is difficult to get satisfactory results, when this test is attempted in patients with endarteritis. In a patient with an interatrial septal defect, corroborated by phonocardiography a negative result was obtained. It suggests that a pronounced positive response to lowering of the diastolic blood pressure close to zero which often occurs after the second series of knee bends in patients with patent ductus arteriosus could favor the diagnosis of patent ductus arteriosus instead of that of interatrial septal defect in situations in which the 3 conditions are considered.

The diagnosis of a superimposed bacterial endocarditis should be considered when there are symptoms of weakness irritability anorexia, feeling of warmth with perspiration chills, cough, and loss of weight, together with an unexplained fever of a week or more especially when a history of recent dental extractions is given. In cases of bacterial endocarditis superimposed on a patent ductus, petechiae are common at the onset. Systemic embolization occurred much later in these cases than in the ordinary subacute bacterial endocarditis pulmonary emboli were more frequent. Hematuria was infrequent. Blood culture was positive early at times from 100 to 400 colonies per cubic centimeter of blood were obtained.

Prior to operative interference in a proved case of patent ductus arteriosus with subacute bacterial endocarditis, the possible presence of contraindications to operation have to be determined. There are 2 contraindications of importance.

The first is the presence of associated congenital cardiac anomalies for which the patent ductus represents a vital compensatory mechanism. Experience has shown that such associated anomalies are most uncommon after infancy and if present would be expected to be revealed in cyanosis from an associated pulmonary stenosis and the signs of coarctation of the aorta aortic stenosis or atresia if one of these conditions were also present. Such associated lesions were not seen in the authors' cases and are said to have been very rare in the cases reported. Septal defects either atrial or ventricular need not be a contraindication to operation.

The second contraindication to operation is extension of the infection beyond the ductus and especially to the left side of the heart. It has been advanced that operation on the ductus could not have any effect on bacterial vegetations in the aorta, on the mitral or aortic valves, and probably not even on vegetations on the pulmonary valve. It is objected that if this were true the high percentage of cures following operation would be difficult to explain. (Most series of cases reported in the literature show that the number of cases of patent ductus arteriosus with subacute endocarditis wherein the valves were spared are so few that up to 1931 only 5 cases had been reported.) Further if extension of the infection to the valves would destroy the chances of cure by ductal ligation, then on the basis of autopsy statistics recovery should not occur in from 65 to 85 per cent of the cases. One of the most important reasons for healing of the valvular infection following surgery is the elimination of the current through the ductus and of the infection in it by this procedure. A forceful blood current with strong eddies and turbulence, appears to be necessary for the development and maintenance of bacterial vegetations in the heart by favoring the production of fibrin necessary for the protection of bacterial growth.

There are 3 indications for operation in these cases.

1 When the causative organism, isolated by blood culture, is found to be penicillin insensitive in vitro.

2 Patients whose bacterial infection has been of long duration, irrespective of whether or not the etiological agent is sensitive to penicillin. The authors suggest that an arbitrary period of 3 months be taken as the period within which operation may be delayed. Reasons for operative interference in these patients would be to avoid extension of the bacterial invasion to other parts of the heart particularly to the left side where eradication of the infection would be more difficult.

3 When the organism which is sensitive to penicillin after a trial of several weeks of chemotherapy cannot be eradicated from the blood stream. Relapse which takes place shortly, may be only in the form of recurrence of the positive blood cultures with little or no fever (such as happened in the case reported in detail in the article). The decision to operate is made easier by either the imminence or pres-

ence of cardiac failure which, in itself is an indication for operation.

In addition to these indications the authors state that (1) the operative mortality is about 8.5 per cent for uncomplicated cases and 15 per cent for those with subacute bacterial endarteritis (2) life expectancy in patients with patent ductus arteriosus, even without infection is considerably below normal without operation the average age of the patients in Maude Abbott's series of fatal cases was 24 years.

EUGENE J. AUDE, M.D.

## ESOPHAGUS AND MEDIASTINUM

Santi M: Pathogenic Varieties of Dilatation of the Esophagus (*Varietà patogenetiche del megacosofo*) *Riv. internaz. clin. ter.*, 1946, 26, 247

Dilatation of the esophagus may be caused by a stenosis of the cardiac sphincter from extrinsic factors such as a functional spasm of the periesophageal sphincter, an organic periesophageal fibrosis, or a mechanical dilatation of the esophagus. The intrinsic factors producing dilatation are functional spasm of the cardiac sphincter, caused by a disturbance of innervation such as lesions of the vagus nerve, and organic lesions resulting in chronic stenosis of the esophagus. A paralysis, atonia, or hypotonia of the wall of the esophagus may be congenital or acquired. The acquired form is caused by lesions of the vagus, disorders of innervation, or war gas.

The symptoms resulting from this condition depend upon the etiology. In a study of 2 cases, it was found that only dysphagia and vomiting was present in the first case while in the second case there was difficulty on swallowing, and a sense of obstruction which was more noticeable with solids. A sensation of having a lump at the region of the xiphoid was present, and a typical anginal retrosternal pain was experienced when lying down. It was therefore necessary for the patient to sleep in a semi-reclining position. Nocturnal cough, followed by vomiting, presents the problem of aspiration of the vomitus. Fainting on a reflex basis, due to compression of the cardiac or vagus nerves, was seen at times.

The diagnosis of megacosofo is dependent on the symptoms and x-ray findings, and this condition must be differentiated from tumors of the mediastinum, angina pectoris, diverticulum of the esophagus, aneurysm of the aorta, and carcinoma of the esophagus.

Because of complications such as pulmonary abscess or mediastinitis, the prognosis is poor.

The etiology determines the form of treatment. Medically the antispasmodics are useful however in some instances, such as the author's second case surgery was indicated and a cardiomyotomy was carried out.

ARTHUR F. CINOLLA, M.D.

Ramos, P: Peptic Ulcer of the Esophagus (*Úlcera péptica del esófago*) *Rev. gastroenter.* 1945, 10, 371

Ramos discusses the different pathological conditions of the esophagus and particularly the peptic

ulcer. He reports the case of a 40 year old Mexican female who for 2 years had epigastric pain radiating to the back and lasting for a few minutes. She had the feeling that the food stopped before it went into the stomach, and, in fact, learned that by very small amounts the distress decreased considerably. A small esophageal ulcer was found by x-ray examination.

The author discusses the pathogenesis, endopathology, symptomatology and treatment of ulcers of the esophagus. WILLIAM E. RICHARDS, M.D.

Engler, C. W: Perforation of the Esophagus Caused by Instrumentation. Review of 1 Cases. *Ann. Otol. Rhinol.*, 1946, 55, 667

In a series of 8 cases of perforation of the esophagus, the cause was a foreign body in 6 instances, of the remaining 2 cases there were acquired bronchoesophageal fistulas, 1 due to cancerization by regressed with suicidal intent and 1 due to syphilis.

Of the 6 patients with perforations caused by foreign bodies 2 were treated conservatively with spontaneous recovery. The 4 others were subjected to mediastinotomy with recovery in 3 cases and died from a fulminating paraesophageal infection after the removal of the foreign body in the other. All patients with bronchoesophageal fistulas died, 1 by first by suicide after discharge from the hospital and the other from the disease.

In all of the cases, roentgenographic examination and endoscopy were important in the diagnosis. In 4 of the cases of esophageal perforation caused by foreign bodies, the foreign bodies were not visualized roentgenographically nor esophagoscopically and were not removed. Eight cases are reported in detail.

EDWIN C. ROBERTSON, M.D.

Trolle, E., and Trolle, D: Treatment of Esophageal Varices by Injections of Sclerosing Agents through the Esophagoscope. *Acta chir. scand.*, 1946, 94, 385.

The authors report the case of a 24 year old man subject to severe recurrent attacks of hematemesis in which a diagnosis of splenic phlebostasis was finally made. The first hematemesis occurred in April, 1940.

In October, 1941 he was operated upon with a diagnosis of ulcer but this was not confirmed. The presence of a normal liver and the absence of ascites with splenomegaly led to further investigation, which revealed esophageal varices.

Splenectomy was done in December, 1941. The spleen weighed 1,150 gm. In June, 1941 hematemesis recurred. Ligation of the coronary veins of the stomach was attempted in August, 1944, but extensive adhesions prevented this.

Injection of the varices under esophagoscopic control was begun in September, 1945, with varices of the sclerosing solution (varix is 5% mono-ethanol amino-oleate, of accepted sclerosing potency).

A total of 32 injections of from 1 to 8 c.c. of varix (only once was quinine and urethane used) were given.

died over 30 months with apparent improvement to be followed by a recurrence of severe bleeding 10 months later.

The patient committed suicide 18 months later as evidence of a favorable effect on the varices could be seen in the esophagus at postmortem examination. His result is striking in view of other favorable clinical results in the literature. The possible reasons might be obtained if the solution were injected subcutaneously or along the vein rather than intravenously provided that a non-necrosing substance (Rivanol) be used.

HIRSH T. LANGSTON M.D.

operates as soon as the diagnostic signs previously mentioned have been found. None of the author's patients were operated on before the eighth day reached the hospital only after the fibrothorax was well advanced.

Either intratracheal ether-oxygen or cyclopropane anesthesia is satisfactory. Positive pressure is used to avoid the danger of mediastinal shift.

A posterolateral incision large enough to admit the operator's hand is made, and a segment of the seventh rib on the left or the sixth rib on the right is resected. Massive clots are removed by hand or suction. The loculi are broken down, fibrous strands are trimmed with scissors (avoiding those which might maintain lung expansion) and the cavity is washed out with saline solution, and the cavity is might incision is carried out. A varying amount of de-cortication is carried out. The freed lung is before the pleural cavity is closed. A mushroom catheter is inserted in the posterior axillary line just before the second thoracotomy and a smaller one is inserted in the second interspace anteriorly. The former provides drainage and the latter evacuates air. One hundred thousand units of penicillin in 100 c.c. of normal saline solution are used to wash out all recesses of the cavity and some are left in place. The wound is closed in layers and a bronchoscope passed before the patient leaves the operating table.

Postoperatively both catheters are connected to sterile rubber tubes and immersed in a sterile water bottle on the floor. The anterior catheter is removed in 2 days. The posterior catheter is removed daily intramuscularly and through the tube is given aged Blow bottles and deep breathing are encouraged. Patients are usually up by the end of a week and usually have smooth postoperative courses. The author has had no deaths or serious complications in 38 thoracotomies. Thirty patients healed promptly with rapid re-expansion of the lung and the other 8 developed infection with delayed expansion and empyema.

The author recommends rib resection because (1) wide exposure and inspection of the pleural cavity is allowed (2) airtight closure is made easier and (3) postoperative pain and discomfort is decreased. (4) encircling parietal sutures which cut off the circulation to the ribs can be avoided. The bacterial reports on aspirated fluid are misleading because infection often is confined to one or a few locules. Portions of the cortex when ground up may show a high percentage of pathogenic organisms although the contained blood clot is sterile. Pathogenic organisms may lie latent in balls or masses of fibrin in the pleural cavity and these should be removed with care and a minimum of trauma. Solid clots, thick strong adhesions and these should be re-integration of sterility. Sluggish or soft fibrin, easy hemolysis on pressure, or a tendency toward should indicate a low grade or latent infection at operation.

## MISCELLANEOUS

—COOK, A. F.: Massive Organizing Hemothorax. *Surgery* 1944, 30: 168.

Hemothorax in war surgery is often large occupying most of the pleural cavity and compressing the lung. Bony thorax injuries are severe with rib comminution and lung parenchymal damage by bony or shell fragments. The blood coagulates and pockets into large or small locules encompassed by fibrin. Eventually this spongelike structure, organized in thick layers over visceral and parietal pleura and the underlying collapsed lung undergoes an irreversible fibrotic process.

This fibrothorax leads to dyspnea on exertion, permanent vital capacity reduction, pleural pain and occasional thoracic scoliosis. Experience shows that the massive organizing hemothorax will not clear up spontaneously but leads to a life of semi-invalidism.

To avoid these results the practice of open thoracotomy evacuation of clots and decortication and rapid re-expansion of the collapsed lung was the policy adopted by thoracic surgeons during the war. This article presents the details of the technical procedure which the author found valuable in accomplishing these ends.

Only about 10 per cent of initial hemothoraces go to organization if prompt and repeated aspiration is carried out. In the author's experience the aspiration is not necessarily due to the presence of the clotting indications for operation are:

- (1) The presence of a massive hemothorax in which a few cubic centimeters of thick dark blood or serum in such cases a large caliber needle should be used and aspiration should be done in at least two places.
- (2) X-ray examinations show massive clouding of one or more loculi. Little or no improvement with progressive roentgenograms. Organizing accumulations involving more than 50 per cent of the pleural space are best treated by thoracotomy those involving less respond well to conservative measures.
- (3) Most surgeons decide on operating between the third and sixth weeks after the wounding. In order to avoid irreversible changes in the lung the author

The advisability of decortication arises once the clotted material is removed. Patients coming to operation from 1 to 3 weeks after injury can be decorticated readily and completely. The imprisoning layer peels away with relative ease leaving the salmon-pink and soot speckled visceral pleura. Minimal bleeding is encountered and re-expansion is readily achieved under positive pressure.

If the process has been present more than 3 weeks, the decortication is progressively more difficult. The fibrin layer is thicker, more tenacious, firm like leather and has become densely adherent to the pleura. Attempts to remove such tissue may lead to bleeding and contamination by tearing into the lung parenchyma. A cleavage plane usually can be found along the diaphragmatic surface of the lung and posteriorly in the vertebral gutter. During decortication an old bronchopleural fistula may be reopened. This should be avoided if possible, but if it should occur the opening may be closed with mattress sutures of chromic catgut. In late cases interstitial pleural fibrosis will prevent full immediate re-expansion. During decortication on the right side the thin walled azygos vein must be avoided. Decortication of the parietal pleura is not necessary and may excite bleeding. The object of decortication is maximal re-expansion of the lung and while the patient is in good condition and there is little bleeding from the freed surfaces, one should not cease his efforts to remove the investment completely.

While the author's early clean cases were closed without drainage, later experience led to catheter drainage in all cases. The postoperative accumulations of blood often cannot be removed by aspiration but can be removed by irrigation through a tube.

When the entire cavity develops suppuration a few days after operation, it usually is due to improper

selection of cases for early catheter removal and disregard for the gross pathological criteria previously mentioned which signal latent empyema. In several of these cases penicillin is ineffective, perhaps because of the presence of gram negative bacilli.

ROBERT R. BOWLOW M.D.

Poppe, E.: Hernia Diaphragmatica Dextra. *Acta radiol.*, Stockh., 1946, 27 305.

Diaphragmatic hernia occurs eight times as often on the left side as on the right, since the liver serves as a buffer for the right diaphragm, and external pressure occasions a far greater force on the unprotected left side of the diaphragm than on the right side.

Most diaphragmatic hernias are of congenital origin with the exception of those in which the hernia is produced by a perforating wound. The clinical diagnosis is difficult. No clinical symptoms are pathognomonic of the condition, but usually there is a combination of thoracic and abdominal symptoms which are often characteristic. Generally the diagnosis must be confirmed by roentgenograms.

Early diagnosis is important, so that operative treatment can be undertaken before irreparable damage has been done. The appearance of cardiac and respiratory complications, as well as the danger of strangulation should always be borne in mind. Operation at an early age is preferable since, if the viscera are allowed to remain in the chest for a long period, the abdomen will not develop sufficiently to accommodate the intestines when they are brought down later.

In several cases of diaphragmatic hernia on the left side and in 1 of the 2 cases on the right side, a gastric or duodenal ulcer was found.

SAMUEL KARN M.D.

# SURGERY OF THE ABDOMEN

## ABDOMINAL WALL AND PERITONEUM

Isaacs, A. H.: Why Hernias Recur. *Am. J. Surg.* 1946  
72 550.

It is the author's contention that the inguinal region must be treated in relation to the dynamics of the area when inguinal hernia is corrected rather than being considered as a fixed anatomical specimen merely requiring the closure of any defects or holes present to correct herniation. He concurs with the opinion of W. J. Lytle of Sheffield (England) that the internal ring is mobile—an active mechanism of closure which under stress moves upward and ward under cover of the internal oblique and transverse muscle, and its action is therefore, that of a sliding valve and not of a shutter or a sphincter. Furthermore, the author indicates that the suture of the internal oblique and transverse abdominal muscle to the inguinal ligament is not only incorrect because union will not result, but the sutures destroy and weaken the muscle and together with the abnormal fixation of the muscle, interfere with the normal myodynamics of the area.

He tabulates five types of recurrence (1) direct hernia, the most frequent (2) indirect hernia (3) saddlebag or pantaloon hernia (4) epigastrial hernia along the semilunar line and (5) bladder

Recurrences are caused by inefficient surgical techniques and incorrect after treatment. The basis for the treatment of indirect inguinal hernia is high ligation of the sac and in direct hernia it is careful repair of the attenuated transversalis fascia. Care should always be taken when repair is made of one type of hernia to make sure that both types are not concurrently present.

Presurgical causes of recurrence are incorrect diagnosis. Improper choice of the type of repair and secondary conditions such as obesity, bronchiectasis, myocardiitis and active syphilis, which enhance the chance of failure.

During surgery many features are of importance in averting recurrence. Anesthesia must give satisfactory relaxation of the tissues without causing postoperative vomiting, straining, or distention. Hemostasis careful asepsis proper placing of the incision, use of the drainage tube only when proper and careful choice of suture material are important. Evaluation of the existing defect by careful dissection and examination and then proper operative correction are important. Divided nerves failure to remove it in elderly patients failure to narrow the abdominal ring or correct defects in the inguinal triangle are important causes of failure.

Posturgically the author advocates postponing weight bearing until the scar tissue is consolidated, which takes about 7 days. He recommends avoid-

ance of coughing straining at bowel movements and attempting to rise up in bed. He advises against strain or hard work for 3 months after operation and as to patients over 45 with poor spongiocytosis he says they should never again return to laborious work.

Indirect hernia with a small internal ring is adequately corrected by ligation of the base of the sac alone. Mild stretching of the neck can be corrected by repair of the transversalis fascia and then imbrication of the external oblique fascia deep to the cord with the superior limb of the fascia sutured to the inguinal ligament and the inferior over it. In this procedure the conjoined tendon is undisturbed.

The Beach technique is also discussed in this flap of the external oblique is swung from a position lateral to the internal inguinal ring to a position medial to it and deep to the cord structures which has the effect of moving the internal ring laterally and of having the cord structures pass laterally and superiorly before they turn acutely in an inferior and medial direction. This adds gravity to an inferior and mitigating against recurrence.

In recurrences of direct hernia the author believes that principally because of inadequate dissection the bladder is frequently overlooked as a cause of recurrence. In the past he has corrected this by plication sutures in the bladder. He now believes because of recurrence in these cases that better results are obtained by excising and closing the portion of the bladder in the hernia.

The use of autogenous grafts is briefly discussed and great credence is placed in the living pedicled fascia lata graft.

FERNANDEZ C. HERNANDEZ, M.D.

Brahm, Y. O.: Remarks Concerning Spiegel's Hernia (Consideraciones sobre las hernias de Spiegel). *Arch. Soc. Cir. Hosp., Santiago, 1946* 16 388.

A case of strangulated Spiegel's hernia on the left side is reported by the author. The majority of Spiegel's hernias occur at the insertion of the lateral border of the rectus muscle and a line connecting the anterior superior iliac spine.

Because of the great frequency of strangulations an operation is indicated whenever Spiegel's hernia is diagnosed unless some contraindications are present. If the hernia is not strangulated, an incision in the direction of the skin lines should be made, the sac should be exposed, isolated, and ligated after retraction of its contents, and after closure of the peritoneum the aponeurosis should be imbricated. If the hernia is large, the muscles and aponeurosis should be sutured in the transverse direction because a suture in the longitudinal direction predisposes to recurrence. In extraordinarily large hernias plastic operations may be indicated and for this purpose the sartorius muscle or preferably the external oblique muscle and the rectus sheath may be used.



Reduction of the strangulated hernia is usually unsuccessful on account of intrasaccular adhesions and bands, which may be responsible for a spurious reduction.

The author's patient was a woman, age fifty-eight who had had a tumor in the left inguinal region for a number of years. Six years prior to admission she developed pain in the involved region with vomiting and meteorism. A diagnosis of a strangulated left inguinal hernia was made, but the operation established the correct diagnosis. After the adhesions between the omentum and the hernial sac were severed, the cyanotic strangulated loops of intestines assumed their normal color and were reduced into the abdominal cavity. The patient made an uneventful recovery. **ARTHUR F. CROLLA, M.D.**

**Young, J. P., Jr., and Cole, W. H.: Intraperitoneal Administration of Succinylsulfathiazole and Phthalylsulfathiazole: Their Use in the Prophylaxis and Treatment of Peritonitis. Arch. Surg. 1946, 53: 183.**

The authors used succinylsulfathiazole and phthalylsulfathiazole both in dogs and in a series of 18 human beings and demonstrated that when the dosage remained within the limits of 0.1 gm. per kilogram of body weight there were no toxic reactions. Careful studies of the urine did not reveal any crystalluria, and examination of the peritoneal cavity of the dogs did not reveal any tendency toward the formation of adhesions. The absorption of the drugs from the peritoneal cavity was rapid almost simulating that of sulfanilamide. The advantage of the two drugs over the sulfanilamide however was that they have a far more adverse effect against the *Escherichia coli*.

The rapid absorption of succinylsulfathiazole and phthalylsulfathiazole means that they are valuable only in the protection from soilage occurring at the time of the operation, and not for any later soilage which may come from a leaking suture line. In 3 cases the authors had the opportunity of observing the effect of the drugs on the *Escherichia coli*. One of these was a ruptured appendicitis and the other a perforation of the cecum secondary to a tuberculous ulcer. At the time of the operation mixed cultures were obtained containing the *Escherichia coli*, the staphylococcus, and the streptococcus. At autopsy only the coccal forms were found.

**WILLIAM C. BECK, M.D.**

## GASTROINTESTINAL TRACT

**Kavazkili, N. E.: The Antitreticular Cytotoxic Serum of Bogomolts in the Treatment of Gastrointestinal Diseases. Frschheiss Dtsch. 1945, 26: 50.**

The author's material comprises more than 200 cases of gastrointestinal ailments which were treated with Bogomolts' serum. All the patients were subjected to detailed study but since most of the cases have already been reported elsewhere this report is

limited to a discussion of the results obtained in the various groups as groups, with abbreviated case histories of 1 or 2 typical patients from 2 of the most important groups.

In the first group are included the patients with malignant neoplasms of the digestive organs, such as cancer of the esophagus, stomach, and small intestines, and to this group the author adds the cases of enterocolitis with grave exhaustion of the general condition (reticuloendothelial system). In the second group are included the patients with chronic colitis of medium severity, and the cases of severe, acute gastroenterocolitis. Finally the third group is made up of the gastric and duodenal ulcer cases and those of chronic gastritis with hyperacidity.

The purpose of this grouping is that of a closer study of dosage, and the author believes that with greater attention to dosage even better results than those recorded here may be attained. However in this report the author does not mention any modification of dosage and seems to have employed the standard practice of injecting 0.05 c.c. of the serum intracutaneously into the skin of the upper arm. In a first course of 3 injections at 3 day intervals, with perhaps a second course in a month or so when the patient shows indication of recurrence. It is emphasized however that this treatment is not directed against the pathological condition itself but against the concurrent depression (blockage) of the reticuloendothelial system, and these groupings are arranged according to the different degrees of depression of the physiologic functioning of this system. No claim is made that the ACS (Peaks prefers the term "reticuloendothelial immune serum" [REISS]) should be used to the exclusion of other accepted methods of treatment directed against the pathological condition itself and in this material, with the exception of a few control patients, other methods such as dietotherapy and atropin were initiated and used concurrently with the injections.

A positive result with ACS was obtained in 80.7 per cent of the gastric and duodenal ulcer cases, with complete disappearance of all subjective and objective symptoms, including healing of the ulcer niche in 32 per cent, which was shown by roentgenography. Among the patients with chronic gastritis there was a complete disappearance of all symptoms in 33.3 per cent of cases, there was improvement in 50 per cent, and failure in 16.7 per cent. In 78.9 per cent of the anacid and subacid cases of gastritis there was an elevation of the acid component of the gastric contents, and in 15.8 per cent of those with anacidity there was a development of free hydrochloric acid. In 75 per cent of those with hyperchlorhydria the acid content was lowered. Of the patients with symptoms of chronic colitis the majority responded with a disappearance of the diarrhea, a decrease of the pain and other symptoms, and a general improvement and feeling of well being.

Although it was thought that the chief indication for ACS in cancer was the prophylactic effect against recurrences, nevertheless the serum was given in 20

cases of inoperable cancer of the stomach and esophagus with the hope of suppressing the tumor growth and inhibiting the growth of metastases. However, in 11 of the patients unexpected results were obtained. There was amelioration of the pains, a stabilization of or increase in the body weight, and an improvement in the blood picture and general health. Even though complete cure of the cancer may not be expected the relief of suffering and the extension in the patient's life expectancy would amply justify the use of the method.

In all these patients one can expect an improvement in the general condition, an increase in strength, appetite and pleasure in living and confidence in the future. The author's experiences in the past 5 years with ACS convinces him that the antitumoral cytotoxic serum is a very valuable constituent in the combined treatment of diseases of the digestive organs. JOHN W. BRENNAN, M.D.

Maimon S. N., and Palmer W. L. Chronic Gastritis: Observations on Its Course and Significance. *Gastroenterology* 1946 6 511

The authors report the changes in the gastric mucous membrane, as seen gastroscopically in 14 patients examined repeatedly over periods ranging from 8 months to 11 years in an effort to determine the course, significance and consequence of the inflammatory processes. The interpretation of the gastroscopic findings is not always easy as variations in the appearance of the gastric mucosa, noted during repeated examinations of the same stomach are extremely frequent. The reasons for these changes are not clear their significance cannot be determined with ease and their prognostic import is difficult to evaluate. Physiological, emotional, physical, and chemical factors seem hopelessly interwoven. Consideration of the few published studies which correlate clinical findings, gastroscopic appearance, and histologic picture of the gastric mucosa shows a striking lack of uniformity in the interpretation of the degree and type of inflammation.

As to the results 6 of the 7 patients with superficial and hypertrophic changes were found on different and multiple occasions to have superficial gastritis at one time and hypertrophic gastritis at another which suggested not only a close relation between the two but also the likelihood that they represented variant phases of the same process. The significance of these changes was not apparent. They seemed to be transitory phenomena with a marked tendency to recur.

Prolonged atrophy was observed in 5 of the total number of cases. In 2 superficial and hypertrophic changes were followed by atrophy while in 1 atrophic changes in the last 2 cases atrophy was always found without other types of inflammation. While the gastroscopic findings in atrophy can be correlated roughly with the histological appearance, no definite inferences can be made as to the course

which the inflammatory process will follow. The authors noted that in general, severe and wide spread atrophy tends to continue unchanged although the reverse occurred in 1 of their cases. The return of the mucosa to a gastroscopically normal appearance does not prove the presence of a normal peptic remission the apparently normal mucosa is unable to secrete acid gastric juice.

The incidence of atrophic gastritis at gastroscopy in various series averages slightly more than 10 per cent. Atrophy of the gastric mucosa seems to occur in gastric carcinoma, anemia and achlorhydria with a frequency greater than one would expect on a purely accidental basis but the relationship of these various processes remains unclear.

In 6 patients with benign gastric ulcer and various degrees of hypertrophic, superficial, and atrophic gastritis, radiation therapy was administered to the gastric fundus to reduce gastric secretion. A ray therapy was followed by atrophic changes in 3 of the patients while in the other 3 superficial and hypertrophic variants were noted. Theoretical and hypertronic would suggest the appearance of an atrophic gastritis following radiation but the almost inevitable return, in time, of a normal secretory response argues against this concept. In the authors small series the changes observed were neither marked nor consistent.

Two patients with both superficial and hypertrophic gastritis prior to supradaphragmatic bilateral vagotomy were found to have only superficial changes postoperatively. EUGENE J. AUST, M.D.

Guadarrama, L. Ulcerated cancer (Ulcerocancer). *Cac med Mexico* 1946 76 95.

Guadarrama has made a very comprehensive review of our present knowledge concerning ulcerated carcinoma. He considers that at present the term ulcerocancer should mean a malignant ulceration of slow evolution but malignant from its beginning. The benign rounded ulcer of the stomach is not a predisposing factor to the development of cancer.

The author emphasizes that only when we have a better understanding of the causes and predisposing factors of both processes will it be possible to know the life history of such conditions. The clinic and the laboratory alone do not permit differentiation between these two lesions. Gastroscopy and roentgenography of the upper gastrointestinal tract are considered most valuable in this differentiation. In cases of patients who are over 40 years of age in which malignancy is suspected resection should be done. In the surgical resections for cancer wide resection of the stomach, the lymphatic nodes and the possible metastasis is indispensable.

WILLIAM E. RICKETTS, M.D.  
Olson H. B., and Norgore M.: Perforated Gastrointestinal Ulcers. *Ann Surg*, 1946 124 479.  
The authors study is based upon 166 case records of perforated gastric and duodenal ulcers treated at

the King County Hospital, Seattle, Washington, from 1938 to 1944 inclusive. Many of the patients admitted were in a poor state of nutrition. Others were chronic alcoholics, old and neglected. Most of the emergency surgery was done by the Resident Staff and junior members of the Attending Staff.

The authors found obliteration of liver dullness a physical sign of some diagnostic value. The patient is placed on the left side for 4 or 5 minutes. If there is an appreciable amount of air in the abdomen, liver dullness will not be found. Shock was not a common finding. Only 7.2 per cent of the patients exhibited evidence of this condition. It is believed that when shock is present in perforated peptic ulcer it is due largely to the action of bile and pancreatic juice which is poured into the abdominal cavity. Later hypoalbuminemia and dehydration also play important roles.

In order to demonstrate pneumoperitoneum roentgenographically the patient is placed on the left side for at least 30 minutes, after which roentgenograms are taken with the patient in this position. The authors believe that a smaller amount of air can be detected by this maneuver than by having the patient in the upright position. In 6.6 per cent of cases the diagnosis was not recognized until autopsy. Most of the patients were moribund upon arrival.

Early in this study 17 patients with *forme fruste* ulcers were treated conservatively with death of 7. Since that time this method of treatment has been abandoned and it is used only in cases in which operation is refused. Surgical treatment was instituted in 138 patients. The authors prefer a transverse incision of about 3 inches in length. The ulcer is closed with a living tag of omentum, and no sulfonamide drugs are introduced into the abdomen or the incision nor are drains inserted. A high percentage of these patients require no further operations after closure of the perforation.

The closure of the abdominal wound with heavy catgut is contraindicated because of the exudate that accompanies its use. Cotton or preferably wire sutures have been found to be most efficacious. Adequate serum protein and ascorbic acid levels must be maintained.

Among the cases reported there were 24 wound infections and 14 wound dehiscences. The over-all mortality in this series was 27.7 per cent, most of the deaths being due to peritonitis and pulmonary complications. The authors present an outline for the general management of perforated peptic ulcer which should be of benefit to those interested in developing the routine for the management of such cases.

HAROLD LAUFMAN, M.D.

Bechrach, W. H., Grossman, M. L., and Ivy, A. C.: Problems in the Etiology of Peptic Ulcer; the Resistance of the Gastrointestinal Tract to the Digestive Action of Its Own Secretions. *Gastroenterology* 1946, 6: 563.

The authors re-examination of the question of why the stomach resists digestion by its own fer-

ments, includes a brief summary of the views on this question held by other workers, together with a discussion of present day concepts of this problem. The following factors are considered:

Resistance of the gastric gland. Studies have shown that in experiments wherein from 0.4 to 0.6 per cent hydrochloric acid is kept in continuous contact with the lining of the stomach, injury occurs first at the pyloric rather than at the fundic area (HCl formed by the parietal cells has a concentration of 0.58 per cent.) The reason why the surface epithelium of that portion of the gastric mucosa which forms acid can tolerate a more or less continuous contact with a solution of 0.58 per cent HCl is unknown at present.

The resistance of the surface epithelium. There is a gradient of susceptibility to acid injury in the gastrointestinal tract. The further away the mucosa from the source of acid formation, the less the resistance of the surface epithelium to injury by acid. Factors responsible for this are probably the epithelial cell structure, the role of the external secretions of the alimentary tract and the blood supply.

The resistance of muscle cells, connective tissue, and fibroblasts, or the resistance of a chronic ulcer to healing. Failure of penetration of an acute ulcer to the serosa (because muscle cells and fibroblasts grown in tissue cultures are killed by exposure to a concentration of HCl similar to that found in the stomach) results from transudation of plasma and the formation of a fibrin coat to buffer the acid and protect the underlying cells, renewal of the exposed surface of newly proliferated fibroblasts, and the possible protective action of mucoid cells growing out to cover the fibroblasts.

It is suggested that there is usually little difference between the potential rate of healing of the acute ulcer of a nonulcerous patient and the "chronic" lesion of an individual with peptic ulcer. A well-controlled series of experiments has shown that in the majority of cases the crater of a gastric or duodenal ulcer disappears within 6 weeks after the patient is placed on strict ulcer management.

The ulcer patient can be described as being one with either a normally resistant upper gastrointestinal mucosa subjected to excessive trauma from abnormally high gastric secretions, or a less resistant mucosa susceptible to injury at normal acid-pepsin levels. The therapeutic desideratum would therefore be to find a physiologically innocuous and non-destructive method to control secretion or to improve the resistance and proliferative activity of the cells because this would heal the acute lesion from which all chronic lesions originate and recurrences would be prevented.

ROBERT J. AUST, M.D.

Harper, W. H., and Lemmer, R. A.: Necrosis and Ulceration of the Intestinal Wall in Simple Intestinal Obstruction. *Bull. Johns Hopkins Hosp.* 1946 70: 807.

Simple intestinal obstruction was artificially produced in 20 dogs at the level of the ligament of

Treitz 20 cm. below the pylorus, in 10 dogs in the mid ileum, 100 cm. distal to the ligament of Treitz, and in 10 dogs in the terminal ileum 5 cm proximal to the ileocecal junction. The obstruction was produced by dividing the intestine between Stone clamps, and inverting both ends of the cut intestine by the Parker Kerr method. Food was withheld for 24 hours before operation and for the duration of life after operation. All dogs were allowed to drink water to 1,000 c.c. a day but received no electrolytes.

The results of this series of experiments show that damage to the intestinal wall occurred in none of the dogs with high intestinal obstruction in 70 per cent of the dogs with mid ileal obstruction and in 80 per cent of the dogs with terminal ileal obstruction. There was no hemorrhage or necrosis in high obstruction there was an average of 0.6 sq. cm. of necrosis in mid ileal obstruction, and an average of 18.3 sq. cm. of necrosis in low ileal obstruction. Actual ulceration did not occur in any animal with high obstruction, in 30 per cent of the animals with mid ileal obstructions, and in 30 per cent of animals with low ileal obstructions. There were no cases of gross perforation of the intestine followed by peritonitis. The lower the obstruction, the greater was the distension and the sooner it occurred. Kinking of the bowel, with formation of partially or completely obstructed isolated loops with an intact blood supply occurred in no case of high obstruction but did occur in most cases of mid ileal or low obstruction.

It is interesting to note that the results of this series of experiments indicate that when water is given ad libitum to dogs with simple obstruction the well established concept, i.e. the higher the obstruction the less the survival time no longer holds. Instead it was found that dogs with high obstruction live longer than those with low obstruction.

Activated pancreatic juice is not an important cause of necrosis or ulceration of the intestinal wall in simple intestinal obstruction since the area and incidence of necrosis and ulceration were greater in the lower obstructions, whereas the pancreatic activity of the intestinal content found at the lower levels was less.

The normal intestinal bacteria, acting upon tissue whose resistance has been lowered by ischemia due to distension are responsible for the ulceration of the intestinal wall that occurs in simple intestinal obstruction. The lower the obstruction, the greater is the incidence of positive peritoneal and heart blood cultures found at autopsy. SAMUEL KAHN, M.D.

Caster, M. R., Udaondo, C. B. and D. Alotto V.: Primary Cancer of the Duodenum (Cáncer primitivo del duodeno). *Presencia médica argentina* 1946 33 1479.

In a study of 7 cases of primary carcinoma of the duodenum seen by the authors, 65 per cent of the lesions were found in the region of the ampulla, 23 per cent were supra-ampullar and 12 per cent were found in the infra-ampullar region. Adenocarcinomas were most frequently found and those in the first and

third segment were annular and followed the lymphatic distribution closely. Ulcerations were seen early with prominent irregular borders. Although metastases and glandular involvement were infrequent, occasionally there was invasion of the neighboring organs.

The clinical symptoms depended upon the site of the lesion and the degree of invasion, as some of the tumors caused no disturbance until stenosis was produced. Those in the duodenal cap or supra-ampullar region often simulated pyloric involvement producing an ulcerlike pain and vomiting of a nonbiliary substance. Melena and occult hemorrhages were common constipation was constant and a palpable mass was found in one third of the cases. The x rays revealed filling defects and stenosis.

Carcinoma of the second part of the duodenum was found most frequently over the ampulla of Vater or nearby it produced an early involvement of the common duct, which resulted in jaundice and signs of infection in the biliary system. Hepatomegaly and biliary distension were seen in one-third of the cases. Differentiation from carcinoma of the pancreas is difficult. Hematemesis and profuse melena are early symptoms.

The lesions in the third part of the duodenum give rise to vague symptoms of dyspepsia due to stenosis. Distension above the stenosis and filling defects may be visualized by means of the x rays.

The prognosis of undiagnosed carcinoma of the duodenum is death in a short time. Surgery is more successful when the diagnosis is made early and the general condition of the patient is good, while the type of operation depends on the site and extension of the tumor. ARTHUR F. CROLLA, M.D.

Costich, K. J., and McNamara, W. L.: Carcinoma of Meckel's Diverticulum. *Ann. Surg.* 1946 124 503.

The literature on tumors of Meckel's diverticulum is reviewed and a new case is reported. The present report brings the total number of cases of this type to 9. In 6 cases the tumors were adenocarcinomas of intestinal mucosa, in 1 case an adenocarcinoma of gastric mucosa, and in 2 cases medullary carcinomas.

Clinically it is very difficult to make a diagnosis of tumor of Meckel's diverticulum before operation or autopsy. The most common symptoms lead to the impression of an acute pathological lesion in the abdomen. The tumor may or may not be palpable, and symptoms do not depend upon the size of the tumor. Complications such as intestinal bleeding, intussusception obstruction or perforation with either local or diffuse peritonitis, may be responsible for calling attention to the condition. Occasionally the lesion can be demonstrated roentgenographically although it is impossible to differentiate an inflammatory lesion from a malignant one.

The case reported is that of a 55 year-old colored male who was admitted to the hospital with acute sharp pain in the abdomen and a history of a similar mild attack some 3 weeks previously. Physical ex-

amination pointed to a diagnosis of acute appendicitis. Exploration revealed a normal appendix in an abdomen containing seropurulent material. The tumor mass of the ileum was exteriorized for later removal. The patient died 6 days later and at autopsy a marked ileus with distension of the entire small bowel above the exteriorized mass was revealed. Sections of the tumor proved it to be an adenocarcinoma of Meckel's diverticulum.

HAROLD LAUTMAN M.D.

Beston, E. D. S.: Cancer of Right Colon (Cancer do colon direito). *Rev cir S Paulo* 1946, 11: 261.

Statistics show a steady increase in the incidence of cancer of the colon; however they show also an increase of operability and a decrease of postoperative mortality.

Any lesion which can be mobilized after ample exposure and which does not involve vital structures, is resectable. Adhesions involving one ureter, one kidney, the stomach, the duodenum, loops of small intestine, pancreas, gall bladder, spleen, and the margin of the liver form no contraindication to the removal of the lesion.

Of 9 cases observed by the author the tumor was located in the left colon in 6 patients, and in the right colon in 3 patients.

Visible blood in the stools was found in 97.7 per cent of cancers of the rectum, in 46 per cent of those in the left colon, and in only 9 per cent of the malignant lesions of the right colon. Metastases appear relatively late.

The author advocates right hemicolectomy with terminolateral anastomosis of the ileum to the transverse colon.

JOSEPH K. NARAT M.D.

Simon, H. E., and Williamson, B.: Prolapse of the Rectum. *South. Surgeon*, 1946, 13: 139.

Cases illustrating the various types of rectal prolapse and their treatment are presented. The great number of surgical procedures that have been suggested particularly for complete rectal prolapse makes the selection of the most appropriate difficult. However since Moschowitz considered the condition a hernia, his suggested cul-de-sac obliteration operation has been considered by many as the operation of choice in the treatment of uncomplicated complete and high prolapse. It is easily accomplished, has a low surgical risk, and accomplishes a high percentage of cure.

In the presence of strangulation and gangrene, amputation of the rectum by ligation over a tube is probably the operation of choice, although stricture must be guarded against and the Moschowitz operation may be necessary later to attain permanent cure. Coincidental cystocele, rectocele, or uterine prolapse should be repaired shortly before or after or at the same time that the Moschowitz operation is done, according to the condition of the patient. Before the menopause, tubal ligation is indicated because pregnancy would favor recurrence. The persistence or appearance of a small amount of

prolapse postoperatively is frequently due to a coincident mucosal prolapse and may require a supplemental operation for its correction.

JOSEPH GARTER, M.D.

Colcock, B. P.: Perforating Wounds of the Colon and Rectum. *Am. J. Surg.* 1946, 72: 343.

The primary objective in the treatment of perforating wounds of the colon, just as in the treatment of battle wounds of any other type, is the preservation of the patient's life. To accomplish this in as high a percentage of patients as possible, three fundamental principles must be kept in mind: first, the perforation must be dealt with in such a manner that a further leakage of intestinal contents into the peritoneal cavity is prevented; second, the manner of closure must be such that there is no marked impairment of the bowel lumen; and last, the procedure should be one that will add a minimum of shock to a patient already suffering from exposure, loss of blood, and the trauma of a severe wound. The colon wound is usually associated with multiple wounds of the small bowel and other abdominal viscera and often with wounds of the extremities, perineum, buttocks, and other parts of the body.

That marked progress toward this primary objective has been achieved is shown by a comparison of the mortality figures of patients with perforating wounds of the abdomen operated upon during the recent conflict with mortality figures for similar groups of patients operated on during World War I. Then the mortality rate ranged from 50 to 75 per cent. In this war it has dropped to the neighborhood of 30 per cent. This includes those dying in the general hospital, sometimes weeks after their injury, and is a tribute to the Medical Corps of the armed forces of the United States. The progress which has been made is the result, partly, of the early and adequate replacement of blood loss. It is frequently necessary to give blood to those patients in amounts as high as 3,000 to 4,000 c.c. during the first 12 hours. It is also partly the result of the extensive use of the sulfonamide drugs and penicillin both intraperitoneally and parenterally and it is due chiefly to the high degree of technical skill employed by the surgeons operating in our forward hospitals. The development of the highly trained surgical team consisting of surgeon, assistant, anesthetist, and surgical nurse, often augmented by a medical officer trained in the treatment of shock, is one of the most significant advances made in the field of military surgery during this war. The widespread use of such teams in the field and evacuation hospitals, operating usually within a few miles of the front lines, has saved many battle casualties which a few years ago would have been considered hopeless from the standpoint of military surgery.

As the mortality decreased, it became possible to concentrate on a secondary objective, namely to decrease the high morbidity associated with these wounds. All too often separation of the laparotomy incision, retraction of the colostomy and the focus

tion of intraperitoneal and subphrenic abscesses followed the successful primary treatment of the wound. Frequently these complications were sufficiently serious to jeopardize the life of the patient.

Exteriorization of the injured segment of the colon has become an accepted principle in the treatment of the majority of perforating wounds of the large bowel yet in 38 per cent of the first group of 25 cases the colostomy stoma was at the level of the skin or beneath when the patients were admitted to the general hospital. In 25 per cent of this group abscesses of the abdominal wall, of the adjacent peritoneal cavity or subphrenic space occurred.

It is obvious that the bowel must not only be exteriorized but it must be exteriorized without tension. If there is any tension on the exteriorized segment, it will inevitably retract regardless of the type of support which is used to hold it above the skin. Exteriorization without tension as well as the formation of a spur of adequate length if such a spur is desired, is dependent on adequate initial mobilization of the visceral and parietal peritoneum and mobilization of the mesentery of the bowel to its central attachments on the posterior abdominal wall, it is possible to exteriorize any segment of the colon terminal ileum or sigmoid at some point on the abdominal wall without tension.

The only difference of opinion concerning one of the essential points in the treatment of rectal perforations namely the drainage of the perineal space is as to whether or not it is necessary to remove the coccyx. There were 7 patients in this group in each of whom the coccyx was not removed at the time drainage was established. No instance of abscess formation as a result of inadequate drainage was observed nor has it occurred in previous experience with cases of this type in which the coccyx was removed. The fundamental principle however is the adequate drainage of contaminated areas. If because of the particular type of injury concerned or because of the limited previous experience with this type of injury the operator believes that he cannot adequately drain the perineal space without removal of the coccyx, he should by all means remove it. On the other hand, he believes adequate drainage can be obtained by dividing the fascia propria transversely at the tip of the coccyx carrying the incision around into either or both of the levator ani muscles if necessary then the coccyx is better left undisturbed.

The surgical management of wounds of the cecum ileocecal valve colon rectosigmoid, and rectum is discussed. A summary of end results is included.

Marked progress has been made in military surgery during the course of the recent war. The lessons learned must not be forgotten. The problems raised must be followed through and the best solutions possible be found so that the military surgeon of tomorrow may begin not where the military surgeon of today began but rather well beyond where he finished.

JOHN E. KIRKPATRICK, M.D.

Hamilton, J. E., and Cattannach, L. M.: Reconstruction of War Wounds of the Colon and Rectum. *Surgery* 1946 30 337

This article is based on the experiences in reconstructing 43 colostomies and 5 traumatic rectal fistulas in 47 patients at Crile General Hospital, Cleveland, Ohio. The closure of these colostomies is different than that of civilian colostomies because of the associated battle injuries which produce complications and the lack of details of construction.

Most of the patients were fatigued and malnourished averaging 117 pounds under their best weight at the time of surgery. The average preoperative build up period was 25 days during which they received a high caloric, high protein and high carbohydrate diet supplemented by multivitamin capsules a day. Those responding poorly received amino acids both in powder form by mouth and in 5 per cent solution by vein. Several examples are cited to emphasize the outstanding value of these amino acid mixtures in hastening the restoration of depleted and bilated patients. Patients with even mild anemia were transfused preoperatively.

Five of the colostomies were closed by the extra peritoneal method the remainder were managed by intraperitoneal closures. In 5 cases end to end closures had to be done.

Preoperatively, a barium study of the distal loop small bowel studies if obstruction or other derangement of the small bowel were suspected and lipiodol studies of all sinuses and fistulas were carried out. In this way four abnormal sinuses or fistulas were discovered which otherwise might have been overlooked.

For 5 days prior to closure 12 gm. of sulfasuxidine were given daily in divided doses and 2 gm. suspended in 2 oz. of water were instilled in the distal loop of the colostomy. No laxative was used and both loops were irrigated with tap water the night before operation. In only 1 case was the drug continued postoperatively. From 3 to 5 gm. of sulfanilamide crystals were applied locally at the time of operation. Postoperatively for several days, 21 patients received penicillin (from 25,000 to 40,000 units intramuscularly every 3 hours) and 17 received sulfadiazine therapy (first by vein then 1 gm. every 4 hours by mouth). The authors stress their confidence in the use of sulfasuxidine.

There was no significant difference between the patients receiving penicillin and those receiving sulfadiazine postoperatively. Wound healing was complete in 10.4 days in 34 patients receiving sulfasuxidine, and they were allowed out of bed in 10 to 5 days.

Anal dilatation and Wangenstein suction for from 30 to 72 hours were used for decompression. Most patients received from 500 to 1,000 c.c. of plasma during or after operation and blood if necessary. Thereafter from 1 to 2 liters each of amino acids and 5 per cent glucose in saline solution were used to maintain hydration.

Intraperitoneal closures were used exclusively in 38 of the colostomies. With sharp dissection and

silk technique" all scar tissue and skin were trimmed away from the stomas and the 2 colonic limbs were inspected. Local adhesions were left whenever possible and when the limbs were fused at their mesenteric border the adhesions were left undisturbed to buttress the closure. A transverse closure was carried out with an inner row of sutures of fine chromic gut including all layers and an outer inverting row of interrupted Cushing sutures of fine cotton, palms being taken to include the submucosa. Any disparity in the size of the lumens was corrected by incising backward from the mouth of the smaller limb along the antimesenteric border and rounding off the corners. None of the 38 patients with intraperitoneal closure has had any sign of obstruction or break down. The one mucous fistula closed spontaneously by the ninetieth day.

The authors do not crush the spur because it is disagreeable or painful to the patient and because of the inadequate information available as to the original colostomy construction. Spur crushing in these cases might cause a jejuno-colic fistula or endanger the blood supply.

In most cases the abdomen was closed in layers with cotton and silk and occasionally a rubber drain was placed to the peritoneum or fascia. The wounds nearly all healed per primam. The delayed closure method of Collier and Volk was not employed. A case report of one of the more difficult intraperitoneal closures is given in detail.

The 8 extraperitoneal closures included 3 unsuccessful ones which were performed overseas. Later the authors made successful closure intraperitoneally. Recurrence of fecal fistula with failure of closure took place in 3 patients, in 1 of whom closure had been attempted twice. Three patients developed intestinal obstruction and 1 died of it. The 7 complications or failures among the 8 extraperitoneal closures have led the authors to favor the intraperitoneal closure as being safer and far more satisfactory.

The authors have closed 6 traumatic rectal fistulas, and in each case the internal opening could be palpated on digital examination. Often the seriousness of these fistulas is underestimated. They tend to recur. From one-quarter to one half of the rectal circumference may be replaced with dense non-epithelialized scar often associated with stricture or an abscess pocket.

In repair complete diversion of the fecal stream is necessary. Adequate exposure often requires a generous incision with removal of the coccyx and of the fifth and sometimes the fourth sacral segment. Freeing the rectum from scar tissue is essential in order to permit closure without tension. Stenosis, if present, should be corrected as in a pyloroplasty by longitudinal incisions into the wall away from the fistula and then a transverse closure. The authors use a double tier of fine interrupted cotton sutures, the inner one through and through and the outer one inverting. A third layer may sometimes be made of the scarred fascia propria. Complete wound closure

is usually impossible and final healing takes place by granulation. All 6 fistulas were successfully closed. A case which showed a traumatic stoma to an abscess cavity containing a metallic foreign body is presented in detail.

ROBERT R. BENTLEY M.D.

### LIVER, GALL BLADDER, PANCREAS, AND SPLEEN

Hershey C. D.: Partial Hepatectomy in Certain Primary Tumors of the Liver. *South. Surgeon*, 1946, 12: 245.

Tumors situated in the left lobe of the liver are more easily and safely removed by lobectomy. A case report is presented in which the left lobe of the liver was completely removed with a successful result.

The patient was a 14 year old girl and the pathological diagnosis was hepatoma. The right lobe of the liver appeared entirely normal. The left hepatic artery the left branch of the portal vein, and the left hepatic duct were ligated with sutures of chromic catgut. An additional row of mattress sutures of chromic catgut was placed along the interlobar sulcus along the relatively avascular line of the lobes. The postoperative course was essentially uneventful.

A recent review of the world literature revealed 33 reported cases of resection of solid adenoma of the liver. There were also 233 cases of resection of liver tumors.

RICHARD J. BERNETT JR., M.D.

Johnstone, G. A., and Ostendorp, J. E.: Cholecystitis with Perforation. *Arch. Surg.* 1945, 51: 1.

Of 12,000 routine autopsies performed at the Los Angeles County Hospital from April, 1936 to January 1945 the cause of death in 33 patients (0.26%) was found to be perforation of the gall bladder. Twenty-eight of the patients had been treated by conservative medical management, and in one-half the cases the condition had been undiagnosed prior to autopsy. Two of the patients had had surgery primarily for cholecystectomy and 4, for exploratory laparotomy.

On the basis of these findings the authors contend that perforation of the gall bladder is neither a rare condition nor seldom fatal. In contradistinction to the belief sometimes held that free perforation is infrequent or that when it occurs the morbid process is "walled off," acute generalized peritonitis was found present in 43 per cent of all cases of perforation.

For purposes of comparison, 105 consecutive cases of cholecystitis in which operation was performed were reviewed, and it was found that the overall mortality rate was 8.3 per cent. When more than 7 days after the onset of the illness had elapsed, the mortality rate rose to 11.4 per cent. In cases in which surgery was done during the first 48 hours, the mortality rate was 5.8 per cent, from which a rate of 2.9 per cent obtains if allowance is made for surgical accident. In 86 of the cases cholecystectomy was performed, and in 18, cholecystostomy. The authors state that surgery was carried out by not

one or two surgical teams, but by a considerable number of operators including surgical specialists, general practitioners, and occasional surgeons. Because of this, their mortality figures have undoubtedly been raised but it is believed that these figures indicate the advisability and safety of early cholecystectomy. Removal of the gall bladder is the procedure of choice in that the fundamental pathological process is thereby eradicated.

WAYNE CAMERON, M.D.

Gatch W D, Batterby J S., and Wadkin, K. G.: The Treatment of Cholecystitis. *J Am M Ass* 1946, 132: 119.

The idea that infection is the sole cause of cholecystitis still prevails and still governs its treatment. Conversely the idea that cholecystitis is caused primarily by chemical action has made slow headway although the reasons for believing it are compelling.

The pertinent facts on the relationship of infection to cholecystitis are the following:

1 Cholecystitis is rare in children, although infections are more commonly observed in children than in adults.

2 In about two-thirds of all cases of cholecystitis, the bile is sterile. The bacterial flora of the normal gall bladder and that of the inflamed gall bladder are the same.

3 The microscopic appearance of the inflamed gall bladder is almost never that of inflammation due to bacteria.

Abdominal wounds for the treatment of acutely inflamed gall bladders almost always heal without infection. On the other hand, numerous observations on injuries to the gall bladder by chemical agents have been made.

We have positive proof that pancreatic juice can cause acute cholecystitis in man, but we lack proof that it is the common or even a frequent, cause. The demonstration of the presence of amylase in high titer or of lipase in the contents of the gall bladder or in the peritoneal fluid is the only conclusive proof that a given case of cholecystitis is due to the action of pancreatic juice.

The bile salts are the only other chemical agents normally present in the body which have been proved to be able to cause cholecystitis in the experimental animal. That they can produce it in man has not yet been demonstrated although the probability that they can do so is strong. The authors have studied this problem in 4 series of experiments.

Series 1 Injecting solutions of bile salts into the gall bladder through a catheter.

Series 2 Injecting a 5 per cent solution of sodium desoxycholate, sodium taurocholate, or sodium glycocholate into a branch of the portal vein.

Series 3 Injecting a solution of activated pancreatic juice into the ampulla of Vater.

Series 4 Injecting bile salts into the portal venous system after ligation of the cystic duct, or keeping the gallbladder empty and squeezing it at intervals.

In the first 3 series the effects were immediate. There was edema, hemorrhage, and inflammation. In the fourth series the gall bladder showed no changes from normal.

In considering the clinical applications of the data obtained from the 4 series of experiments certain questions arise:

1 *Is early operation for acute cholecystitis the proper treatment?* The opinion is given that about equally good results can be obtained by either early or late operation, provided the surgeon uses good judgment on the individual case. Thus, if the inflammation is violent and the symptoms are growing progressively worse an early operation should be performed to avoid the dangers of perforation of the gall bladder. The fact that the gall bladder quickly recovers from chemical injury of rather pronounced severity supports the practice of postponing operation on patients whose symptoms are of moderate severity and nonprogressive.

2 *Is the gallbladder ever a focus of infection?* The removal of a gall bladder which does not show signs of disease on the theory that it is a focus of infection can no longer be justified. The mere presence of bacteria in the gall bladder does not indicate that they are injuring the gall bladder or any other part of the body.

3 *Is prolonged drainage of the gall bladder or of the common duct in the absence of jaundice in the hope of ridding the liver and biliary system of infection justified?* No. The absence of bile from the intestine hinders the digestion of fats and the absorption of fat soluble vitamins.

4 *Is there any danger in opening the gall bladder and removing its contents in performing cholecystectomy?* No. Failure to resort to this procedure often makes cholecystectomy a needlessly dangerous operation. This is true especially when the gall bladder is greatly distended or when adhesions surround the gall bladder and cystic duct.

5 *Should the common bile duct be opened when the tissues around it are edematous or when the head of the pancreas is thickened?* No, because it may have been severely damaged by activated pancreatic juice. Its incision and exploration in this event may cause its rupture or occlusion. Its exploration may prove unnecessary. It can be explored with safety at a second operation if signs of occlusion persist.

STEPHEN A. ZIMMAN, M.D.

Munilla, A.: Congenital Malformations of the Extrahepatic Biliary Tract with Subhepatic Obstructive Jaundice (Malformaciones congénitas de las vías biliares extrahepáticas con ictericia obstructiva subhepática). *Arch. surg. med.*, 1946, 28: 331.

The author discusses the syndrome of subhepatic obstructive jaundice produced by malformations of the biliary tract and describes 6 cases of this condition.

The first patient was a newborn who a week after birth had an increase of his jaundice, a slight clinical



increase of the size of his liver and spleen, acholic stools, choluria and melena. The infant died at the age of 3 months. The autopsy showed an atresia of the hepatic duct, hepatic cirrhosis, and hypertrophy of the pyloric musculature.

The second patient was a 9 day old child who had progressive jaundice since birth. At autopsy the spleen was located in the left side and atresia of the biliary tract was noted.

The third patient also had progressive jaundice since birth, acholic stools, choluria, and hepatosplenomegaly. At operation atresia of the gall bladder and biliary tract was found.

A similar picture was found in a fourth patient with jaundice since birth, splenomegaly and ascites. At autopsy absence of the biliary tract was noted.

WILLIAM E. RICKETTS, M.D.

Welborn M. B. The Management of Common Duct Stone Missed at Operation. *S. & H. Surgeon* 946 2 185

Two cases of common duct stone missed at the time of operation and subsequently demonstrated by postoperative cholangiography are reported. In 1 case the overlooked stone was apparently fragmented by instillations of ether into the "T" tube and the fragments subsequently were expelled into the duodenum.

JOSEPH GASTER, M.D.

### MISCELLANEOUS

Bingham, D. L. C.: Surgical Complications of Amebiasis. *Canad. M. Ass. J.* 946, 55 34

With the recent widespread distribution of Canadian soldiers throughout areas of the world where the incidence of amebiasis was high and the subsequent high incidence of amebic infection in these soldiers the author expects an increase in amebiasis and its complications in Canada where heretofore, it was uncommon. He presents a timely discussion of its surgical complications.

The active entamoeba histolytica penetrates living tissue and its usual portal is through the mucous membrane of the colon where it produces characteristic ulcers. From the submucosa the organism may penetrate the muscle and peritoneal layers and give rise to peritonitis, with or without visible perforation. It may be carried to the liver and from there the entamoeba may be deposited in the lung, spleen or brain. Therefore it is obvious that the manifestations of the disease will be quite protean with a wide variety of complications. These may be classified as follows:

Complications of the disease in the bowel, amebic hepatitis and its complications, complications due to more widespread dissemination.

The more important surgical complications of the disease in the large bowel are pericolic infection with or without perforation, pseudo appendicitis, hemorrhage, and amebic granuloma.

Pericolic infections are most common in the cecal region and the symptoms closely resemble those of

appendicitis. There is usually a history of past or present dysentery of varying severity. A palpable mass may ascend from the right iliac fossa toward the hepatic flexure and in some the thickened ascending colon may be palpated above the inflammatory swelling. The liver may also be enlarged and tender. If operated upon, the colon will be found irregularly thickened friable, and resembling damp blotting paper.

The appendix is commonly involved and its removal is disastrous because secondary perforation invariably follows. If the abdomen is opened the paracolic gutter should be drained and followed by specific medical therapy. If operation is not done the infection may resolve or form an abscess. The latter should be drained and appropriate medical therapy instituted. If specific therapy is not used phlegmonous ulceration will probably ensue.

The left colon is less commonly involved. Symptoms are essentially the same. Mortality from peritonitis is higher because of less tendency toward localization. Treatment is the same as for the right side but the pouch of Douglas should be drained as soon as the diagnosis of pelvic peritonitis is established.

Catastrophic hemorrhage from the colon may occur in amebiasis. Most cases respond to repeated transfusions, penicillin, and emetine some may require surgical correction. The one case in the author's experience was controlled by ligation of the ileocolic artery which supplied the hemorrhaging area.

Amebic granuloma is rare, and may be mistaken for carcinoma.

Amebic hepatitis and liver abscess are early and late stages of infection of the liver. The first responds to emetine therapy while the latter usually does not, and therapy is a point in differential diagnosis. Amebic hepatitis exhibits every gradation from the intensely acute to the most chronic and insidious, being delayed for years after the initial infection. Liver enlargement, fever, leukocytosis, and diminution or loss of movement of the right diaphragm are characteristic in varying degrees of acute or chronic hepatitis. Jaundice is mild if present. Once the diagnosis is established, emetine therapy (1 gr. daily) should be administered for from 10 to 12 days. If suppuration is not present rapid cure will result. If symptoms do not disappear the liver should be aspirated by a systematic exploration with a medium sized trochar and cannula to a depth of 3 1/2 inches, and as many as 6 punctures may be made before pus is found. The cavity should be aspirated and filled with penicillin solution. Aspiration should be followed by a second course of emetine 10 days after the first course. Aspiration may have to be repeated. Abscesses are single or solitary in 70 per cent of the cases, they contain either a yellow or chocolate colored viscid material which is not offensive. Amebae may not be found but are usually present in scrapings from the abscess cavity wall.

FREDERICK C. HOCKEY, M.D.

Fitzsalmans, J : Some Observations on Nonspecific Abdominal Lymphadenitis *N Zealand M J* 1946 45 248.

Because of an obvious general increase in interest in abdominal lymphadenitis and in an attempt to stimulate wider interest the author records the following observations

Sixty per cent of the cases occur between the ages of 6 and 16 and 91 per cent under the age of 26. The duration of symptoms varied widely from a few hours days weeks up to 6 months and even 3 years. The incidence of upper respiratory infection is no greater in the author's series of 300 cases than in the average population. Appendectomy was performed in 99 of 100 cases. The leucocytes ranged from 1,400 to 26,000. A slight relative lymphocytosis (from 50 to 60%) was very constantly observed. The author concludes, however that consideration of the total white cell count in the differential diagnosis is not only valueless but definitely misleading. The mesenteric and pre-aortic glands are enlarged and in 3 cases the iliac adenitis followed the vessels as far as Poupert's ligament but the femoral glands were not palpable in the groin and thigh.

The clinical features are pyrexia (in 100%) abdominal pain (in 99%) recurring for weeks months or years, and accompanied by nausea or vomiting and precipitated by motion of the abdominal contents waxy pallor fatigue underweight and under development for age. Muscular rigidity or guarding is the important differentiation from appendicitis. The author found that 6 per cent of the cases of primary lymphadenitis developed a true appendicitis

secondarily. He also states that this condition not infrequently causes dyspepsia and peptic ulcer and that it is a common cause for so-called post-appendectomy pain.

At operation these glands exhibit a purplish red blush on the surface of the mesentery. The total volume of enlarged glands is considered to be of prognostic value. The glands involve the mesentery and pre-aortic glands, right up to the diaphragm and in a few cases enlarged glands may be palpated in the lower part of the posterior cervical triangle which suggests that they are the extreme upper limits of a chain of enlarged glands extending from the lower abdomen to the neck.

Microscopic examination reveals chronic inflammatory change. No organism has been identified. The author presents a diagrammatic representation of the different grades of the condition from subclinical to diagnosable clinical levels.

The only important form of treatment is rest for periods of from 6 weeks up to 6 months. Benefit often credited to appendectomy in cases of so-called chronic appendicitis derives from the coincidental bed rest.

Separation of this condition from the conglomerate group of appendicitislike abdominal pains entails and necessitates some important changes. Since it has been included in all groups of cases described and looked upon as appendicitis it is obvious that the conception of true appendicitis must be revised. Practically all statistics relative to appendicitis include those of nonspecific lymphadenitis and are vitiated thereby and therefore they must be accepted with due reserve.

JOSEPH GASTEL, M.D.

# GYNECOLOGY

## UTERUS

Trainor, R., and Peace, V. B.: Carcinoma of the Cervix with Special Reference to Young Women (Il carcinoma del collo uterino in rapporto alla età, con particolare riferimento alle donne giovani) *Clin. esist.* 1945 47 129

The authors report a series of 669 cases of carcinoma of the cervix seen at their clinic during the years from 1936 to 1942. One patient the youngest in the series, was 14 years of age. The incidence of carcinoma of the cervix at other ages was as follows: 14 per cent of the patients were from 10 to 20 years of age; 3.5 per cent were 21 to 30 years; 21.9 per cent were 31 to 40 years; 36.95 per cent were 41 to 50 years; 27.95 per cent were 51 to 60 years; 8.53 per cent were 61 to 70 years; and 1.24 per cent were over 70 years of age.

Morphological typing of the 669 cases revealed that 8 per cent of the patients were of type 1, 74 per cent were of type 2, and 18 per cent were of type 3. Irrespective of age groups, the greatest number of patients were of type 2.

Menstrual periods were regular in the majority of patients although a form of hypermenorrhea was present in patients in the fourth, fifth and sixth decades of life. Twenty four of the patients were under 30 years of age. In 20 of these the menstrual period was regular. The flow was scant in 1 patient, in 3 patients the amount varied and in 1 patient there was intermenstrual bleeding. Of the total number of patients, 6.27 per cent were multiparas.

In 13.29 per cent of the 669 cases of carcinoma of the cervix, the symptoms appeared in less than 1 year after delivery. In 5.09 per cent symptoms appeared in from 1 to 2 years.

ARTHUR F. CIPOLLA, M.D.

Stefanelli, S.: A Rare Case of Hemoperitoneum (Raro caso di emoperitoneo) *Clin. esist.* 1946, 48 33.

The author enumerates the different causes of hemoperitoneum and states that hemoperitoneum caused by rupture of an ovarian follicle or of a corpus luteum is no longer a rarity. He reports and discusses a case of a large hemoperitoneum caused by rupture of a superficial vein of a large subserous fibroid, of which condition there are only 29 cases in the literature. In all of the 29 cases reported the ruptured vessel was located on the posterior surface of the uterus. The cause of the rupture was given as continuous friction over the sacral promontory although local edema necrosis and sudden violent abdominal contractions are also considered as etiological factors. In the author's case the ruptured vein was located on the lateral right side of the fibroma, and corroborated the clinical picture as given by Albrecht i.e. (1) the syndrome of acute

anemia with collapse (2) peritoneal reaction with muscle defense, (3) sharp sudden pain and (4) the presence of a fibromatous mass.

The author's case was that of an unmarried woman 43 years old with a negative history who in the last 2 years had noticed a mass in the hypogastric region which had gradually increased in size. During the night she suffered sharp abdominal pain, at first located in the lower quadrant and then gradually involving the upper abdomen. This was accompanied by nausea. The abdomen was tense and skin pale and rectally a hard mass was felt in the smaller pelvis. A diagnosis of fibroma twisted on its pedicle was made and a laparotomy was performed. This revealed a large hemoperitoneum, containing more than a liter of blood, which had been caused by rupture of a subserous vein located on the lateral right surface of a fibroma. A subtotal hysterectomy was done. The removed mass consisted of multiple fibromas with a large subserous vein, and weighed 1,050 gm.

The author attributes the diagnostic error to lack of evaluation of the anemia symptoms, and the cause of the vein rupture to the friction of the uterus on the sacral promontory.

JOSEPH M. A. PATE, M.D.

Acciolla, D.: Statistical Data Obtained from the Perugia Obstetrical and Gynecological Clinic on Uterine Fibromyoma and Fibromatosis from Jan. 1 1936 to Dec. 31, 1944 (Dati statistici e considerazioni sul materiale di fibromi e fibromatosis uterina nella Clinica Ostetrica e Ginecologica di Perugia dal gennaio 1936 al 31 dicembre 1944) *Fed. gyna.*, Genova, 1946 41-75.

In a study of 715 cases of uterine fibromyoma and fibromatosis, it was found that an alteration of the menses, characterized by hyperpolymenorrhea, was present. An anatomical and pathological change in the ovaries in association with the fibromyoma was observed in 42 per cent of the cases, while in 56 cases other organs such as the appendix and salpinx were involved. The author states that uterine malformations, which are present in 1 per cent of the cases, do not seem to have any etiopathogenic connection with the neoplasm. In 1 per cent of the patients, tuberculosis associated with myoma was observed while fibromas in conjunction with pregnancy were present in 1.25 per cent.

A total of 595 surgical operations were performed and in 120 cases radium and roentgen therapy were used. Subtotal hysterectomy was done in 68 per cent of all cases, and was considered to be the treatment of choice, as carcinoma of the cervical stump was found in 1 of 3 cases (4.8%). Few complications have kept the morbidity low while 8 deaths constituted a 1.34 per cent mortality rate.

ARTHUR F. CIPOLLA, M.D.

De Moraes, A.: Uterine Choriocarcinoma (Córdocarcinoma do útero) *Rev. bras. cir.* 1946 15 197

A case of malignant chorioepithelioma (choriocarcinoma) occurring in a 23 year old white house wife was reported on October 16 1944. She was considered well and without evidence of metastases after extirpation of the adnexae and a subtotal hysterectomy on April 23 1944. She presented herself because of severe and rather continuous uterine bleeding. This followed the interruption of a pregnancy because of poor general health on December 4, 1943. A normal child living and well had been delivered on July 10, 1943 but her first pregnancy had been interrupted, presumably for the presence of a mole.

The red cell count was 2,000,000 and 250,000 units of gonadotropic hormone per liter were recovered from the urine on the date of operation. By May 12 this had reduced to 50,000 units. Frank's pregnancy test was negative in May and October 1944. Convalescence was uneventful except for a transient pulmonary complication.

Numerous photographs illustrating the gross and microscopic aspects of the specimen are appended and a discussion of the problem of benign and malignant moles, based on the literature, is presented.

HERMAN T. LANGSTON M.D.

Gordon, C. A. The Manchester Operation with Special Reference to Parturition and Complete Prolapse. A Report of 206 Cases. *Am. J. Obst.* 1946, 52 228.

In a series of 206 Manchester operations, there were 36 women of less than 40 years of age, 16 of whom were less than 35 years old. Parturition has been known to occur in 10 of these. In 5 of these cases, no details of labor are available, nor is the actual end result known except in 1 case in which prolapse recurred. The essential data of the other 5 cases are reviewed. Prolapse did not recur in any case.

The relative merits of the combined operative procedure of vaginal repair and abdominal uterine suspension and the Manchester operation during the reproductive period are compared. The author recommends the Manchester procedure. In the author's experience the operation has given excellent results in 62 cases of complete prolapse in which observation has continued for long periods of time.

EDWARD L. CORNWELL, M.D.

### EXTERNAL GENITALIA

Watson, B. P. and Gusberg, S. B.: Prevention and Treatment of Carcinoma of the Vulva. *Am. J. Obst.* 1946, 52 179.

Carcinoma of the vulva is one of the rarer gynecological lesions. Like carcinoma elsewhere, successful treatment depends very largely upon early diagnosis. An even more important factor is the recognition and treatment of conditions which predispose to the disease. To emphasize certain significant

correlations suggested from their experience, the authors report 30 cases which came under their observation.

The singular importance of the prophylaxis and early diagnosis in this disease is made obvious by the fact that the average time lapse from the onset of symptoms to the beginning of treatment in this group was three and three fourths years. The symptom of vulvar pruritus in middle-aged women is a significant one. Temporizing measures are unjustified in the face of premonitory lesions whose relation to cancer is evident. The authors believe that any irritated or ulcerated lesion which does not yield in a short time to simple therapy should be subjected to biopsy by free excision. Every leucoplakic area which causes constant itching and necessitates scratching for its relief—with consequent breaking or fissuring—should be excised. Treatment with ointments, hormones and roentgen irradiation has no place in such cases.

The operation of radical vulvectomy with bilateral dissection of the superficial inguino-femoral nodes is the procedure of choice. Wide local excision may be used, both for biopsy and for its therapeutic value in cases of low grade malignancy. Roentgen therapy does not appear to be of value. The gravity of prognosis with extension of the disease into the vagina is notable in this series of cases.

The authors are not as pessimistic concerning the general group of vulva carcinomas as are many observers. They believe that many patients can be cured especially by recognition of the early symptoms and the early use of radical surgical therapy.

EDWARD L. CORNWELL, M.D.

### MISCELLANEOUS

Grigler, C. M. Urological Complications following Operation for Imperforate Hymen. *J. Urol.* Balt., 1946, 56 211.

A 21 year old negroess had had an operation for the correction of an imperforate hymen. Two years later she was seen because of constant leakage of urinous fluid and dyspareunia. Examination revealed complete destruction of the entire urethra, the external and internal sphincters and the anterior two-thirds of the bladder trigone. A thorough urological examination showed an essentially normal upper urinary tract. It was apparent that the bladder had been the organ used for coitus and because of edema and inflammation the vaginal walls had almost coalesced.

Plastic reconstruction of the bladder and urethra was abandoned because of the extent of destruction but since it had become useful as a fairly satisfactory organ for coitus, decision was made to allow its function to remain as such, and to detour the urinary tract into the bowel.

The operation was done in three stages. The right ureter was transferred into the sigmoid by the Wharton technique, first, the left ureter later and finally the cervix into the bladder trigone area. The

urinary tract functioned adequately sphincter control was adequate, menstrual flow and dysmenorrhea improved and the dyspareunia was relieved.

Two years later the patient presented herself and inquired regarding the possibilities of being able to have children. Examination revealed the cervix, uterus, and tubes to be normal.

GEORGE BRADBURY M.D.

Herrera R. G: Treatment of Vaginal Discharge (Tratamiento del flujo genital) *Rev. Soc. Obst. Gyn. B. Aires* 1946, 25: 90.

In the author's series of 804 cases of vaginal discharge he emphasizes the importance of making certain the presence of a discharge, its origin, composition and etiology.

A discharge which is due to salpinx involvement, such as suppurative processes and carcinoma, produces a flow which is yellow amber in color and occasionally contains tumor cells. The treatment is mainly surgical.

Carcinoma of the uterus produces a watery purulent, or mucous discharge which may contain tumor cells, while adenocarcinoma produces a white discharge benign basal adenoma and submucous myoma produce a serous discharge. Inflammatory endometritis caused by gonococcus, septic infection, or tuberculosis produces a purulent discharge, and if a cervical stenosis exists a pyometra results. The presence of foreign bodies in the uterus is also an etiological factor.

The treatment for malignant tumors is hysterectomy and for benign tumors, surgical extirpation. Inflammatory lesions are treated with sulfonamides and penicillin however the treatment of tuberculous lesions is aimed at the associated infection. Foreign bodies are removed, and if the leucorrhoea persists, a dilatation and curettage is indicated. Senile endometritis is treated with radium.

One of the most frequent causes of vaginal discharge is the presence of cervical lesions. In some of the patients with vagosympathetic disturbances, there was a hypersecretion of the endocervical glands which responded favorably to atropine. Neoplastic lesions are treated with radium or by surgical removal. Cervical tears due to obstetrical deliveries are repaired. Sulfonamides and penicillin are useful in the treatment of gonococcal infections while chronic cervicitis may be treated with silver nitrate tampons and also cauterization, followed by the local use of sulfanilamide, and if the cervix becomes secondarily infected, douches are useful.

Vaginal discharge is dependent upon the change of pH, a disturbance of glycogenesis which is caused by ovarian hypersecretion and produces an environment for bacteria with resulting erosions and discharge. Normally the vaginal secretion is white of acid reaction, and a flora of vaginal organisms. A pathological discharge is yellow greenish yellow thick, and foamy, with an acid reaction.

Genital hypoplasia is caused by the effect on the ovaries of anemia, tuberculosis diabetes etc.,

and a white discharge occurs which at times contains pyogenic bacteria.

Other causes of vaginal discharge are passive congestion of the pelvic organs due to ovarian tumors, uterine tumors and retrodisplacements also foreign bodies such as pessaries, and chemical irritants such as quinine and alum.

The treatment of tumors and foreign bodies is removal, while ovarian insufficiency is treated with estrogens. Local treatment with silver nitrate, acid douches in some cases and general measures such as regulation of sexual relation, cleanliness, repair of perineal tears dilatation of a stenosed perineum, and exercise, fresh air and nourishing food are helpful.

Trichomonas vaginitis is characterized by a foamy whitish discharge, and an intense pruritis which is worse after menstruation. Identification of the organism confirms the diagnosis. Arsenical powders or silver picrate are used in the treatment of this condition.

Vulvovaginitis due to *Monilia albicans* produces burning and itching which is aggravated by touch, micturition, coitus, etc. The discharge is small in amount and acid. Erythematous or erosive lesions with white plaques in the vagina, on smear are of diagnostic value. These lesions are treated with sodium bicarbonate tampons and gentian violet.

Vaginitis due to diphtheria produces an abundant purulent discharge with a yellow white membrane on a red vaginal mucosa. Treatment is with serum.

ARTHUR F. CROOK, M.D.

Serdukov M. G: Results in the Treatment of Gynecologic and Obstetric Conditions with Bogomolts Antitreticular Cytotoxic Serum (ACS) *Vrachevskoe Delo*, 1945, 26: 51.

The material here reported consists of 435 gynecologic and obstetric cases. The treatment consisted of intracutaneous injections on the anterior aspect of the upper arm, the first course of 0.1 0.2 and 0.3 at 3 day intervals of Bogomolts' serum, to be followed at not less than a month's time by the second course of 0.2 0.3 0.5 and 0.7. This second course, with its higher dosages, was given when the patient's response to the first was weak, or when a more rapid response was desired. Following all of these injections (more than 300) not a single instance of complication or harmful effect was observed. The local reaction was a reddening and some swelling of the skin with perhaps a small blister formation or generalized itching.

The inflammatory diseases comprised 137 cases with such conditions as periparimetritis adhaerens, periparassalpingo-oophoritis, metroendometritis, by droasalpinx, pyosalpinx, erosions, endocervicitis, and vulvovaginitis. Treatment of these cases with ACS resulted in the disappearance of pains, normalization of the menstrual cycles, and resolution of the infiltrative processes. In this group 25 per cent of the women were sterile however following treatment with ACS 8 per cent became pregnant. There were 41 cases of endocrinopathy with infantile atrophic

conditions, including conical cervix, infantile under development of the uterus and absent or scant menses. In this group the treatment with ACS had been preceded without much result, by organo-therapy diathermy and massage. Sixty per cent of these patients were without children and following treatment with ACS 6 became pregnant. In 15 there was a correction of the oligomenorrhea or amenorrhea with increase in the size of the uterus and its blood supply.

The third group into which the author divides his material consisted of 40 patients with fibrotic metropathias and subserous fibromyomas, the tumors varying in size from a billiard ball to that of two fists. Following treatment with ACS there was shrinking of the tumor mass when adhesions and inflammatory process were present the serum in this wise contributing toward the patient's readiness for operation. Menstrual disturbances were corrected.

The fourth group included 77 cases of vegetative neuroses, endocrine and climacteric disturbances and high blood pressure. In these patients the climacteric symptoms had lasted from 1 to 20 years and included the usual manifestations such as hot flashes, sweating, headaches, loss of memory and strength, sleeplessness, palpitation of the heart and idea impulses. Blood pressures were as high as 250/180 and 280/200. In this group the results of ACS treatment were most striking. In 90 per cent there was a complete relief from the menopausal syndrome. The blood pressures went down rapidly to normal and remained down.

In the fifth group there were 15 toxemias of pregnancy. ACS relieved the symptoms in every instance and the pregnancy progressed to the birth of a normal child. Results were quite as striking in the group of 25 mothers with poorly developed breasts and hypogalactia. Following the second injection a marked increase in both the size of the breast and in the milk flow developed. The results were attributed both to a local hyperemia and to stimulation of function of the milk producing epithelium of the mammary glands.

The seventh group included 25 patients who had either been operated for cancer of the cervix, or were harboring precancerous lesions and who complained of pain, weakness, depression and loss of weight and capacity for work. Treatment with ACS brought about not only amelioration of the subjective symptoms, healing of the ulcers and erosions, and softening down of the deforming scars from previous operation, but caused the previously ineffective medical measures (manganese and iodides) to become effective.

Finally the eighth group included 70 patients with a variety of complaints complicating the gynecological ailment, such as gastric ulcers, hyperacid gastric catarrh (20 patients), hepatitis, stomatitis, and eczema. Practically all these patients evidenced remarkable response to ACS.

In the vast majority of this whole material in addition to the more specific ameliorative or curative

effects from ACS the patients showed increase in weight and strength, and improvement in appetite and ability to sleep. They would develop a cheerful hopeful life outlook and the general laboratory picture would improve with an increase in hemoglobin, red cell count and relative and absolute numbers of monocytes, and there was a shortening of the clotting and bleeding time of the blood and in the time of resorption of test dyes (unblocking of the reticulo-endothelial system).

As regards the ultimate results the author maintains that the maximal effects in 50 per cent of the cases last from a half year to 1 or 2 years. In the event of a recurrence of the complaints the repetition of the ACS medication will reconstitute the original effects of the treatment. JOHN W. BRUNHAM, M.D.

Silvestroni E. Tamburello S. and Bianco I.: The Influence of Some Sexual Hormones and of Cholesterol in the Productive Phenomena in the Uterus and in the Mammary Gland (Influenza di alcuni ormoni sessuali e della colesterina sui fenomeni produttivi nell'utero e nella mammella). *Tumori Milano* 1941 27 339.

The authors conducted a series of experiments to determine whether or not some hormones, especially the estrogens, cause malignant tumors. Fifty adult rats were subjected to oophorectomy. Twenty-seven days after the surgical procedure the rats were divided in five groups and for a long period of time were given injections of estrogen, progesterone, testosterone propionate and cholesterol alone or combined. Autopsies were carried out and histological changes in the uterus and breast were studied.

The authors are of the opinion that with the continued injection of folliculin the hyperplastic and metaplastic processes in the uterus and mammary gland recede and that malignancy does not occur. Their conclusions differ from those of Bonser, Stuckland, Connal and Geschickter who claim that the estrogens are carcinogenic even in animals refractory to such preparations. The results of Geschickter therefore must be further confirmed. The authors are not alone in their view because the results obtained by Livraga (1937), Korenchevsky and Hall (1938), Emge (1939), and Silvestroni (1939) have been the same. On the other hand Gardner, Allen, Smith and Strong, and McEwen (1938-1939) have observed the appearance of uterine cancer after the administration of estrogens. They conclude that while the sexual hormones may start a process capable of causing malignant changes in an hereditary substratum predisposed to cancer, still it is very difficult to cause cancer by estrogenic stimulation alone.

Testosterone is believed to have an antineoplastic property instead of a carcinogenic one. This view is held by Lacassagne, Raynaud, Nathanson and Andervont. Lacassagne believes that injections of large doses of testosterone given early in life prevent cancer by bringing to a standstill the development of the mammary gland. This corresponds to the early

Rat	1	2	3	4	5	6	7	8	9	10
Treatment	Died after days	Died after days	Died after days	Died after days	Died after days	Died after days	Died after days	Died after days	Died after days	Died after days
Folliculin	57	96	801	311	547	305	353	413	415	415
Estradiol dipropionate and progesterone	50	80	104	143	166	170	15	32	278	301
Folliculin and cholesterol	243	245	278	325	327	410	41	415	415	415
Testosterone propionate	65	125	174	222	275	323	330	253	294	297
Testosterone propionate and cholesterol	140	32	16	205	312	375	374	395	411	411

castration of Lathrop and Loeb (1916) "Microscopical examination of the breast (Lacassagne & Raynaud 1939) of some animals has demonstrated that large injections of testosterone started shortly after birth stop the development of the mammary gland in female rats the breast of these animals consisting of a rare primary duct with the cell at complete rest. The architecture is identical with the histological findings of the breast of the normal adult male rat." In their series the authors observe that in castrated female rats (therefore deprived of ovarian function) the administration of testosterone causes a great proliferation of the epithelial and connective tissue rather than mammary atrophy, the process continuing in some animals beyond 60 days.

They conclude therefore, that the function of testosterone is proliferative rather than oncogenic. Progesterone given in large doses (up to 7 mgm of progesterone weekly) does not inhibit but enhances the hyperplastic and metaplastic processes induced in the uterus by the folliculin and if the injections are continued a regression of the process takes place. The animals treated with cholesterol and folliculin, and cholesterol and testosterone appeared to be in a better nutritional state and lived much longer than the animals treated with folliculin or testosterone alone. Histologically the uterus and mammary gland showed a more healthy condition of the cells rather than an indication of malignant changes.

JOSEPH M. A. PARK, M.D.

# OBSTETRICS

## PREGNANCY AND ITS COMPLICATIONS

De la Fuente Campano L.: Interstitial Pregnancy (Embarazo Intersticial) *Rev. esp. obst. ginec.* 1946 3 194.

The author reports a case of interstitial pregnancy in a 35 year old woman. The fetus was located in the right interstitial portion of the uterus. Following rupture, the patient was operated upon with an uneventful postoperative course.

A detailed discussion of interstitial pregnancy is presented

WILLIAM E. RICKETTS, M.D.

Robertson, G. G.: Nausea and Vomiting of Pregnancy: A Study in Psychosomatic and Social Medicine *Lancet* Lond. 1946 1 336

The author first became interested in this problem through his discovery of a dyspeptic syndrome in nonpregnant women. The symptoms of this syndrome include dyspepsia and cessation of sexual interest soon after marriage. The symptoms usually become manifest in the late evening or at the week end when the threat of coitus is strongest. Attacks of nausea and vomiting occurred frequently. The patients came to dread coitus and developed signs of anxiety. These patients were not psychoneurotic.

This syndrome was first recognized in 1938 by the author and he named it 'rejection dyspepsia.' By 1943 after studying many women with this syndrome it became evident that these women invariably had a history of protracted or severe nausea and vomiting during their pregnancies.

As a result of these observations the theory is postulated that nausea and vomiting of pregnancy is related to frigidity. Further study revealed that many of these patients displayed a very strong attachment to their mothers or were very dependent on them.

The triad of symptoms in this syndrome therefore included dyspepsia, mother attachment and sexual frigidity. These symptoms first appear before marriage or soon after marriage.

The author investigated 100 consecutive pregnant women: 57 had nausea and vomiting and 43 had none. The latter group was considered as controls. Of the 57 patients 6 had a history of previous dyspepsia against none of the controls; 20 of the 57 patients showed undue mother attachment against 4 of the 43 controls, and 40 of the 57 patients showed disturbed sexual functioning against 4 of the 43 controls. Sex is therefore considered an important factor in the etiology of nausea and vomiting of pregnancy.

The mechanism whereby a pregnant woman's ailment takes the form of nausea and vomiting is described as follows. A psychosomatic approach suggests that the nausea and vomiting may represent the physical expression of an emotional constellation

in which disgust is predominant. It also suggests that the biochemical changes associated with pregnancy probably lower the threshold of the physical expression of a latent or subconscious disgust hence when the ovum dies or the fetus is removed, the threshold to physical expression is again raised and vomiting ceases. In other words, pregnancy serves as a trigger. These suggestions are consistent with the absence of any proved toxin, the probable change of hormonal secretions accompanying subconscious emotional activity (as well as pregnancy), and the absence of any specific pathological lesion.

In summary the author states that he has given a clinical and statistical investigation of the nausea and vomiting of pregnancy, demonstrating that the syndrome may be the physiological expression of an underlying emotional state which may be equated with that of disgust. The etiological factors involved are disturbed coital function, undue mother attachment, and a history of previous dyspepsia. Relevant factors in the life situation are frequency of undressed coitus and the physical propinquity of the mother. Therapy is suggested along these lines.

HARRY FIELDS, M.D.

Vasa, P. and Haiminen E.: On Fetal Electrocardiography *Acta obst. gyn. scand.* 1946 26 249

The authors believe that the only available methods of determining the condition of the fetus namely palpation and auscultation are inadequate and, therefore, they attempt to use the electrocardiograph in further studies along these lines.

They attempt to answer the following questions:

1. Is the fetus alive or not?
2. Is there a single or a multiple pregnancy involved?
3. What is the presentation or position of the fetus at any given time?
4. Is there anything pathological to be observed in the fetal heart action?
5. Can the effect of occurrences incidental to pregnancy or delivery (such as labor pains, rise in mother's temperature, drug reactions) be observed in the heart action of the fetus?
6. Can fetal electrocardiography be used as a reliable method of early diagnosis of pregnancy?

Cramer in 1906 reported the first successful examination of fetal heart action with the aid of an electrocardiograph tracing. He used abdomen-vagina and abdomen-rectum couplings. Strassman and Mussey (1938) were able to determine whether the fetus was alive or dead in 52 cases and thought they could determine the position of the fetus. They used upper extremity and one thigh coupling.

Sjndergaard (1942) in 15 of 17 cases observed positive results with the abdominal application of the electrocardiograph. In the 2 negative cases, 1 fetus was dead and 1 alive. Using the abdominal



application, Bortor (1943) recorded a fetal electrocardiograph 35 days before delivery in 51 patients. Application to the navel and symphysis has given results to Haynal and Keffner (1924), Mackawa and Toyoshima (1930), Yashura (1931) and Bell (1938).

According to the literature available to the authors only Puts and Ulrich (1941) and Sændergaard succeeded in recording fetal electrocardiograms during the early stages of pregnancy.

In the diagnosis of double pregnancy the electrocardiograph was successfully used by Dressler, Morris and Moskowitz, Sændergaard and Bortor and others. The literature they say is meager because only positive results are recorded.

In 1945 the authors began work with an old fashioned Siemens electrocardiograph but later a more modern model made by the same company with amplifiers was added in the form of a 20-power amplifying tube and a rapidly revolving cassette. The patient was kept inside a grounded wire net.

The authors used several couplings, namely upper extremity and thigh, vagina fundus, and another method in which a flexible rod was run up between the membranes and the uterus and the vagina. They report the method caused the patients no trouble, but it was inconvenient, did not give good results, and was not simple enough for practical clinical work. The vaginal method was inconvenient also.

In the method of choice one electrode was applied to the symphysis and one on either side of the fundus, and in early pregnancy (third and fourth month) application was made from the abdomen to the portio.

Thirty cases were studied during different stages of pregnancy—5 cases in the tenth month, 10 cases in the ninth, 4 in the eighth, 3 in the seventh, 2 in the sixth, 3 in the fifth, 2 in the fourth and 1 in the third. Positive results were obtained if the fetus was alive. In 1 case no waves appeared during the fifth month, and induction later revealed a dead and macerated fetus.

The authors believe that they can tell whether the fetus is alive or dead, but they could not determine position, presentation or attitude. They believe it is possibly an early method of diagnosing pregnancy as it was positive in 1 case at the 3rd month. The fetal and maternal heart rates were proved to be independent.

BYRONO F. HENKERT, M.D.

Portes L., and Granjon, A.: The Presentations in Twin Deliveries (Les présentations au cours des accouchements gemellaires). *Gyn. obst. Par.* 1946 45: 59.

The authors present a statistical analysis of a series of 1,000 twin deliveries (2,000 babies) according to their presentations. Abnormal presentations, such as occipitoposterior, forehead, face breech, and shoulder presentation occur more frequently in the second than in the first twin. In order to avoid the danger and high mortality of these pathological pre-

sentations, the authors suggest the performance of a prophylactic internal version in the second twin in all such cases.

WILLIAM M. SORRELL, M.D.

## LABOR AND ITS COMPLICATIONS

Guyer H. B. and Heaton, C. E.: The Fetal Risk in Breech Delivery. *Am. J. Obs.*, 1946, 51: 354.

Statistics from many clinics over a long period of time have shown a high fetal mortality rate in breech as compared to vertex delivery. Despite refinements in technique, there has been no significant improvement since Holland in 1922, showed that 75 per cent of the term fetal deaths in breech deliveries are due to laceration of the tentorium cerebelli with subdural hemorrhage. Since no standard has been accepted for the exclusion of complicating factors, mortality rates of different authors have varied considerably, and there has been no agreement as to the amount of fetal risk involved in breech delivery itself.

To determine this fetal risk, the authors studied 1,708 cases of primary breech delivery occurring at the Bellevue Hospital of New York between 1934 and 1944. There were 220 stillbirths and neonatal deaths, or a gross fetal mortality rate of 31 per cent.

Breech delivery with complicating conditions, such as nonviable infants, premature infants, twins, prolapse of the cord, maceration of the fetus, congenital defects pre-eclampsia and eclampsia, premature separation of the placenta, placenta previa, hemorrhagic disease of the newborn and lacerations, were then excluded. There remained 352 normal breech deliveries with 16 fetal deaths, giving a corrected fetal mortality rate of 4.5 per cent. Of the 16 fetal deaths, 11 or 69 per cent, showed evidence of birth injury at autopsy. Of the 11 cases, 8, or 73 per cent, showed evidence of slight to moderate degree of disproportion between fetus and pelvis.

Every primipara, and any multipara, with a history of difficult or premature deliveries, in whom a breech presentation is found that cannot be changed by external version should be carefully studied both clinically and radiologically. The size of the fetus should be estimated with care. On the basis of these studies, if slight to moderate disproportion is found to exist, an elective or early cesarean section is indicated.

JOHN R. WORTH, M.D.

Dieckmann W. J.: Fetal Mortality in Breech Delivery. *Am. J. Obs.*, 1946, 51: 349.

Breech delivery according to reports, still has a fetal mortality ranging from 3.8 to 59.0 per cent. The average gross mortality is 7.7 per cent, corrected to 4.2 per cent for term fetuses on 5 maternity services. The mortality in premature deliveries is over 25 per cent.

Fetal deaths as a result of breech delivery are due principally to prematurity, intracranial injury asphyxia, and visceral injuries. Twenty-three per cent of the premature infants showed no demonstrable cause of death at autopsy and although anesthetic drugs were used infrequently anesthetics were used

at delivery. The author believes that women in premature labor should have no analgesic drug and should have a minimal amount of anesthesia at delivery the latter if possible being conducted under local anesthesia.

External version should be attempted repeatedly after the thirty-second week. No undue force and no anesthetics are to be used.

Dieckmann presents a systematic outline for the management of breech delivery but insists that each case be evaluated individually. First of all elective cesarean section should be performed in all patients in whom the pelvis is contracted (or borderline) with a large baby. Primiparas who are 35 years and older should have a cesarean section. Labor should be allowed to progress normally but a final decision as to management should be made after 6 to 18 hours of labor and/or ruptured membranes. Large doses of analgesic drugs should only be given when labor is progressing normally.

In a test of labor in a breech delivery one is to be guided primarily by the length of time it takes for the cervix to dilate. When progress is slow and vaginal delivery is preferred, the author suggests the use of a large (9 to 11 cm.) Voorhees bag inserted into the vagina.

Dieckmann believes that although one should not interfere with normal progress the prompt recognition of abnormal labor especially when there is no progress in the presence of a completely dilatable cervix, will do much to lower fetal mortality. Delivery must always be accomplished when there is no descent for 1 hour in the presence of a completely dilatable cervix. Deep surgical anesthesia best with drop ether is a distinct aid to delivery. The delivery must be slow and deliberate. A deep episiotomy should be performed. The Potter technique for the delivery of the shoulders will prevent complications. The head should be delivered with the aid of the Celsus-Weigand Martin maneuver or the combined with forceps. After delivery the vagina, cervix, and lower uterine segment should be examined for laceration and ruptures.

JOHN R. WOLFF, M.D.

### MISCELLANEOUS

André-Thomas: Obstetrical Paralysis of the Upper Limb (*Les paralysies obstétricales du membre supérieur*). *Gyn. édu.*, Par., 1946 45 76 175.

Birth palsies of the arm may be of either central or peripheral origin. The former may be caused by prolonged hard labor by the application of forceps or by the cord which may encircle the neck and cause strangulation. The baby is born asphyctic and convulsions are frequent. Peripheral palsies due to injury of the brachial plexus seem to be caused more often by forceful traction on the head and neck than by pressure of forceps in any case faulty or brutal manipulations, e.g. in attempting to bring down the arm are the causative factors in most cases.

The author reports 40 personal cases and discusses more than 1 000 cases recorded in the literature.

By far the most frequently encountered obstetrical paralysis is the superior type of Erb-Duchenne. The involved muscles are the deltoid, the supraspinatus and infraspinatus, the biceps brachialis, the supinator longus and the extensors of the hand. The limb hangs down parallel to the trunk, the shoulder is drooped, the hand is in pronation and internal rotation and the fingers are flexed tightly in the palm. Since the triceps is spared and hypertonic due to the lack of antagonists the forearm can be extended farther on flexion on the paralyzed side than on the normal side where as flexion on the paralyzed side is limited as compared with the normal side.

A number of manipulations to determine the degree of paralysis of the individual muscles are described. The symptoms are not limited to the arm in all cases, but include the movements of the head and neck. The head can be passively rotated farther to the normal side than to the affected side and the chin can be approached closer on the normal shoulder than on the paralyzed side. The radial reflex is lost whereas the tricipital reflex is increased. The sensibility is normal in most cases. No edema or hematoma in the region of the brachial plexus was ever found.

As to the prognosis about half of the cases clear up completely within periods from 3 weeks to 2 or 3 years. It is difficult to establish a correct prognosis during the first few weeks or months. Only after a period of about 3 months will the different signs especially the electrical reactions and the radial reflex help to establish the prognosis. About half of the patients retain some degree of paralysis permanently.

In older children, the picture is very different from the syndrome in the newborn and in the infant the shoulder is hyperextended due to hypertony of the trapezius the arm is less abducted and the elbow more flexed than in the infant. In most of these cases the deltoid and the flexors of the forearm have regained some of their function whereas the position of internal rotation and pronation persists. Complete paralysis involving the fifth cervical and first dorsal roots is rare and occurred in only 3 per cent of the recorded cases. In most cases the sensibility is involved too the anesthesia including the hand forearm and elbow region. The tendon reflexes are abolished. Frequently the Horner syndrome (muosis endophthalmia) and narrowing of the palpebral fissure is present indicating involvement of the first dorsal root. Vascular disturbances and sympathetic symptoms are frequent, such as lowering of the skin temperature and absence of sweat secretion. In the later course of the condition atrophy of the bones and muscles is more pronounced.

The inferior type of Klumpke involving the seventh and eighth dorsal nerves, is also very rare. All the small muscles of the hand are involved (the thenar hypothesis the lumbricals and interossei). The only possible movement is extension of the first phalanx. The Horner syndrome is usually present

and very pronounced. Disturbances of sensibility involve the third and fourth finger and the medial aspect of the forearm. Nothing is said of the prognosis of this type.

Bilateral palsies are rare too they seem to occur especially in breech presentations due to the pressure of the fingers of the obstetrician on the cervical and supraclavicular region. The superior type of paralysis is predominant in bilateral palsies. The paralysis may clear up completely within weeks or months however permanent bilateral palsies have been observed too.

The diagnosis of the plexus paralysis seldom presents any difficulties. The condition has to be differentiated from fractures and dislocations of the clavicle and humerus. Paralysis of cerebral origin almost always is found to involve the leg as well as the arm.

The author discusses in detail the pathology and pathogenesis of obstetrical paralysis. Because of the scarcity of pathological reports, little is known as yet about these questions. In the rare cases in which pathological studies were possible, the findings were, hemorrhages near or in the plexus, stretching and tearing of nerve fibers, and rupture of the spinal roots above or below the spinal ganglia, which occurred in several cases sometimes the plexus was caught in cicatricial tissue. Different causes may be responsible. There are many cases on record in which the paralysis occurred in spontaneous delivery either after prolonged hard labor or after precipitation. In most cases however obstetrical maneuvers are held responsible. The paralysis occurs more frequently in breech than in cephalic presentation considering the much higher incidence of cephalic delivery. As to the causing mechanism, it would seem, from experiments, that traction on the head and

neck plays a more important role than pressure. If the traction is exerted from the head downward, the superior roots are affected most. In the opposite case, as in breech extractions the inferior roots are injured first. However these experiments do not explain why the sensitivity is normal in most cases of upper paralysis. As the experiments were done on cadavers, many factors are quite different from the condition in the living and, on the whole, it seems that at present very little is known as to just what happens in plexus paralysis, especially just where, in the course from the spinal medulla to the nerves, most lesions occur.

As to therapy it appears doubtful if the customary electro- and physiotherapy are effective and useful. Some authors maintain that the galvanic treatment may cause contractures and retractures of muscles. Early surgery (dissection of scar tissue pressing on the nerves) has not proved effective. A great number of authors recommend orthopedic apparatuses which fix the arm in abduction of 90° the elbow is rotated externally the forearm is flexed at a right angle and supinated. The author doubts whether much can be accomplished by these inconvenient appliances. Much more beneficial is corrective surgery which, however, should not be done before the age of 4 to 5 years. Many operations have been suggested, such as tenotomies, resection or transplantation of muscles, etc. The author considers as the ideal operation in older children the osteotomy of the humerus in its upper or lower third, followed by anterior rotation of the distal fragment. This operation corrects the vicious pronation and inward rotation of the forearm and makes the hands more useful, it enables the children to write and to use the fork and spoon with the paralyzed arm.

WERNER M. SCHULTZ, M.D.

# GENITOURINARY SURGERY

## ADRENAL, KIDNEY AND URETER

Esperen, T., and Dahl Iversen E: The Clinical Picture and Treatment of Pheochromocytomas of the Suprarenal. *Acta chir scand* 1946 94 271

The authors describe the development of the marrow cells and the different tumor forms correspond to the different stages of development. Up to the present time about 120 cases of intra-adrenal pheochromocytoma and probably only 15 cases of extra-adrenal pheochromocytoma have been reported, most of them necropsy findings. The pathogenesis, symptomatology, diagnosis and differential diagnosis are reviewed, and the results of surgical treatment are mentioned. The operative mortality is high. Of 46 patients operated on (the authors included) for both extra and intra-adrenal pheochromocytomas 12 (26 per cent) died.

The authors relate 2 cases of their own.

The first patient was a man 49 years of age with paroxysmal hypertension due to a benign pheochromocytoma of the right adrenal. The blood pressure was found to be increased from four and one-half to five times during attacks. Treatment with methylthiouracil resulted in complete disappearance of the attacks. The tumor, which weighed about 1,400 grams, was removed with good result.

The second patient was a boy 10 years of age with permanent hypertension due to a pheochromocytoma. Operation through a left lumbar incision failed to demonstrate the tumor. The patient died 6 hours after the exploratory intervention probably from shock. At autopsy a malignant pheochromocytoma (4.5 by 3 by 3 cm.) was found situated in front of the large vessels connected by a small pedicle with the lower mesial angle of the left adrenal gland.

The authors believe that the only treatment in these cases is extirpation as soon as the diagnosis has been established and the patient's condition permits. They recommend preoperative treatment prior to extirpation of the adrenal gland. The reports in the literature as well as their own experiences lead the authors to believe that there may be reason to consider whether the best principle might not be to choose the abdominal approach in all cases of pheochromocytoma, irrespective of the size of the tumor and even when the location is known. When the tumor is large, they recommend Shipley's incision which is counteracted by percutin blood transfusion and, if necessary the administration of adrenalin.

JOHN A. LOVY, M.D.

Florence, T. J., Howland, W. S., and Weens H. S.: Intravenous Urography in Acute Renal Colic. *J Urol*, Balt., 1946, 56 244

The authors studied a group of patients with acute renal colic by means of intravenous urography using

intravenous diodrast solution preceded by pantopon and atropine. In 10 cases a nephrogram (opacification of the kidney shadow after intravenous administration of contrast medium) was obtained.

The authors are impressed by the frequency of the phenomenon, and the infrequent mention of it in standard urology texts. They explain it as follows:

In complete ureteral obstruction the intrarenal pressure gradually rises to a level at which glomerular filtration is suppressed, the tubular epithelium function and may excrete diodrast which accumulates in the tubular apparatus leading to a diffuse opacification of the renal shadow on intravenous urography as soon as the obstruction is relieved. The contrast medium passes readily from the tubules into the kidney pelvis and the kidney shadow returns to normal density. Nephrograms were obtained in cases of stricture as well as in calculous ureteral obstruction. In a survey of 23 cases, roentgenograms showed opaque calculi in only 11 but intravenous urography demonstrated a calculous or a ureteral obstruction in all but 1 case. In 5 of these cases blockage was so complete as to produce a nephrogram.

The principal advantage of intravenous urography is that it facilitates the early recognition of urinary tract obstruction and the differential diagnosis of acute abdominal conditions. The authors stress the opacification of the kidney (nephrogram) as a sign of ureteral blockage.

DAVID ROSENBLUM, M.D.

Nesbit R. M., and Adams, F. M.: Wilms Tumor. *J Pediatr* S. Louis, 1946 29 295

The authors report a series of 16 cases of Wilms tumor. The patients were treated at the University Hospital Ann Arbor Michigan during the 9 year period from Jan. 1 1934 to Jan. 1, 1943.

In 3 of the cases the tumors did not entirely conform with the usual pathological picture. Two of them were diagnosed as adenocarcinomas, one of which might have been a variant of a Wilms tumor. In the third case the tumor was diagnosed as a teratoma. It is believed that these 3 cases should be included in this series for clinically the condition was indistinguishable from a typical Wilms tumor.

The diagnosis of a Wilms tumor is not difficult for the physician to make. In a child, usually under 5 years of age with a history of progressive enlargement of the abdomen and with the finding on physical examination of a firm, nontender, smooth, or finely nodular mass which usually fills one-half of the abdomen the presumptive diagnosis of a Wilms tumor can quickly be made. The second most common abdominal tumor in childhood and one which gives the most difficulty in the differential diagnosis is the sympathoblastoma or neuroblastoma, of the

The diagnosis is usually established by pyelography. Subcutaneous or intravenous injection of diodrast is quite simple and in many instances satisfactory results are obtained. If results are not successful, and if it is considered that pyelograms are necessary for the diagnosis, the retrograde method is used.

The so-called characteristic pyelographic changes seen in a Wilm's tumor are (1) distortion of the renal pelvis and calices, (2) displacement of the renal pelvis upward, downward, or lateralward depending on the position of the tumor within the kidney and (3) failure of visualization of the kidney pelvis. However it should be remembered that these described changes are not absolutely diagnostic, but merely suggestive of a Wilm's tumor. When no contrast medium can be seen in the pelvis or calices on the affected side the diagnostician must think of hydronephrosis as well as neoplasm.

A procedure formerly used as an aid in the diagnosis, but now thrown into discard is that of aspiration biopsy. It is believed that the risk of setting malignant cells free into the peritoneal cavity as metastatic sites does not warrant this procedure being carried out.

The series of cases is small and the fact that the treatment has varied from patient to patient makes it impossible to draw any conclusions as to what is the proper form of therapy. However in recent years the following policy has been adopted in treating these patients: preoperative irradiation is reserved for those cases in which the tumor is so large that operative removal would be technically very difficult thus minimizing the chances for survival. Postoperative irradiation was formerly employed only in those patients in whom regional metastases were grossly evident at the time of operation, or if a pathological study of the regional lymph nodes showed metastatic involvement. However now the policy of giving all patients postoperative irradiation has been adopted. This change in policy has been made because 3 of the 8 living patients very definitely owe their survival to irradiation therapy. As such, it is now felt that every patient should have the benefit of possible lifesaving postoperative irradiation.

In summary the authors state that the diagnosis of a Wilm's tumor was confirmed by pathological study in all cases. Of the 16 children 8 are still living for a period of time ranging from  $3\frac{1}{4}$  to  $11\frac{1}{4}$  years since the institution of treatment.

It is of particular interest to note that of the 8 children apparently cured only 7 had nephrectomies. The survivor who was not operated upon was first seen here in 1933 at the age of 14 months with idiopathic hydrocephalus. She was next seen in March 1935 with the new complaint of abdominal enlargement, the hydrocephalus had since become arrested. Physical examination at that time revealed a huge finely nodular mass occupying the entire right half of the abdomen. An intravenous pyelogram failed to show any visualization of the

right renal pelvis. An aspiration punch biopsy was sufficiently diagnostic to make a clear-cut diagnosis of Wilm's tumor. Chest x-rays showed a right pleural effusion interpreted as being due to metastatic lesions in the lung. Therefore the tumor was considered to be inoperable and the patient was given palliative irradiation therapy over the right abdomen and right chest. She received a total of 1,800 roentgens in divided doses over a period of 2 weeks time. She was not seen again until 1939, when an examination revealed no evidence of any abdominal mass and x-rays showed that the chest was clear. She was last examined in October 1945, and was free from evidences of neoplasm at that time, 10 years following the original diagnosis.

Twelve of the 16 patients had nephrectomies. Seven of these children have lived long enough postoperatively to be considered cured by the standards set up by most authors.

Two of the patients, at operation, had gross evidence of retroperitoneal extension of the tumor. They were given postoperative irradiation, and the fact that they are still living shows adequately the value of this procedure.

With one exception all of the 5 patients who had nephrectomies and have since died showed evidence of metastases within 6 months postoperatively.

Operation was denied 4 of the 16 patients, either because of pulmonary metastases, or because they were in such poor condition that they were considered hopeless operative risks.

JOSEPH A. LOSEY, M.D.

Everett, H. S., and Wayburn, G. J.: A Unique Case of Submucosal Epithelial Nests in the Ureter and Renal Pelvis. *J. Urol. Balt.*, 94, 50, 51.

The authors report the case of a 55 year old colored female patient who suffered with gross hematuria and was finally subjected to a left nephrectomy and partial ureterectomy which demonstrated grossly a normal kidney and upper ureter. However upon microscopic study of the upper ureter it was found to contain numerous solid nests of epithelial cells which penetrated into the submucosal connective tissue and muscularis, and in one area the lesion had eroded into the lumen, revealing free cells and suggesting early squamous cell carcinoma.

In 1893 von Brunn found such a lesion in the upper ureter and bladder. It was thought by this authority to be due to an infolding of the epithelium. Since the initial report of this condition by von Brunn, lesions of this character have been described and this origin is still obscure. Morse, in a study of 235 necropsies, found these inclusion bodies present in 108 individuals. Von Limbeck suggested that a central liquefaction of these inclusions produced a cystic condition i.e. cystitis cystica, ureteritis cystica, etc.

Patch and Rhea believed these cell nests in the bladder to be the forerunners of cystic and glandular conditions which in turn lead to adenocarcinoma. Stirling and Ash uphold this opinion, and Bothe only

last year reported his experience in finding benign cell nests in one portion of the ureter or pelvis and gross carcinoma in another. This leads to the ever important step of removing the entire ureter in carcinoma of the renal pelvis to prevent its not infrequent recurrence in the stump.

ROBERT LICH, JR., M.D.

### BLADDER, URETHRA, AND PENIS

Coe, F. O., and Arthur P. S.: A New Medium for Cystourethrography. *Am. J. Roentg.*, 1946, 56, 362.

Since 1939 the authors have used a medium called viscorayopake for cystourethrography. This is an aqueous solution with approximately 50 per cent organic iodine compound and 5 per cent polyvinyl alcohol. It fulfills all the necessary requirements of a good contrast medium for cystourethrography: namely maximum opacity, minimum irritation, homogeneous nature, suitable viscosity, and it is not necessary to remove the dye from the bladder and urethra after instillation as it is miscible with urine. This preparation has been used in all types of cases, including traumatic rupture of the urethra and there have been no unusual reactions.

The following is a brief description of the technique employed. The only equipment necessary is a 30 c.c. syringe with 5 cm. of soft rubber catheter firmly attached to the tip as an adapter.

A plain roentgenogram of the abdomen is taken first. The bladder is emptied of urine. The patient is placed in the right anterior oblique position, i.e. with the left hip slightly elevated by use of a sand bag under the left hip. The right thigh is flexed and the left extended. The tube is centered directly over the symphysis pubis and a technique making use of the Potter Bucky diaphragm is employed. The operator then inserts the soft rubber catheter adapter into the urethra with the right hand, forcibly extends the penis with the left hand and at the same time exerts considerable pressure about the adapter to prevent the dye from regurgitating. Twenty cubic centimeters of the dye are slowly but steadily injected; the operator's hands are protected with  $\frac{3}{8}$  inch of lead plate and the first exposure of a stereo pair is made. It is important to keep constant pressure on the plunger of the syringe at all times. While the plate is being changed the remaining 10 c.c. are injected and the second exposure is made. The anteroposterior roentgenogram is made by immediately placing the patient in the supine position and continuing the pressure on the plunger of the syringe. It is not necessary to remove the dye mechanically.

JOHN A. LOFF, M.D.

Vermooten, V.: Rupture of the Urethra: A New Diagnostic Sign. *J. Urol.*, Balt., 1946, 56, 223.

Injury to the urethra or bladder commonly occurs with crushing wounds to the lower half of the abdomen. The extent of the injury is often difficult to determine. There are numerous diagnostic aids which



Fig. 1 (Vermooten) Showing how an examining finger in contact with apex of prostate, is pushed upward, prostate is also readily pushed up, indicating a complete rupture of the urethra.

include rectal palpation. Injection of a radio-opaque contrast medium through the urethra for delineation of extravasated urine and cystoscopic examination. The author strongly condemns the practice of injecting a known quantity of sterile fluid through a urethral catheter and measuring its return; such practice, he states, is not only harmful but can only yield wrong information.

The most common type of urethral injury in males is a complete rupture at the level of the apex of the prostate, i.e. just above the urogenital diaphragm. In such a case, the pubococcygeus muscle which forms the anterior border of the levator ani muscle contracts and elevates the prostate, this process being aided by the accumulation of blood in the space of Retzius. A wide separation results between the prostate and membranous urethra which with subsequent scar formation will make later attempts to excise the scar and reanastomose the urethra impossible or at best will produce a persistent stricture which will require frequent dilatations.

The author has utilized this anatomical situation both as a diagnostic aid and as a guide in treatment. He has found that on rectal palpation in those instances in which the urethra has been completely divided at the apex of the prostate he was able to locate the apex of the prostate and to push it up and away (Fig. 1). Conversely in those instances in which the prostate could not be dislodged with the examining finger the urethra had not been completely torn across.

The nature of the pelvic injury usually precludes placing a patient in the exaggerated lithotomy position necessary for doing a primary suture of the divided ends of the urethra. This has led the author to attempt to restore the continuity of the urethra by bringing traction on the prostate to return it to its correct anatomical position. Traction has been accomplished with the aid of a Hagner or Pilcher bag or, preferably a Foley balloon catheter. A urethral sound is passed through the urethra to the site of rupture and then guided into the prostatic urethra by introducing a finger into the posterior urethra through a suprapubic cystotomy incision and in that way guiding the sound into the bladder. The distal end of the catheter is threaded on the sound and withdrawn through the urethra, bringing the bag to rest upon the upper surface of the prostate gland. Traction is best maintained by tying the catheter to a band which has been fastened to the lateral aspect of the knee just below the patella. In this way, traction is maintained constantly regardless of whether the knee is straight or flexed. Tension is maintained for 3 weeks, after which the catheter is left in place for an additional 3 weeks.

In a relatively large series of cases, the author has successfully prevented the development of severe strictures.

CLARENCE V. HODGES, M.D.

Fjeldsøen A. B.: Abacterial Pyuria Presenting as Urethritis. *Brit. Med. J.* 1946, 2: 493.

In view of the increasing recognition given to this clinical syndrome (Donovan, 1945; Peters, 1946) the records of 3 cases, noted over a period of 3 months at a military hospital in the United Kingdom, are presented in detail.

The patients had reported as sick, or were referred to a special treatment center on account of persistent urethral discharge. Two cases had been seen on previous occasions and were given courses of sulfathiazole, urethral irrigations and intravenous fever therapy (T.A.B. vaccine) but with no permanent relief from their symptoms.

These patients had all received the recognized treatment for cystitis and urethritis, but in no case had a permanent cure been effected. Specific urethritis was excluded. A cystitis was assumed in all cases, but no organism could be detected after repeated attempts at culture. In the 3 cases presenting a synovitis of the knee, old gonococcal infection was excluded.

Causation is discussed by Donovan (1945). Renal causes were excluded in his series of cases, and a virus cause was suggested whether organic arsenicals have any therapeutic value in a virus infection is questioned by the author (Peters, 1946). According to Lydon (1945) recurrent attacks simulating pyelitis occur during the course of trichomonas vaginalis infection in the male. In view of this the author ventures to suggest trichomonas vaginalis as a possible cause of abacterial pyuria.

As the 3 patients in question had received prolonged treatment by the recognized therapeutic

measures, with no permanent relief the effect of intravenous neosphenamine was dramatic in its action. Follow-up on these 3 patients was limited to one month because of constant troop movements, but no recurrences of the condition were reported. It would be interesting to know whether any other investigations have been carried out to explore the possibility of trichomonas vaginalis as a potential cause of abacterial pyuria.

JOHN E. KIRKPATRICK, M.D.

## GENITAL ORGANS

Dalpoite, T. V.: Genuine Prostatic Lithiasis (La litiasis prostática verdadera). *Bol. Soc. cir. Rosario*, 1946, 13: 50.

The author concurs with others in his opinion that there is no pathognomonic symptom of prostatic lithiasis. The general picture is that of a chronic prostatitis or other prostatic affection, and therefore he recommends that all roentgenological examinations of the urinary passages include the region of the prostate.

As regards calculi in the region of the posterior urethra, however, a sharp distinction may be made between the stones which arise in other parts of the urinary tract to later become lodged in the posterior urethra, and calculi which develop and remain embedded in the prostate itself. The former are apt to cause sudden fulminant symptoms with complete obstruction of the urinary stream, the latter are apt to be more chronic manifestations with gradual and usually incomplete urinary obstruction.

In only 1 of the author's 8 patients was there any pain in the region of the loins and this pain was never comparable to a Dietl's crisis. In this case there was evidence roentgenologically of dilatation of the kidney pelvis which was ascribable to a moderate degree of nephroptosis. Urethral structure was usually present in fact, in only 3 instances of this material did the urethra appear to be entirely normal in caliber. The stones were always multiple and varied in size from that of a hazelnut to mere sand.

The urethroscopic route is preferred for treatment by the author perhaps after dilatation of the stricture. By this route not only can the larger calculi be grasped and removed perhaps with the finger in the rectum aiding the manipulations, but many of the small stones can be washed out directly. In 3 instances, however, the perineal approach to the condition was chosen—both had cystoperineal, or cystorectal fistulas—and in 1 instance a suprapubic cystotomy was done. The author did not attempt a prostatectomy, and, in particular, did not attempt performance of the radical extracapsular prostatectomy of Henline.

The author regards the endoscopic method as ideal both for diagnosis and for removal of the concretions, even when the operation has to be repeated, so long as the stones are not larger than a pea. However, even with the larger concretions the stone may be rocked out of its bed, with perhaps the aid of the

finger in the rectum pushed back into the bladder and later broken with the lithotrite. Following removal of the calculi prophylaxis would seem to suggest subsequent attention to the usually accompanying strictural condition. Of course, chemotherapy is recommended for the secondary infectious processes.

In 3 of these patients crystallographic study of the calculi proved a predominance of calcium carbonate in their composition. JOHN W. BARNHAM, M.D.

Neubitt, R. M., and Plumb, R. T.: Prostatic Carcinoma. *Surgery* 1946 20 263.

The purpose of the present report has been to provide data on a large series of patients with cancer of the prostate who have been followed for periods up to 19 years.

Comparative data in the series studied indicate that survival rates are significantly prolonged by endocrine modifications. Whether other or comparable series would show a similar advantage in favor of endocrine therapy of patients with prostatic carcinoma can only be a subject for speculation but the comparative survival rates among patients with metastases suggest that castration or estrogenic therapy has a beneficial effect on the survival curve.

Only a study of the final data on closed series of cases will disclose how the longevity of the greatest survivors in each series will compare, and will settle the question regarding a possible acceleration of neoplastic activity in isolated cases by modifications of hormonal status. JOHN A. LOFF, M.D.

Cox, H. T.: Carcinoma of the Prostate. *Brit. M. J.* 1946, 2 191.

Thirty cases of late carcinoma of the prostate treated by transurethral resection of the prostate and stilbesterol therapy at the Withington Hospital, Manchester are presented. Normal micturition was restored in every case except one. The author prefers the cold punch to the diathermy loop because he believes that the latter may be followed by large sloughs. As much malignant tissue as possible should be removed, down to the prostatic capsule and from all four quadrants.

The most obvious effect of stilbesterol therapy is the dramatic and rapid relief of metastatic pain. The author believes that the dosages employed are often too low and that apparent failures of stilbesterol therapy may be due to this cause. Disastrous results may follow continued treatment on a lowered maintenance dose, even when the dose is reduced at a time when the malignant process appears to be under control both clinically and pathologically. In the later cases in this series treatment was started on 30 mgm. of stilbesterol daily.

Cardiac complications developed in 4 cases as a result of stilbesterol therapy. When dieneestrol was used instead, complete relief was obtained in each instance. This substance is said to be three times as active estrogenically as stilbesterol.

Pathological grading of the lesion according to Muir's classification is an important step in the treat-

ment of carcinoma of the prostate. It provides an approximate estimation of the survival period. A lack of this knowledge may render fallacious any attempt to interpret, in terms of survival periods the benefit of estrogen therapy or any other therapy.

The acid serum phosphatase estimations are classified into three groups: those below 4 units per 100 milliliters as normal, those between 4 and 10 units as suspicious, and those at or over 10 units as diagnostic of carcinoma with secondaries. No case of a false positive has been recorded in this series; the word positive referring to a figure of 10 or over. Advanced Paget's disease constitutes the only exception. In this condition, however, there is an extremely high level of alkaline phosphatase as opposed to the very moderate elevation found in carcinoma of the prostate.

False negatives (carcinoma with secondaries and a low acid serum phosphatase) are known to occur but their incidence in 50 per cent of cases is sufficient to limit the value of the test and to discredit the value of all normal readings. These experiences show how fallacious the practice of relying on the acid serum phosphatase estimation for the control of stilbesterol dosage may be. FREDERICK A. LLOYD, M.D.

Arias, O.: Clinical Forms of Nicolas Favre's Disease (Las formas clínicas de la enfermedad de Nicolás y Favre). *Rev. urol. México* 1946 4 364.

Arias discusses the clinical forms of Nicolas Favre's disease. He considers the following forms of infection as developing through the genital organs: Lymphogranulomatous chancre, which appears in different forms and takes the herpetiform type in 73 per cent, simulates syphilis in 12 per cent, takes a nodular form in 9, simulates Ducrey's chancre in 6 and produces an infiltration in the layers in 3 per cent.

He considers also the lymphogranulomatous urethritis and the lymphogranulomatous meatitis. In the latter form he differentiates 4 types: the truncular lymphangitis, the early regional edema, the inguinoliac lymph node invasion and the genitourinary invasion.

Four main forms of adenitis may occur in the disease: the latent form, adenitis simulating syphilitic adenitis, adenitis with sudden onset and general symptoms, and adenitis of slow evolution.

The author describes the sign of "lymph node shock" when despite acute inflammation of the lymph nodes, there is no tenderness in the inflamed region and the sign of "shakiness" produced by the displacement of the indurated lymph nodes over the deeper layers because of the lack of involvement of such tissues early in the disease.

In the late complications are included genital elephantiasis, urethropenial fistulas, urethral prostatic neorectal syndromes, and rectal complications with or without stenosis. The last complications occur through the rectal lymphatics or through the urethroprostatic rectal lymph channels.

WILLIAM E. RICKETTS, M.D.



## MISCELLANEOUS

Jeffcoate, T. N. A.: Male Infertility. *Brit. M. J.* 2: 185

In a large proportion of cases infertility results not from one but several factors which may be distributed between the two partners. A statement of the cause of childlessness in any marriage should consist in a listing of all the infertility factors present. Treatment should aim at the elimination of as many of the infertility factors as possible.

Physical examination of the male is of strictly limited value. If the findings are positive—e.g., atrophied testes—then they are significant but if the findings are negative no conclusion is possible. Male fertility is mainly assessed by semen analysis.

As a result of an assessment of male fertility in 491 private and 115 hospital cases of sterility the author has established the following criteria of sterility: (a) a semen volume repeatedly below 0.5 ml., or a total sperm count below 50 million (b) with this exception, no count above 30 million milliliter was considered abnormal (c) asthenospermia was diagnosed only if the motility was below 40 per cent at the end of from 6 to 8 hours (d) semen was not considered subfertile unless more than 50 per cent of the spermatozoa were malformed. The sperm count was considered the most important single criterion. A count of 10 million per milliliter or less, was taken to mean a serious impairment of fertility.

In the author's series pregnancies occurred with counts as low as 2 million per milliliter and also in several cases of azoospermia. He explains the latter by the probable presence of intermittent obstructions in the genital passages.

The treatment consisted of general health measures, the administration of Vitamin E (although its efficacy was questioned) and the use of gonadotropin. Although no claims were made as to the efficacy of the last named substance, a rather consistent increase in the sperm count seemed to follow in the 14 cases in which it was employed and prompt pregnancy followed after prolonged sterility in several cases.

Basal metabolic determinations were not made and thyroid extract was not employed by the author.

Among 169 men found to have seminal faults, 26 produced at least one pregnancy since their investigation and after treatment of either themselves or their wives, or both. **FREDERICK A. LYNN, M.D.**

Werner A. A.: The Male Climacteric. *J. Am. M. Ass.* 1946, 133: 88.

Werner reports 273 cases of patients with the "male climacteric." The symptoms of this syndrome may be present in eunuchism, cryptorchidism, hypogonadism, castration, and the climacteric. The most prevalent time for this decline of gonadal function (climacteric) is between the ages of 45 and 55 years.

Diagnostic evidence for the condition is chiefly subjective and results from gonadopituitary im-

balance, with disturbance of the autonomic and central nervous systems. The symptoms are (1) nervous, (2) circulatory and (3) general. There is an intense subjective nervousness or feeling of tension and tremulousness, especially during the night or in the morning, and irritability. The patients are hard to please, sleep poorly and are excitable. There is numbness, tingling of the hands, and formication. Vertigo and occipitocervical headache is common. There is decrease in memory in the ability for mental concentration, and depression or melancholia. Circulatory symptoms are hot flushes, perspiration, a smothering sensation, tachycardia, dyspnea, palpitation, cardiac consciousness, vertigo, and cold or tremulous. The patients tire easily are debilitated, and experience a loss of potency with persistence of libido. Frequently constipation, distention and postprandial cruetation are seen.

Werner administers 25 mgm. of testosterone propionate every other day omitting Sunday for a month or two, and then twice a week for 1 month, and then once weekly. When the patient develops endocrine stability the symptoms do not return after cessation of the treatment.

Of the 273 patients studied, 130 were in the climacteric. The author warns that one can almost surely promise a climacteric patient relief from his symptoms and a feeling of well-being, but not a return of libido and potency.

**DAVID ROSENBLUM, M.D.**

Wilson, J. G., Leahy A. D., and Benjamins, J. A.: Study of Experimental Urinary Calculi. *J. Urol. Balt.*, 1946, 56: 151.

The authors have previously described a method for the experimental production of urinary calculi in rats by multiple injections of estradiol dipropionate during the first two weeks of life. It was found that a high percentage of male rats so treated formed stones subsequently and the assumption was made that all such males were potential stone formers. A necessary condition for the formation of calculi was found to be that the animals must be fed on a well balanced diet which contained minerals somewhat in excess of the basal requirements for normal growth and reproduction. In animals, similarly treated, that were maintained on a diet that was nutritionally adequate but contained near-minimal quantities of minerals the incidence of stones was greatly reduced.

It was the object of the present experiment to determine whether the stone-forming potentiality was permanent or transient, i.e., dependent upon age, rate of growth, or some immediate sequelae of the hormonal treatment. The plan was to delay the early development of calculi by feeding treated rats for several months on a diet low in minerals, then to transfer the rats to a diet containing a surplus of minerals.

Treated males and females were fed the low mineral diet until they reached ages ranging from 135 to 157 days, after which a majority of both sexes

were transferred to the high mineral diet. Ten of 13 males developed stones within from 24 to 125 days following this transfer. None of the females of the similarly treated group developed stones. None of the control series of males and females that were maintained on a low mineral diet developed stones. Infection in the urinary tract did not seem to be a determining factor as with one exception all animals in this and in an earlier series showed evidence of infection at some time during the experiment. The reaction of the urine was thought to play a role as the urine of males on a high mineral diet became alkaline within a few days after the diet was instituted and remained so thereafter while the urine of control males (on low mineral diet) and of all females ranged from acid to neutral. A higher incidence of gross pathology of the urinary tract was found in males maintained on the high mineral diet. In females, the diet did not appear to affect the occurrence of abnormalities in the urinary tract.

The conclusion reached in the present study is that the stone-forming tendency induced in male rats by the methods described is not transitory and that it may be retained for several months in an undiminished though latent form. The interpretation advanced by the authors regarding the relation between diet and lithiasis is that the dietary content of minerals is the critical factor in stone formation in treated males. They postulate a series of changes in which initiated by the hormonal effects of hypertrophy (and possibly inflammation) of the lower genitourinary tract, there is narrowing of the urethral lumen and a consequent resistance to the flow of urine. This may predispose to urinary tract infection. A high mineral diet renders the urine alkaline. The cycle of stagnation, infection, and alkaluria continues to the point where normally soluble urinary stones become insoluble, crystallize, and thereby initiate the process of calculus formation.

CLARENCE V. HODGES, M.D.

Gierst, G.: Enterococci in Urinary Tract Infections. *Acta chir scand.*, 1946 94 suppl 109.

Since its use by Thiercelin the term enterococcus has had a somewhat variable and hazy meaning. In some cases the name has been applied rather specifically as a synonym for streptococcus faecalis but most workers have used the term enterococcus in a loose group sense to designate faecal streptococci which have in common some of the outstanding characteristics of the streptococcus faecalis. Through the application of a wider assortment of tests and from more extensive studies of individual species, there has gradually evolved a rather definite and clearly defined enterococcus division of the streptococci.

The enterococci occur either in short chains or in pairs. The individual cocci are elongated and are sometimes almost bacillary. They are differentiated from other known species of the streptococci by their combination of low minimum and high maximum temperatures of growth, greater tolerance of salt and

alkali, high thermal death points, and resistance to relatively strong concentrations of methylene blue. The fermentation of mannitol is an especially constant characteristic. Inulin is only rarely attacked. Enterococci show a tolerance to bile, and some strains are able to liquefy gelatin which differentiates them from other streptococci.

The enterococci are divided into 3 types (Sherman) (1) the streptococcus faecalis, which is non-hemolytic and nonproteolytic (2) the streptococcus liquefaciens which is nonhemolytic and proteolytic and (3) the streptococcus zymogenes which embraces all of the hemolyzing strains independently of their capacity to liquefy gelatin.

The author carried out a clinical bacteriological investigation of the urological cases which were being treated at the surgical clinic of Karolinska Sjukhuset (Stockholm) from May 1942 to July 1943. A total of 673 cases were studied, 383 of the patients being men and 290 women. Two hundred and seventy three streptococcal strains were isolated from the urine, of which 240 (88%) were enterococci. One hundred and forty two (59%) of the latter were nonhemolyzing and 45 of these (32%) liquefied gelatin. Ninety eight (41%) were hemolyzing and 5 (5%) of these liquefied gelatin. The different types of enterococci seemed to show an equal ability to grow in an acid urine. Urines having a pH below 5 had a bacteriostatic effect. The enterococci do not show a tendency to split urea.

The effect of the following antiseptics was also studied chloramine 1:100, rivanol 1:1,000, potassium permanganate boric acid solutions 1:4,000 and 1:400, silver nitrate 1:1,000, and chinosol 1:1,000. Chloramine produced its full effect in all tests after 10 minutes. The effect of the other solutions was irregular.

Discrepancies may occur between smears and cultures. A vigorous growth of the *Bacillus coli* can hinder or prevent the growth of cocci on solid media. The *Bacillus proteus*, if present, may by its extensive growth prevent the identification of other bacteria unless special cultures are employed. Further discrepancies may occur because of the nonviability of bacteria seen on the smear. Bacteria may be demonstrated for a longer time in smears than in cultures.

Contamination by urethral flora may present difficulties especially in voided urine specimens from men. This error is diminished but not entirely eliminated in second glass and catheterized specimens. In order to determine whether enterococci are normally present in the male urethra, the author tested 100 urine specimens. Enterococci were found in only 2 cases.

The *Bacillus coli* was the bacterium most commonly found in patients on admission. During the period of hospitalization enterococci were most usually observed. In more than every fourth case an enterococcal infection arose later. In general an enterococcal infection appears most clearly during, and in connection with treatment with the sulfona-

mides. Modern chemotherapy has shown the clinical importance of enterococci in infections of the urinary tract.

The enterococci are secondary invaders of the urinary tract. Of 216 of the author's patients infected with enterococci, only 38 displayed such infections on admission.

Enterococcal infection appears commonly in connection with catheter drainage. This was demonstrated in 151 of 189 cases studied by the author.

Infection with the *Bacillus coli* and staphylococci under corresponding conditions was only about half as common as infection arising from enterococci.

Enterococci are bacteria of relatively low virulence and invasive power. In the urinary tract they do not in some cases give rise either to subjective or objective symptoms, but in other cases they are able to cause slight distress and slight inflammatory changes. In cases in which more severe inflammatory changes existed the author was able to demonstrate the simultaneous presence of other bacteria.

It is questionable whether the enterococci play any significant role in the formation of calculi. The various types of enterococci are clinically equivalent to each other.

Sulfathiazole is ineffective in the treatment of infections caused by enterococci. If this drug is given prophylactically in catheter treatment, the urine will nearly always become infected with enterococci in pure culture. Neosarphenamine is likewise ineffective. Favorable results are obtained with mannitolic acid.

An enterococcal infection arising in connection with urological instrumentation almost regularly disappears unless a complication such as residual urine stricture or calculus exists.

FREDERICK A. LLOYD, M.D.

Fish, G. W.: Oxidized Cellulose (Absorbable Hemostatic Gauze, Cellulose Acid); Its Use in Genito-urinary Surgery. *J. Urol., Balt.*, 1945, 54: 171.

The author has used oxidized cellulose gauze to assist in hemostasis in a variety of urological operations. In suprapubic prostatectomy he inserts one or more rolls of 2 by 18 inch 4 ply gauze pads into the enucleated gland cavity and exerts gentle but firm pressure for 2 or 3 minutes. When hemostasis is established the bladder is closed about a suprapubic tube which is removed after the fourth day. The gauze normally is absorbed within 10 days and excreted by the kidneys, and when removal needs to be expedited this can be accomplished by irrigations with 5 per cent sodium bicarbonate solution since the gauze is soluble in weak alkali.

In order to use this gauze successfully the following criteria must be observed: (1) the gauze must come in active contact with the bleeding point, and (2) a sufficiently large quantity of gauze must be used to cover the bleeding surface completely and if pressure is needed it is not necessary to apply it for more than 2 or 3 minutes.

The author used the gauze in 108 instances to control bleeding in the enucleated prostatic bed following suprapubic prostatectomy and in a few instances in virtually all types of urological operations, so that the total series represents 156 cases. The results have been gratifying in every instance, and the gauze was found to be particularly useful in nephrotomy in which a thin absorbable pad placed between the renal halves controlled the bleeding with the use of only a few 40 chromic mattress sutures. The postoperative nephrectomy bed which is the site of much cortical collateral circulation also permits the use of this hemostatic gauze to great advantage.

RONERT LACK, JR., M.D.

# SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

## CONDITIONS OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Nagler F P O : Penicillin Treatment of Experimental Osteomyelitis in Rabbits. *Austral J Zool* 1946, 13: 206

The author produced experimental osteomyelitis in rabbits by first injecting sodium morrhuate into the proximal epiphysis of the tibia to cause tissue damage and a region of impaired circulation and then inoculating a strain of the staphylococcus aureus 48 hours later.

In one group of animals, treatment with penicillin was started 6 days after infection was produced with out significant effect. In another group treatment was started 48 hours after infection was produced with beneficial effects although there was evidence of bone destruction in all cases.

Penicillin was given as a suspension in peanut oil and became over a period of 3 weeks in a dose of 1 Oxford unit per gram of animal. This amount corresponds approximately to the daily administration of 600,000 Oxford units to an adult patient weighing 70 kgm.

Lereuf, J., and Laurence, G : Remarks on 53 Cases of Acute Osteomyelitis Treated with Penicillin (*Remarques sur 53 cas d'ostomyélite aiguë traitée par la pénicilline*). *Mem Acad chir, Paris* 1946, 72: 93

The authors patients were all treated by immediate immobilization of the affected limb in a cast and the administration of 100,000 units of penicillin per day up to a total dosage of 1,000,000 units. In the patients whose general condition appeared to be especially severe the daily amounts of penicillin were raised to 250,000 units and this amount was administered both intramuscularly and intravenously. The study covered approximately a year's work.

There were 5 deaths on the ninth day (1.9 per cent) and without roentgenological evidence of abscess and abscess formation but with roentgenologically detectable lesions of the bone. Finally there were 32 more or less extensive bone involvement. In the first of these groups the author believes that resolution of the condition could have taken place without penicillin in fact he is unable to rule out the possibility of diagnostic error in these patients. Fifteen patients recovered without abscess formation which is an abnormally high percentage (46.9 per cent) for such cases and might be construed as an argument for the efficacy of penicillin nevertheless 2 of the patients had been ill for 24 and 45 days respectively before coming under treatment and already showed signs of resolution of their conditions without suppuration.

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All of these cases involved the femur or humerus, where masses of muscle and other tissues surround and overlay the focus of disease and frequently are found to enclose masses of devitalized tissues and products of inflammation these might develop abscess later. The 32 cases which went on to suppuration comprised 18 tibias, 8 femurs, 1 ilium, 1 humerus, 2 ulnas, 1 radius, 1 clavicle, and 3 of multiple osseous foci. Fourteen of the patients recovered after harboring suppurative processes lasting less than 3 months 3 recovered after repeated operations (in some instances after repeated operations) and 14 still have residual fistulas. The remaining patient had recovered from a focus in the femur when a secondary lesion of the iliac bone developed and despite penicillin went on to form a residual fistula. However in some of this last group there has not been time as yet to evaluate the percentage of possible future spontaneous healing. The authors did not wish to report this series so soon however they believed that their penicillin center should keep the profession constantly informed and they kept the what they believed were a number of interesting conclusions to impart at this time.

On the whole the most disappointing thing about penicillin was its failure to prevent the suppuration and sequestration of the early stages of osteomyelitis. A tabular study of their data shows that as many patients who were observed in the very earliest period course as did those coming under penicillin treatment in the later stages. The general resistance of the patient seems to count for too much in this condition to enable penicillin to fully counteract the natural tendencies of the disease process. Nevertheless the authors still have enough confidence in the drug to believe that further intensive study of the question of dosage may be of value.

JOHN W. BRENNAN, M.D.  
*Am J Roent*, 1946, 56: 169

The particular characteristic of the neuropathic arthropathies is the endochondral ossification under the joint cartilage which ordinarily becomes stationary with the formation of a continuous bony bone lamella, while the so-called preliminary calcification zone becomes extensively revived. The first step of this revival is the proliferation of the cartilage. The second step is a forward pushing of the preliminary calcification zone and the third step is the penetration of vascular marrow recesses into the joint reacts on all occasions with the resumption of endochondral ossification. The degree of this ossification is so great and so diverse that by dint of simultaneous absorption and proliferation an enormous incongruity of the joint surfaces may result.

The author describes a case in which a neuropathic joint developed in a patient who had been bedfast for 15 years. He believes that the continued pressure of the body weight is quite adequate to be a source of trauma in an insensitive joint. He believes the changes observed in neuropathic arthropathy appear to be brought about by repeated subclinical traumas occurring in an insensitive joint and that there is no definite evidence of the existence of trophic nerves.

EMIL C. ROSENBERG, M.D.

Schajowicz, F., and Alarcón, F. O.: Sarcomatous Change in Paget's Osteitis Deformans (La transformación sarcomatosa de la osteitis deformante de Paget) *Rev orlop traumat.*, B Air 1946, 15 33.

In 1935 Schajowicz collected a bibliography of 58 cases of malignant degeneration of Paget's osteitis deformans from the world literature and added a case of his own. As the frequency of Paget's disease is not known, it is impossible to say just what proportion of cases undergo malignant degeneration, but it is probably about 7 per cent.

A new case is described in this article. The patient, a man of 63, had had chronic rheumatism for about 8 years. Within the past 3 months the pain had become localized at the lower end of the femur around the knee and he was obliged to remain in bed with the knee in semiflexion and external rotation. A roentgenogram of this knee showed the typical picture of Paget's disease with the mosaic appearance due to alternate destruction and new formation of bone. Smears made from a puncture showed many round, oval, and polyhedral cells with a moderate number of giant cells, most of them with only a few nuclei. The tissue was very rich in cells and blood vessels and, although it showed some resemblance to malignant giant cell tumor, a diagnosis of osteogenic osteolytic sarcoma (according to the North American classification of malignant osteoblastoma with myeloplaxas according to the classification of Brachetto-Brian) was made. Roentgenograms of the knee and pelvis and photomicrographs of the cell structure of the Paget's disease and the sarcoma were given.

The patient was given roentgen treatment with 3,000 units over several fields which relieved the pain, but another roentgenogram made 30 days later showed that the tumor had continued to progress. The patient is now being given daily injections of folliculin. Repeated doses of acid phosphatase are indicated in this case, although this remedy may be contraindicated in cases in which the rapid destruction of bone tissue causes an increase of acid phosphatase.

An endocrine factor has been suspected in the causation of Paget's disease, and various glands including the thyroid, parathyroids, and suprarenals, have been held responsible. However the author believes that the endocrine influence is from the male sex glands, as all but 4 of the 58 cases previously reported, as well as this 1, occurred in males, and the

macroscopic and microscopic pictures of malignant Paget's disease are quite similar to those of bone metastases from carcinoma of the prostate.

AUDREY G. MORROW, M.D.

McLaughlin, H. L.: Lesions of the Musculotendinous Cuff of the Shoulder: Observations on the Pathology, Course, and Treatment of Calcific Deposits. *Ann. Surg.* 1946, 124 354.

The Fracture Service of the Presbyterian Hospital in New York has had the opportunity to study almost 2,000 lesions in which the symptoms centered around a calcific deposit to produce the condition commonly diagnosed and treated as calcified subdeltoid bursitis.

Gross, microscopic and bacteriological studies of the condition have been possible in about 200 patients, including all stages of the condition, who were subjected to operation.

The earliest microscopic evidences of the lesion consist of hyaline degeneration in the collagen of the tendon fibers. The involved fibers soon become fibrillated and form loosened bands of fibers within the substance of the tendon. Motion of the part, aided by progression of the local degenerative change, further loosens these fibrillated strands, finally breaks them free from their attachments to the more normal surrounding tendon, and casts them into rice-like bodies occupying a cavity within the substance of the tendon. Continued motion grinds these rice-like particles into a finely pulverized vesicle substance composed of necrotic tendon debris. Almost all deposits productive of pain in the shoulder contain a sufficient concentration of calcium salts so that their presence and anatomic location become demonstrable by adequate roentgenological studies of the part.

Quiescent calcific deposits are encountered roentgenologically. So long as the deposit remains buried in tendon it tends to remain quiescent, but sooner or later it gradually or suddenly penetrates the overlying tendon fibers to come into contact with the floor of the subdeltoid bursa. Operative findings have demonstrated that the degree of inflammation varies in accordance with the quantity of irritant material in contact with the bursal floor.

The deposit productive of chronic symptoms is invariably a dry cheesy or waxy-like and infiltrated through tendon tissue within a relatively poorly circumscribed cavity under little or no tension. The deposit productive of acute pain is always wet, greasy of the consistency of tooth paste or heavy cream, and is under distinct tension within a rather well defined cavity from which the material is apt to well defined cavity from which the material is apt to logically manifested by a rather dense shadow with an ill-defined or irregular periphery whereas the acutely inflamed deposit is represented by a well defined globular and frequently flocculent shadow of relatively less opacity.

As for treatment the immediate problem usually demands a decision between curative and purely

palliative therapy. Seldom is anyone but the patient qualified to make such a decision.

The chronic condition warranting curative therapy deserves operative removal of the deposit as the only certain and speedy method of obtaining permanent relief. The chronic condition warranting nothing more than palliation may be treated by any combination of sedative measures that are convenient and that result in reduction of pain. Simple home measures including heat, aspirin, and a program designed to prevent disuse and stiffness of the arm have been found to be as efficient as all types of formal therapy.

The acute condition warrants curative therapy. The treatment of choice is puncture of the tense deposit and aspiration of its contents by needle under local anesthesia. Palliation usually is necessary during the next few days. Multiple deposits in the acutely inflamed shoulder and certain other selected acute cases warrant operative intervention.

RUDOLPH S. REICH, M.D.

Smith, F. M.: Displacement of the Medial Epicondyle of the Humerus into the Elbow Joint. *Ann. Surg.*, 1946, 124, 410.

This article reviews and evaluates the results in 31 consecutive cases of fracture of the epiphysis of the medial epicondyle of the humerus with displacement into the elbow joint. Each of these cases was either accompanied by a posterior or posterolateral dislocation of the elbow joint or had been subjected to reduction of such a dislocation previously. Each case was treated by open operation. Of the 31 cases thus treated, 30 have been followed carefully for years, the average follow up period being between 4 and 5 years.

Displacement occurs mainly between the ages of 7 and 17 years. There are two main types, namely, (1) mild to moderate separation of the epicondyle from the condyle and (2) complete avulsion of the epicondyle with downward and lateral displacement and incarceration into the elbow joint. This article deals only with the second of these conditions.

Diagnosis by clinical examination is extremely difficult because of the large amount of early swelling and acute tenderness. The condition may be suspected if there is obvious dislocation of both forearm bones and the usual marked prominence of the medial epicondyle cannot be palpated in its normal position. However, the displaced epicondyle when not felt in its normal location may have swung posteriorly as a stripped-up periosteal attachment and not be truly in the joint cavity. Roentgenological examination is the only sure and safe way to make the diagnosis. If there is any doubt about where the epicondyle is, films of the uninjured elbow in identical positions should be made for comparison. An important part of the clinical examination should be to test both sensory and motor function.

At operation the medial aspect of the elbow joint may be exposed either through a longitudinal incision or a transverse one along the flexion crease. When the joint is exposed the nearly circular medial

aspect of the trochlear process is seen covered by articular cartilage. Immediately below this are seen the converging fibers of the glistening white fascia overlying the surface of the flexor-pronator muscles. These fibers and muscles curl laterally into the joint cavity just distal to the trochlea. If this fascia is pulled upon by a mouse toothed forceps, the incarcerated epicondyle will "pop out" into full view. It can then be reattached to its original site or it can be excised.

There were 7 patients who also presented ulnar nerve palsy on admission and 1 case showed a temporary palsy after operation. All of them recovered complete function of the nerve.

The patients who responded best and promptly and who have continued to do so are those that were immobilized in a posterior molded plaster splint for less than 3 weeks after operation or had only a sling.

Summing up the end results, 6 patients obtained completely perfect results, 4 have excellent results, 9 have good to excellent results, and 1 has a fair to good result. The remaining patient died of the anesthesia on the table before the wound could be closed. From the economic standpoint every patient followed up showed complete use of the elbow with out any handicap whatsoever.

RUDOLPH S. REICH, M.D.

Marottóli O. R.: Synovial Sarcoma (Malignant Synovioma) of the Elbow (Sarcoma sinovial [sinovioma maligno] del codo). *Rev. As. Méd. Argent.*, 1946, 60, 505.

A 23 year old patient noticed a swelling of his left elbow 8 years prior to admission to the hospital. The mass caused only slight pain in the beginning but gradually the intensity increased.

Inspection revealed a globular deformity of the left elbow. The local temperature was increased. On palpation the tumor appeared to be of a solid character but had an elastic consistency and was not attached to the skin. There was no adenopathy. Flexion and extension of the left elbow were markedly limited while supination and pronation were not affected. Roentgenograms disclosed a shadow corresponding to the location of the tumor with evidence of calcification.

Two days after biopsy an amputation of the upper third of the left arm was performed under general anesthesia.

The dimensions of the tumor were 8 by 3½ cm.

The histological examination revealed the presence of connective tissue and adenomatous cavities.

From the purely histological point of view tumors originating from the synovia may be classified as endotheliomas, peritheliomas, or sarcomatous endotheliomas but their origin from the synovia justifies the term synovioma or synovialoma. Histological and clinical evidence of malignancy explains the generic term synovial sarcoma.

The evolution of such tumors is usually slow averaging 5-7 years. Metastases are found most frequently in the lungs. According to Lewis calcareous

deposits visible in roentgenograms are pathognomonic.

Conservative surgical procedures such as extirpation of the tumor lead to disaster. Early amputation with extirpation of the lymph glands is the method of choice. JOSEPH K. NARAY, M.D.

Nofia, M. C.: Congenital Luxation of the Knee (Sobre la luxación congénita de la rótula). *Cirugía por locomotor* 1946 3 65.

Only 2 cases of congenital luxation of the knee were seen among 18 000 admissions to the orthopedic service of the author's hospital. Females are more often afflicted than males. Many hypotheses are advanced regarding the origin of the disability. It is seldom observed before the first decade and then it usually follows some trauma.

In minor cases mechanical appliances are employed—massage, physical therapy and similar measures. These are ineffective in advanced cases. The various operative techniques are named in accordance with the tissue attacked such as bone, capsular ligament, tendons, or muscles.

A case report is presented of a patient who had high grade luxation of the knee which produced no symptoms. The condition was recognized following a fall. At operation none of the standard techniques, such as arthrodesis, arthroplasty, and pettellectomy could be employed as the structures generally utilized were absent, rudimentary, or otherwise inadequate. Simple arthrodesis was followed by complete normal function. STEPHEN A. ZIEGLER, M.D.

Rozas, J. T.: Plasmacytoma of Both Legs (Plasmocitoma cruris duplex). *Cirugía por locomotor* 1946, 3 11.

Rozas discusses a case of bilateral femoral plasmacytoma associated with simultaneous pathological fracture in a 50 year old man. The tumors were osteolytic without evidence of periosteal reaction.

Multiple myeloma, when typical, offers little difficulty in diagnosis. However, the many variants because of resemblance to other diseases, present diagnostic problems of the highest magnitude. These lesions arise from the red bone marrow cells, are osteolytic, and are definitely malignant. The bones chiefly affected are the vertebrae, ribs, cranium, pelvis, and, least frequently, the femur and tibia.

There are 4 recognized histological types, depending upon the character of the predominant cell, the plasmacytic, myelocytic, erythroblastic, and lymphocytic. Clinically the classification is of little significance and there is no characteristic syndrome. There is at times some rheumatoid or neuralgic pain frequently the first sign of the disease is a spontaneous fracture or a fracture following an insignificant trauma. There may be an anemia suggestive of the pernicious form. Other symptoms depend upon the location of the tumor. Stereal punctures are especially helpful in diagnosis.

Characteristic of the disease is the disturbed protein metabolism and the appearance of Bence Jones

albuminuria. Roentgenologically the process appears to be osteolytic, and the bony reaction is similar to that of diffuse osteoporosis.

The differential diagnosis must be made from metastatic carcinomatosis, osteitis fibrosa, Schaeffer-Christian and Paget's diseases, and osteoblastic sarcoma, or Ewing's tumor.

Considerable controversy exists over solitary myelomas. Their localization is in the thoracic vertebrae, pelvis, femur but most frequently in the cranium, cervical vertebra, and rarely in the mandible, clavicle, tibia, and sternum.

Two other case histories are given, 1 of a 63 year old woman whose chief complaints were those of attacks of lumbago. Roentgenograms showed a pathological fracture of the body of the first lumbar vertebra. The other case demonstrated an apparently solitary myeloma in a 51 year old woman who suffered a pathological fracture of the body of the seventh thoracic vertebra. STEPHEN A. ZIEGLER, M.D.

#### SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

D'Aubigné, R. M. and Lance, P.: The Treatment of Bone Defects of the Upper Extremities in War Casualties (Traitement des pertes de substance osseuse du membre supérieur chez les blessés de guerre). *Mém. Acad. chir. Par.* 1946, 73 85.

The author had the opportunity to treat 60 cases with loss of bone substance which have occurred within the last year. Thirty-five patients have had bone defects of the upper extremity and the rest have had defects of the lower extremity. The results of the treatment of bone defects of the upper extremity are reported in this article and the end results of the treatment of defects of the lower extremity will be reported at a later date.

This article does not offer a new way of treatment based on biological, physiological and operative techniques, but describes one way of treating these cases. Twenty-six patients had loss of bony substance of the diaphysis, 5 of whom were operated on after 3 months. There were 11 cases of bone defect of the humerus which showed union of the fragments, 1 bone graft was fractured. There were 5 cases involving the forearm and 4, the ulna, 3 of which healed normally and in 1 case the bone graft was broken. Three cases had bone loss of the radius and all 3 healed completely. One case of bone loss of the metacarpal healed satisfactorily. Two cases of bone loss of the upper portion of the humerus were treated with fibular grafts with fair results. Three arthrodeses of the shoulder were done with iliac bone grafts and very good results were obtained. There were 2 cases of bone defect of the lower humerus which were treated by iliac bone grafts with good results. Two cases of bone loss of the lower extremity of the radius were treated with cubital and tibial bone grafts. Both healed very well.

The author's first concern was the treatment of the infection. In most all cases the extremities were in-

ected at the time they were first seen. It is not the purpose of this article to discuss the treatment of osteomyelitis, but the fact is worth mentioning that osteomyelitis of the bones of the upper extremity very rarely follows a prolonged course. Twenty-six of the 35 patients observed were completely healed at the time that they arrived at the center. Nine had ulceration or fistula and 2 of them had to be treated for osteomyelitis but could not be operated on because of this fact. The remaining 7 had to be treated on this fact. Healing was obtained in 1 case by removing the sequestra in 2 cases by 3 grafts in 2 other cases by secondary suture and in 1 case by pedicled grafts, in 1 case spontaneous healing occurred. A delay of at least 1 month after the complete healing of the skin is indispensable before any bony intervention is contemplated. In spite of the short waiting period the author had only 1 case of late infection (5 months after the operation), no graft was lost and no suppuration occurred. This fact is probably due to the penicillin therapy which had been given systematically before and after the operation. One hundred thousand units of penicillin were given 2 days prior to the operation and were continued in cases in which an elevation of temperature persisted. The observation was made that the risk of an infection is less serious in the upper extremity than in the lower one where infections are more frequent and much more serious.

No bone operation should be undertaken unless the skin covering this area is adequate. In most of the cases the skin was adherent to the bone, of poor quality and ready to form ulcers. These scars should be resected and replaced by pedicled grafts. On the forearm and on the hand abdominal tubular grafts were used. This graft from the abdominal wall was removed in the usual manner. On the arm where the skin is looser it was usually possible to cover the lost skin by a rotation graft from the immediate neighborhood. The donor area of the skin graft was immediately covered by a free skin graft.

The proper treatment of loss of bone substance presents two important problems (1) the replacement of the missing bone, and (2) the immobilization of the fragments. These two problems are intimately related because the fixation of the fragments should be complete and prolonged. It is impossible and dangerous to count on an external apparatus to give proper immobilization. The immobilization should be instituted right on the bone itself. The following technique was followed.

In certain cases the two fragments could be approximated. This method was indicated particularly if the loss of the bone substance was associated with a loss of a portion of a nerve. Two cases with radial nerve fusions were treated in this manner with excellent results. If the lesion was localized too close to the upper extremity the diaphyseal fragment was impacted into the epiphysis and fixed with wire. This method was employed in 1 case with a good result. If one applies this method to a lesion localized into the diaphysis of the humerus the fragments

must be carefully and solidly fixed. For this purpose a bone plate was used, but as a rule a tibial graft is preferable. A Kuentscher spike was used in 1 case. This method assured an excellent alignment but there was a tendency for the fragments to separate. This happened in 1 of the authors' cases. It became necessary to use a bone plate in addition to the intramedullary fixation. There were 5 unions in 6 cases of loss of bone substance in the diaphysis of the humerus and 1 delayed union in which it was necessary to employ a tibial graft following the use of a Kuentscher spike. In cases of bone defect of the arm and in most cases of loss of bone substance of the forearm the normal length of the bone should be preserved and the loss of bone substance should be replaced by bone grafting. Iliac and tibial grafts were used. The tibial graft is very rigid and assures a firm immobilization. It should be the method of choice in cases of loss of bone substance in the forearm.

In the beginning an inlay bone graft was used. In the proximal fragment the tibial graft was used as an inlay graft and was introduced into the medullary canal of the distal fragment. This resulted in a fracture of the graft. This type of treatment was completely abandoned. Finally the following technique was followed.

The two ends of the fragments were prepared only on one of their sides in order to preserve their blood supply. The length of the bone graft was accurately measured. The graft was taken from the medial aspect of the tibia. The length of the graft should be at least three times as long as the bone defect. With removal of the graft from its bed four holes are drilled into the graft. After removal of the graft cancellous bone was also removed. The graft was fixed into the recipient area by screws that were exactly measured. The periosteum on the donor site was united with catgut.

The tibial graft offers the advantage of being very solid. However at the same time it has the disadvantage that due to its density it has the disadvantage that its revascularization is very slow. The iliac graft offers considerable advantage from this point of view. The technique for the use of iliac grafts is comparatively simple.

A curved incision is made over the iliac crest. The muscular insertions are detached subperiosteally and the graft is removed from the underlying portion of the crest with the use of the electric saw. The iliac bone is readily permeated from all sides by buds of connective tissue. However it is less solid than the tibial graft and it cannot be utilized as long a piece as the tibial graft. Therefore it is necessary very often to use it together with a bone plate, a Kuentscher spike.

Destruction of the upper extremity of the humerus presents a difficult problem. If the bone destruction is limited and the muscles are preserved, one could suspend the humerus by a wire through the coracoid or acromion process as proposed by Leryche and Patel. The author has used this method in 1 case. In another case the loss of the bone substance was



considerable but the deltoid muscle was intact and the missing humeral head was replaced by the upper extremity of the fibula. The 2 patients in these cases have preserved good motion of the shoulder but abduction is considerably limited. In cases in which the destruction of bone is associated with destruction of the surrounding muscles, fusion of the shoulder is necessary. In 3 cases iliac grafts were employed with excellent result. The humerus was maintained in position with the Kuentzner spike which was inserted into the scapula. In cases in which the distal extremity of the radius is lost it is advisable to use a tibial graft which is attached to the diaphysis of the radius and impacted into the first row of the carpal bones.

In conclusion the author offered the following suggestions: (1) do not operate unless the skin is loose and well vascularized, (2) use grafts favorable for bony union (the cancellous bone of the iliac crest is one of the best sources), (3) always respect the vascular supply of the bony fragments, and (4) assure a firm fixation of the fragments and of the bone graft and do not rely on the immobilization of a cast.

GEORGE I. RIZZO, M.D.

Étienne, E., Lapeyrie, M., and Campo A.: The Route of Internal Access to the Hip Joint (La voie d'accès interne de l'articulation de la hanche). *J. chir. Par.* 1946, 63: 115.

With regard to the route of internal access to the hip joint, the authors state that if the thigh is in a position of flexion, abduction, and external rotation, the distance from the medial aspect to the head of the femur is reduced to almost half as compared with the normal position; the average distance from the skin to the head of the femur being only 4 to 5

cm. Furthermore, the joint is easily accessible through the gap of the adductor muscles, and better exposure of the round ligament can be obtained than in any other position.

The technique of operation is as follows: a longitudinal skin incision of 7 to 10 cm. is made on the medial aspect of the thigh, two fingers breadth distally from a line drawn between the pubic spine to the ischial spine. The joint is approached between the internal rectus and the great adductor then between this muscle and the small adductor. The posterior branch of the obturator nerve is exposed. The capsule of the joint is incised in the longitudinal axis. In order to expose the round ligament, the thigh is rotated internally.

The advantages of this method are that the operation is not mutilating; all muscles, important vessels, and nerves are spared; a short incision is sufficient; the shock of operation is reduced to a minimum; the joint is approached from the inferior and medial aspect, in which region the capsule is less important functionally; and the round ligament is easily accessible.

This method of procedure is indicated for open reduction of a congenital luxation, drainage of the joint, and resection. The authors believe that approach to the joint from the medial aspect of the head of the femur is preferable to other methods in all cases except those in which extreme abduction cannot be accomplished because of an old ankylosis.

WERNER M. SOLMANN, M.D.

## FRACTURES AND DISLOCATIONS

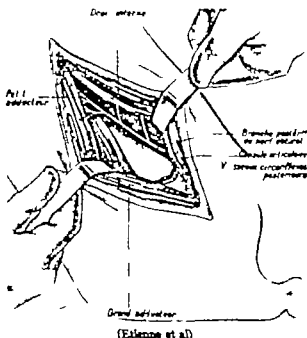
Caffey J.: Multiple Fractures in the Long Bones of Infants Suffering from Chronic Subdural Hematoma. *Am. J. Roent.* 1946, 56: 165.

The author presents a report of 6 cases of chronic subdural hematoma and associated multiple fractures of the long bones in infants. None of the infants were believed to have suffered any injury to the long bones, and there were no roentgen or clinical evidences of general or local disease which would account for a predisposition of the bones to pathological fracture. The majority of fractures of this type develop after the onset of the subdural hematoma. In the cases described the fractures appeared to be of traumatic origin but the traumatic episode and causal mechanisms remain obscure. Routine examination of the long bones in patients with subdural hematoma is necessary for the identification of fractures, since many of them are silent clinically and the presence of unexplained fractures in the long bones warrants investigation for subdural hematoma.

EMIL C. ROSENTHAL, M.D.

Salaverry, M.: Articular and Nerve Complications following Epitrochlear Fracture (Complicaciones articulares y nerviosas de las fracturas de la epitroclea). *Chir. y apar. locomotor* 1946, 3: 96.

Although epitrochlear fractures in themselves are relatively simple, the complications which may oc-



cur are extremely grave as far as the rehabilitation of the arm is concerned. This is due to the structural relationship of the epitrochlea to the ulnar nerve, the articular capsule, and the humeroulnar articulation.

A displaced epitrochlear fracture fragment with rupture of the internal ligament may result in fibrosis of the capsule, limitation of extension, disproportion of the internal humeroulnar articulation, separation of the superficial articulation, and formation of a valgus. In addition to these mechanical disturbances, the ulnar nerve may become involved because of the distention, traction, inflexion and pull on the fragment or secondarily by its incorporation in the fibrous cicatrization of bony callus.

In the treatment one must consider the dislocation, the possible valgus deformity, interference of superficial radiocondylar articulation, and the formation of a permanent lateral displacement. If surgical intervention is contemplated one of two procedures is offered: (1) the surgical extirpation of the fragment, or (2) its fixation to the humerus with catgut.

Salaverry describes his personal experiences in the management of these fractures: he employed traction after effective manual reduction and followed each case closely with the aid of roentgenography and by being alert to the patient's announced symptomatology. When nerve injuries existed liberation of the nerve was accomplished surgically by resection of the fibrous cicatrization or bony callus, or by transplantation of the nerve if indicated.

Eleven case histories with 20 roentgenographs are presented and the treatment in each case is indicated.

STEPHEN A. ZIEGLER, M.D.

Bannerman M. M.: Fractures of the Carpal Scaphoid Bone; An Analysis of 66 Cases. *Arch. Surg.*, 1946 55 164.

A series of 66 cases of fracture of the carpal scaphoid is reported covering a period of 2 years at two large Army General Hospitals. This series constitutes 5 per cent of all the fractures seen during this time. Forty two per cent of the fractures of the scaphoid bone were not diagnosed at the time of injury. In 35 per cent of this series the fractures were diagnosed as sprains and were not examined roentgenologically or the roentgenograms were reported negative for fracture and the diagnosis missed. In instances in which pain and swelling of the wrist persisted and especially those with the pain and tenderness in the region of the anatomic snuff box, careful re-evaluation and re-examination of the wrist are indicated. Multiple roentgenograms of the wrist at the time of injury may be helpful in making diagnosis.

In 85 per cent, or 56 of a series of 66 cases the fracture of the carpal scaphoid seen within 12 months after injury healed by prolonged immobilization in a skin tight cast including the thumb. All fractures less than 6 months old healed by this method.

Operative intervention was not instituted until after at least 2 months of immobilization without improvement. Operative treatment was performed in 10 cases. Six fractures healed with good results. In 2 cases of fracture showing pronounced arthritic changes, the distal fragment was removed with good results in 1 case. The type of surgery used in these cases is not described.

C. FRED GORING, M.D.

Daumerle, L., and De Koerle, E.: Fractures of the Neck of the Femur (*Les fractures du col du fémur*). *Bruzelles méd.* 1946 36 649.

On the basis of the work done by Pauwels, the authors develop a theory of the mechanical forces involved in the healing of fractures of the neck of the femur and deduce the principles and technique of treatment.

In contradistinction to all other fractures of the body, only endosteal callus is formed in fractures of the femoral neck, but no periosteal callus formation occurs.

The formation of the endosteal callus is a slow process, particularly sensitive to the mechanical forces acting upon it. Bone formation is stimulated by pressure, whereas traction causes degeneration into connective or cartilaginous tissue formation, resulting in pseudarthrosis or nearthrosis. As no periosteal callus is formed, and as the neck forms an angle with the axis of the diaphysis, the beneficial action of pressure cannot take place when the patient gets out of bed and weight bearing is started. On the contrary the proximal fragment acts like the arm of a lever pulling the fragments apart and preventing consolidation. The more obtuse this angle of inclination, the more serious is the prognosis. The authors distinguish 3 categories of fracture, according to the greater or lesser obtuseness of this angle.

To avoid the danger of pseudarthrosis and the additional danger of hypostatic pneumonia and circulatory disturbances in elderly patients, the treatment of choice is internal fixation. The authors discuss the different techniques of this procedure in detail and advocate pegging with the Smith Petersen nail. To accomplish correct direction of the nail, the apparatus of Merle d'Aubigny is used. Since an incision of 3 cm. only is necessary, the shock of operation is negligible even in old patients. This method assures perfect consolidation whatever the angle of inclination may be and avoids the danger of circulatory disturbances.

In 26 of a series of 28 cases the authors had complete success with this method.

WERNER M. SOLOVITZ, M.D.

Incian, A. C.: Late Complications of the Fractures of the Neck of the Femur Treated Surgically (*Complicaciones tardías de las fracturas del cuello del fémur tratadas quirúrgicamente*). *Cir. ortop. traumatol. Habana*, 1945, 12 143.

Incian discussed the late complications of the surgically treated fractures of the neck of the femur.

The causes for such complications are listed as follows: bad reduction of the fracture, deficient maintenance after reduction, improper fixation of the fragments of the bones, improper placing of the osteosynthesis, infection and circulatory damage that lead to the absorption of the head of the femur, retardation of the consolidation, pseudarthrosis, and necrotic changes in the neck of the femur.

The appropriate selection of the better type of treatment is considered indispensable to avoid such complications and this selection must be individual in each case.

The bone graft with internal fixation by the Smith Petersen technique gave the best results in the fractures of the head of the femur and of the transcervical fracture of the femur with reabsorption of the neck.

WILLIAM E. RICKETS, M.D.

Olausson, T.: Intra Articular Fractures in the Upper End of the Tibia and Lower End of the Femur. *Acta chir. scand.* 1946 94: 407

Fifty-one intra-articular fractures of the upper end of the tibia and 8 of the lower end of the femur are reported by the author. Nineteen of the fractures were located in the lateral tibial condyle; in 7 cases the medial condyle of the tibia was split. In 13 the fracture was bicondylar; in 6 small marginal fractures of the tibial condyles were found; and in another 6 there was an isolated fracture of the intercondylar eminence.

Of the 19 fractures in the lateral tibial condyle, 14 were comminuted depressed fractures, 2 were non comminuted depressed fractures, and 3 were splitting fractures.

Operative treatment was employed only in the last mentioned group. In most of the cases the fractures were treated by manipulations resulting in im-

perfect reduction. The entire material was treated during the period from 1931 to 1941.

A check-up of 51 patients in 1942 showed the results to be satisfactory in 38 and poor in 13. The poor results were attributable chiefly to the instability of the knee with abnormal lateral mobility, while deforming arthrosis played only a minor role.

The author concludes from his investigation that more frequent employment of operative procedure may be followed by better results.

JOSEPH K. NARBY, M.D.

## ORTHOPEDICS IN GENERAL

Hudack, S. S.: A Study in Articular Replacement. *J. N. Surg.* 1946 124: 377

An experiment was carried out in which chrome steel alloy was used to replace the humeral head in the dog. The donor element was seated into the medullary canal in the dog's shoulder. A series of 6 dogs was used. In general, full use was attained at the end of 3 months. On passive examination there was limitation of motion. Three of the animals survived the operation well over 6 months. A 5 year survival is reported. The postoperative course is explained in detail. The postmortem examination is reported in detail with a series of roentgenograms and photomicrographs. Three types of adaptive tissues surrounding the donor element are described. The tissue surrounding the nonweight-bearing part of the flanged nail is described as dense stratified connective tissue lying on flattened bone trabeculae. In the areas where there is weight bearing with compression stress, the tissue is more fibrocartilaginous. The areas where there is more stress show a combination of the fibrous and fibrocartilaginous elements.

RICHARD J. BICKETT, JR., M.D.

# SURGERY OF THE BLOOD AND LYMPH SYSTEMS

## BLOOD VESSELS

Homans, J.: The Late Results of Femoral Thrombophlebitis and Their Treatment. *N England J M.*, 1946, 255-249.

The author presents the end results of thrombosis in the veins of the lower extremities and indicates that an obstructive inflammatory thrombosis is the late stage toward which all thrombotic processes tend. It is probable that this is by far the most frequent result of all the venous thromboses in the lower limbs. However many cases do undergo spontaneous cure. In some instances thrombi retain their soft character and when this occurs it is likely to cause pulmonary embolism.

In analyzing the 156 cases which formed the basis of the author's report, the late results of femorolliac thrombophlebitis are presented in 5 groups, viz.

Group 1. In this group some degree of edema remains, so that the ankle and lower leg swell during the hours of work or standing discomfort is unimportant congestion is not a feature the skin is healthy and the edema recedes or disappears over night.

Group 2. Here postphlebitic pigmentation and induration are present and ulceration in a variety of forms often occurs.

Sixty-one per cent of the author's cases fell into groups 1 and 2. The physical changes are considered by some to be due to sensitization of the tissues to foreign proteins absorbed from the feet, toes and nailbeds, the retained antigen causing vascular wall damage, and leading to extravasation of blood pigmentation and ultimately slow fat necrosis and scarring. Varicosity of the saphenous system, secondary to the original thrombophlebitis, contributes to the local disorder.

Group 3. In this group a pain complex becomes established early in the convalescence. Irrespective of all other signs this is often associated with vasomotor changes in the skin of the affected leg and a stockinglike paresthesia. Seventeen per cent of the cases were in this group.

Group 4. The leg is the seat of marked congestion.

Group 5. In this group recurrent thromboses occur in the deep and often in the superficial veins. The attacks, because they usually involve veins previously thrombosed and re-canalized are less severe than the original thrombophlebitis.

The recommended treatment is as follows:

Groups 1 and 2. Rest in bed with the legs slightly elevated the use of elastic stockings or a semi-elastic bandage from toes to knees when the patient is up and about treatment of the skin to do away with sources of absorbable protein substances derived chiefly from fungi saphenous vein section when this system is varicose radical excision and skin grafting should be used only occasionally.

Group 3. Almost invariably the condition is relieved by sympathetic lumbar block followed by reinfusing blocks or even sympathectomy in some cases.

Group 4. Since no valveless veins draining the lower limbs (except the iliac veins and the vena cava) are capable of forwarding blood against gravity and since the column of blood they contain transmits high back pressures on lifting straining and coughing their interruption must always benefit and can never harm the venous return. The recanalized thrombosed femoral vein may also be a source of the congestion seen in this group. The author recommends a study of the femoral and saphenous systems and if necessary an exploration by incision in the groin. If diseased the saphenous vein should be divided, as well as the common femoral vein if the vein below the entrance of the deep femoral vein is diseased.

Group 5. The best treatment for these cases of recurrent femoral thrombosis is ligation of the corresponding iliac vein. This high division secures the best collateral venous circulation and gives the greatest help in the prevention of future thrombosis and embolism.

EDWARD H. CAMP, M.D.

Fontaine, R., and Forster E.: Two Additional Cases of Gangrene of the Limbs of Venous Origin (Deux nouvelles observations de gangrène des membres d'origine veineuse). *Lyon chir.*, 1946, 47-173.

The two exemplars of this peculiar form of anoxemia leading to gangrene do not add anything to our knowledge of the subject nevertheless, the authors' cases are worthy of report because of the rareness of the condition and because of the emphasis to be inferred with regard to the necessity of a timely diagnosis.

The first case was that of a 40 year old male (apparently in normal health except for a somewhat shortened bleeding and coagulation time) who was subjected to an extensive hemorrhoidectomy. At the time of operation the hemorrhoids were discovered to be extensively thrombosed. The clots were removed by curettage. A couple of days later the right calf and the entire left leg became swollen and indurated. Later the process on the right side spread to the entire leg thigh and lower abdomen on that side and a few days after this the right foot developed evidences of gangrene. Eventually the left foot also developed patches of gangrene the process however remained limited to the toes more or less, with a small patch on the dorsum of the foot. All the toes on this foot were eventually lost except the fourth toe and the basal phalanx of the third toe. On the right foot, all of the skin, including that of the lower third of the leg, sloughed away, leaving the bare granulating derma. The toes on this foot, however, largely recovered without sloughing as did

the heel and the region of the achilles tendon behind. Skin grafts were applied to the bare areas and the patient was later able to walk without pain or other inconvenience. He resumed his former avocation (cabinet maker) and worked in the garden while at home. Excellent photographs depict the progress of the case and the final results obtained.

Arteriography was unsuccessful in this patient and amputation was decided against on the evidence of the enormous extent of the original edema, which suggested a venous rather than an arterial block, and persistence of the arterial pulsations in both extremities throughout the entire time.

The second case was that of an 8 year old boy who suffered a heavy fall on the left arm. The diagnosis, without roentgenological examination was fracture of the left elbow. A splint was applied but was later removed because of the development of edema. The entire forearm became cold and blue and eventually gangrenous. At amputation the humeral artery was exposed initially and arteriography was attempted. This again was unsuccessful however the entire packet of vessels were extirpated en bloc from the amputated specimen. The artery of the arm was firmly contracted but intact, as were its branches. All of the veins on the contrary were blocked by recent thrombotic processes. The authors believe that a concomitant arterial spasm may favor the development of the gangrene but is not indispensable to its development.

JOHN W. BREDMAN, M.D.

Gross, R. E. Surgical Treatment for Dysphagia Lusoria. *Ann. Surg.* 1946 24 531.

Dysphagia lusoria has long been recognized as impairment of swallowing which occurs when a right subclavian artery arises abnormally from the left side of the aortic arch and then passes behind or in

front of the esophagus, and thereby compresses the esophageal tube. The condition was recognized as early as 1794 by Bayford. An anomalous subclavian artery can exist without making itself manifest. In occasional patients the disturbance in swallowing may be severe enough to interfere seriously with health and nutrition. Dysphagia is most likely to appear or to be aggravated (1) when the artery is taut and stretches across the esophagus like a bowstring (2) when the vessel becomes sclerotic and less elastic in the later years of life or (3) when there is aneurysmal dilatation of the artery. Copeland has discussed the detection of the anomaly by roentgenological studies.

The author reports the case of a four months old baby who was referred to the hospital because of difficulty in feeding. The symptoms had been progressive to the point where it was becoming difficult to feed the child because of regurgitation of undigested milk. Changes in the formula were without apparent benefit. Small amounts of cereal would be taken, but the child would refuse milk for several hours thereafter.

The child had gained in weight in spite of the feeding problem, but it was apparent that the increase was due to frequent small feedings rather than a normal schedule of feeding. The diagnosis was made by roentgenological examination after the ingestion of a thin barium mixture. The lateral projection revealed an indentation of the posterior wall of the esophagus at the level of the third thoracic vertebra. When viewed anteroposteriorly this filling lay in the oblique direction and suggested that there was an elongated narrow structure which ran upward and to the right between the vertebral column and the esophagus.

An operation was performed under cyclopropane anesthesia. An anterolateral approach was made through the left side of the chest, and the pleural cavity was entered through the third interspace. The third and second costal cartilages were divided, giving excellent exposure of the mediastinum. The aortic arch lay in normal position. The thymus was partially dissected and exposure was gained toward the patient's right so that the entire arch and its various branches could be adequately viewed. The right subclavian artery arose in an anomalous fashion from the posterior aspect of the left side of the aortic arch and then coursed upward and to the right, behind the esophagus. The right subclavian artery was liberated through its bed and then doubly ligated and divided near the aortic arch. The distal portion of the artery was permitted to retract to the patient's right and beyond the esophagus. Following operation, the child was given limited fluids for the first 36 hours, after which it was given a normal diet, with complete freedom from symptoms.

In summary the author points out that dysphagia lusoria can be treated by surgical means. He also stresses the fact that the intrathoracic heart of the subclavian artery can be divided with impunity because the second and third portions of the vessel



Fig. 1

Fig. 2

Fig. (Gross) Drawing of anatomic arrangement found at operation. The anomalous right subclavian artery compresses the posterior wall of the esophagus. L.C.C.A., left common carotid artery L.S.A., left subclavian artery R.C.C.A., right common carotid artery R.S.A., right subclavian artery

Fig. 2 Surgical procedure. Esophageal compression has been relieved by dividing the right subclavian artery (Courtesy of J. B. Lippincott Co.)

have collateral channels which are sufficient to maintain a satisfactory flow of blood to the right arm.

PAUL MERRELL, M.D.

### BLOOD; TRANSFUSION

Aggeler, P. M., Howard J., and Lucia, S. P.: Platelet Counts and Platelet Function. *Blood J. Hemat.*, 1946 1: 472.

The purpose of this study was to determine the significance of reductions in the platelet count in terms of well established normal standards and to define the relationships which exist between the platelet count and the results of tests of the bleeding time, coagulation time, clot retraction and capillary fragility.

Observations of the bleeding time, coagulation time, capillary fragility, clot retraction and platelet count were made on each of 64 normal subjects and on 404 patients suffering from various diseases. Although the authors emphasize the point that the normal values for platelet counts must be ascertained in each laboratory by the person doing these counts, they found the normal value by the Roes and Ecker method to be mean 409,000 per cu. mm. with a normal range of from 273,000 to 545,000 per cu. mm. A significant relationship between the platelet count and the results of tests of bleeding time, clot retraction and capillary fragility was found but none could be established between the platelet count and the coagulation time. The authors discuss factors other than platelet count or platelet function which may influence the results.

The critical level of the platelet count below which abnormal bleeding is likely to occur was found to be 190,000 per cu. mm. In primary thrombocytopenic purpura, and 230,000 per cu. mm. in secondary thrombocytopenic purpura but this critical level is not an infallible one as exceptions in either direction were found.

In all cases of primary thrombocytopenic purpura and in most of those of secondary thrombocytopenic purpura, the bleeding time was markedly prolonged and the clot retraction definitely diminished. Similarly the tests were abnormal in about half of the patients with thrombocytopenic purpura without bleeding or with thrombocytopenic purpura associated with other hemorrhagic states. The capillary fragility was increased in about three-fourths of the patients with thrombocytopenic purpura, in one-half of those with secondary thrombocytopenic purpura and in less than one half of those with thrombocytopenic purpura without bleeding or thrombocytopenic purpura complicating other hemorrhagic states.

In the stage of recovery from thrombocytopenic purpura, dissociation of the tests was sometimes found and was of aid in predicting a remission of the disease. When the results of the tests returned to normal while the platelet count still remained below the normal range it was interpreted as evidence of the variability in the functional capacity of the platelets.

EDWARD H. CAMP, M.D.

Flink, E. B.: Blood Transfusion Studies. The Differentiation of Hemolytic and Nonhemolytic Transfusion Reactions. *J. Lab. Clin. M.* 1946 31: 1067.

It is emphasized that the plasma must be examined for hemoglobinemia after every transfusion reaction. Despite this accepted knowledge, the author states that in many reports transfusion reactions are being classified on the basis of the degree of fever and the severity of the clinical manifestations.

The reported incidence of all kinds of reactions varies between 3 and 5 per cent. Of these, the ratio of hemolytic reactions is quite low. In a series of 43,284 transfusions collected from the literature by Kilduffe and DeBakey the incidence of hemolytic reactions was 1.8 per cent for 1,000 transfusions, and the mortality 1.4 per cent.

Most investigators are agreed that unless the blood is more than 9 days old the age of the blood does not influence the incidence of febrile reactions. However, stored blood older than this tends to produce reactions.

Hemolytic reactions are most frequently caused by group incompatibility or are attributed to the occurrence of isoenzymes such as anti Rh agglutinins and occasionally to overheated blood. There have been many reports of the safe use of blood from universal donors.

Transfusion reactions generally fall into the following groups: (1) simple febrile reactions due to pyrogenic substances, (2) allergic reactions, and (3) circulatory reactions accompanied by intravascular hemolysis. It is pointed out that in most cases the hemolytic type of reaction cannot be detected by clinical signs alone.

The author has carried out a study to ascertain the significance of hemoglobinemia in reactions to transfusion. First a study of 58 transfusions given to patients with diseases associated with anemia was made by a careful technique to determine the plasma hemoglobin level. No significant hemolysis was noted. Nineteen febrile reactions to transfusions were studied and were proved to be nonhemolytic. Five cases of hemolytic reaction to transfusion were studied during the years 1942 and 1944 and the author believes that the finding of hemolytic reactions and early transient hemoglobinemia without hemoglobinuria in 3 patients substantiates the contention that hemoglobinemia is a fundamental and pathognomonic feature of intravascular hemolysis. One patient developed anuria and died as a result of uremia. This patient had had the highest plasma hemoglobin level observed in any of the 5 patients with hemolytic reactions which observation lends support to the thesis that the plasma hemoglobin level is an important factor in the development of renal damage.

In closing it is stressed that in the presence of any reaction the type whether hemolytic or non hemolytic, should be determined and a search made for the exact cause so that it may be eliminated.

LEROY J. KLEINBAUMER, M.D.

## RETICULOENDOTHELIAL SYSTEM

Irnler, A. E.: Reticuloendotheliosis: With Report of 2 Cases. *Am. J. Roentg.* 1946 56 343

Single or multiple granulomatous lesions of bone with or without soft tissue involvement, diabetes insipidus or exophthalmos, have been variously classified as certain forms of xanthomatosis, Hand-Schüller-Christian's disease, Letterer-Siwe's disease, lipoid histiocytosis, lipoidosis, lipoid granulomatosis, eosinophilic granuloma, solitary granuloma, and reticuloendotheliosis.

Following a review of the literature and the presentation of 2 cases from the Letterman General Hospital, San Francisco, California, the author finds that the separation of Hand-Schüller-Christian's disease, eosinophilic granuloma or solitary granuloma of bone and Letterer-Siwe's disease into specific disease entities is not valid on the basis of the evidence at hand.

There are insufficient data to support the claim of a lipid metabolic disorder as the primary causative factor. There are no pathological or roentgenological findings that warrant classifying these syndromes as individual diseases. It is believed that all these processes are variants of a hyperplastic reaction of the reticuloendothelial system and can be properly grouped under the term reticuloendotheliosis. Eosinophilic granuloma or solitary granuloma of bone represents a localized or focal hyperplasia of the reticuloendothelial system.

The stage of the disease process in the hypophysis and tuber cinereum will determine the response of the diabetes insipidus to roentgen therapy. Little or no improvement will occur if the infiltration is in the stage of fibrosis.

The pulmonary pathology is comparable to that found in the bones which in its early stages, is a granulomatous process and in the healing phase is almost entirely fibrosis. Pulmonary involvement in the early phase responds to deep roentgen therapy but lesions that have gone on to fibrosis show very little change.

Satisfactory response of the bone, pituitary and pulmonary lesions can be obtained with relatively

small doses of roentgen irradiation. In the 2 cases reported, 600 roentgens, measured in air, to any one field was exceeded on only one occasion. None of the skull lesions received more than 400 roentgens, measured in air, through any one field.

BENJAMIN GOLDMAN, M.D.

## LYMPH GLANDS AND LYMPHATIC VESSELS

Gonçalves, A. P.: Association of Brazilian Blastomycosis and Tuberculosis in Glandular Lesions (Associação de blastomicose brasileira e tuberculose em lesões ganglionares). *Rev. Brasil. med.* 1946, 3 325.

The author reports 2 cases of suppurative lymphadenitis, in which Brazilian blastomycosis was associated with tuberculosis.

In the first patient a mucous blastomycosis lesion of the right tonsil was associated with a suppurative axillary and cervical adenopathy with fistula formation, which was thought to be of the same origin. The second patient presented (in addition to Brazilian blastomycosis of the mucosa of the oral cavity and the cervical lymph nodes) an extensive pulmonary tuberculosis.

The correct diagnosis was established by means of inoculations in guinea pigs with pus obtained from the cervical nodes.

In the first patient the tonsillar lesion healed under the influence of sulfamerazine for a while considerable improvement of the lymphadenopathy was observed but later on it became stationary. The second patient succumbed to his condition.

Reference to the literature shows that the simultaneous occurrence of Brazilian blastomycosis and tuberculosis has been reported as such in only one patient.

Failure of the sulfonamides to produce a cure of Brazilian blastomycosis justifies a suspicion of concomitant tuberculosis, and suggests inoculation of guinea pigs.

The author gained the impression that tuberculosis inhibits to some extent the spread of *Paracoccidioides brasiliensis* infection.

JOSEPH K. NARAY, M.D.

## SURGICAL TECHNIQUE

### OPERATIVE SURGERY AND TECHNIQUE; POSTOPERATIVE TREATMENT

Webster, G. V. and Rowland, W. D.: *Skin Grafting the Burned Dorsum of the Hand.* *Ann Surg* 1946 124 449.

When the dorsum of the hand is burned the elastic fibers which are situated very near the thin skin are easily damaged. This results in local fibrosis with stiffening and a seriously crippled hand.

The authors state that the type of surgery used in the care of this problem is dependent upon the type of burn. They divide the usual 3 "degrees" of burns into 8 groups: the first degree having 2 groups, and each of the other 2 degrees having 3 groups. As to the early care of the burned hand they believe that early grafting of this open wound is the ideal procedure when there is a full thickness loss. It prevents added loss of body fluids; it minimizes the amount of infection; it renders sterile an open wound at the earliest possible time and it prevents to a large degree the resulting crippling fibrosis which occurs when the wound is not covered. The treatment, therefore, is directed toward closing the wound at the earliest possible moment. This includes cleanliness, compression and rest, although it is believed that splinting is contraindicated after a few days. The authors rather feel that daily baths in normal saline solution with finger exercises is the procedure of choice. General care includes nutrition, correction of the loss of protein, oftentimes by means of extra feedings, plasma, blood glucose, amino acids and high vitamin intake. Sulfadiazine and penicillin are worthwhile adjuncts.

Oftentimes local conditions make a permanent repair ill advised and in these cases the authors believe that temporary skin grafting is of utmost value. In these cases they also object to small deep grafts and advise split thickness grafts. The disadvantages of making a permanent repair too early are that the marginal scar becomes hypertrophic, contracture of the scar tissue bed causes wrinkling of the graft and webbing occurs between the fingers which requires secondary operations to obtain a satisfactory result. Late skin grafting has the advantages of being an elective operation; complications can be reduced to a minimum, there is little or no chance of residual bacterial action in the operative field and all scars can be removed down to the normal underlying tissues.

Late grafting of the burned dorsum of the hand closely follows the technique of other operations on the hand. Preparation the night before is directed toward cleaning and trimming the fingernails and scrubbing and soaking the hand. After this, the area is shaved. Repair is made with a tourniquet. A dermatome graft is secured. The scar tissue is removed and the graft is applied. When the burn has been deep enough to destroy bones and tendons, a

thick split graft is not adequate and a pedicled flap must be used. A one stage flap usually can be taken down in from 18 to 21 days; tendons can be grafted beneath this and if necessary bone work can be done. These flaps should not be used distal to the metacarpophalangeal joints as they result in an unsightly and unwieldy finger. In certain cases capsulotomy is necessary.

The authors mention certain unsolved problems one of which is the distorted and destroyed finger nails. Their removal does not alter the shape while excision of the nail bed becomes painful whether it is covered with a graft or allowed to heal by scar. The second problem is the loss of an extensor tendon on the dorsum of the finger. Covering these fingers with a pedicled flap and then grafting tendons beneath the flap gives poor end results. The problem of circulation after burn is a blue and cold hand but the therapeutic possibilities of sympathectomy have not as yet been fully investigated. The fourth problem is one of matching color and this also has not as yet been satisfactorily solved. LOUIS T. BYARS, M.D.

Hecht, H. H.: *Reactions to Intravenously Administered Amino Acids (Casein Hydrolysates)* *Am J Med Sci*, 1946 213 55.

Hecht administered 550 infusions of 1.5 to 7 per cent amino acid (casein hydrolysate) solutions in 5 per cent dextrose in saline, 5 per cent dextrose in water or in normal saline, to 303 patients, in order to study the reactions. Pyogenic activity had been excluded by testing the solutions on rabbits. The patients were chosen at random from the various services of the hospital except that only patients who had been free of fever for a period of at least 5 days were used. The total amount administered in one infusion (most subjects were given 2 infusions) was 500 c.c. and the speed of administration averaged 500 c.c. in one hour. In some cases serial determinations of blood amino acid levels were carried out before, during and after the infusions.

Reactions of some kind were observed in 7 per cent of the subjects and in 4 per cent of the infusions. There were no alarming reactions, nor any which resulted in long-lasting damage.

Fever and chills were present in 8 patients and were believed to be due to accidental contamination of the infusion set. This incidence appears to be no higher than that in comparable series of plasma or blood transfusions. Nausea, hot flushes, dizziness and vomiting occurred in 8 cases. The author suggests that these reactions may be due to fast infusion resulting in a rapid rise of blood amino acid levels, and there is reason to believe that some individual component of the amino acid mixture rather than the total amino acid level is responsible for such a reaction. Contrary to opinions of previous students of the subject liver damage seems not to favor the



occurrence of amino acid infusion reactions. The author makes certain recommendations which he believes may be helpful in reducing the incidence of unfavorable amino acid reactions (1) as amino acid dextrose mixtures are an excellent medium for bacterial growth they should be made up with the greatest of care by the physician himself and their preparation should not be left to the nursing staff (2) the mixture should be administered immediately after being made up (3) the rate of in flow should not exceed 15 c.c. of hydrolysate (=100 c.c. paremine<sup>7</sup>) per hour (4) as prolonged parenteral feeding of amino acids will result in vein damage one should start with a vein on the dorsum manus and gradually move proximally with subsequent infusions.

HEINRICH LAMM, M.D.

Altmeppen W. A.: Acute Secondary Parotitis. *Surgery* 1946 30 19

During a period of 9 years, the author saw 49 patients with acute secondary parotitis. The average age of these patients was 47.5 years. The infection was of sudden onset during the course of a primary disease. The lesion was unilateral in the majority of cases and was accompanied by a sharp elevation of body temperature, pulse rate and white blood count. Purulent material obtained from the parotid abscess was monobacterial in 23 cases and polybacterial in 14 cases.

The plan of treatment consisted of the administration of from 120 to 250 minims of Lugol's solution per day. With improvement, the daily dose was decreased. When oral medication was not possible, Lugol's solution was given by hypodermoclysis along with physiological saline. The average dose of Lugol's solution was 823.4 minims administered over a period of 7 days. In every case an abscess, when present, was drained either before or during treatment. In 2 cases penicillin was used in conjunction with Lugol's solution and in 3 cases penicillin alone was used. In 43 cases treated with Lugol's solution resolution occurred in 19 and partial resolution with abscess in 5. In 6 cases, parotitis was in a state of resolution but the patient died of the primary disease. Signs of resolution only became manifest after a lag period of 36 to 48 hours and then the temperature and pulse rate began to decline and local clinical signs began to show improvement.

The use of penicillin alone for the treatment of secondary parotitis was also very encouraging. Although the mortality rate was 30.6 per cent it was noted that at the time of death the parotitis was in a state of resolution in all but 1 case.

The beneficial action of Lugol's solution is due to the bacteriostatic potency of iodine and its stimulation of the secretion of the salivary glands, thus inhibiting suppression of the parotid gland. Penicillin is an effective chemotherapeutic agent since this type of infection is pyogenic. In one case penicillin cleared up the parotitis where Lugol's solution had failed. The best results were obtained in early cases while the parotitis was in the diffuse inflammatory

state, before the onset of necrosis or abscess formation.

BERNARD G. P. SHAW, M.D.

#### ANTISEPTIC SURGERY TREATMENT OF WOUNDS AND INFECTIONS

Levenson, S. M., Adams, M. A., Green, R. W., Land, C. C., and Taylor, F. H. L.: Plasma Alpha Amino Nitrogen Levels in Patients with Thermal Burns. *N. England J. M.* 1946 335 467

The authors report on a study of the plasma amino nitrogen levels in 12 severely burned patients. In 8 of the 12 cases there was a significant elevation of the plasma amino nitrogen level but in none of the 12 cases was there a fall in the plasma level. In 7 of the 8 patients having an elevation of the alpha amino nitrogen level burns involving over 35 per cent of the body surface were present. Clinical shock was present in 7 of these 8 cases, while shock was present in only 1 of the 4 cases showing no elevation of the alpha amino nitrogen level. Of the 8 patients showing the elevation 7 had an elevation of the nonprotein nitrogen, however in all but 1 patient the rise in alpha amino nitrogen preceded the rise in the nonprotein nitrogen. The prothrombin time was prolonged in 4 of the 5 patients with elevated alpha amino nitrogen levels on whom determinations were made. On the other hand, there was no prolongation of the prothrombin time in the 3 patients having no elevation of the alpha amino nitrogen on whom the determinations were made.

The authors conclude that there is a close correlation between the elevation of the plasma alpha amino nitrogen concentration, the extent of the burn, the degree of the shock, and the prolongation of the prothrombin time.

It is probable that the rise in alpha amino nitrogen is the result of 2 factors, the increased rate of nitrogen metabolism and the decrease in liver function.

F. J. LEEHMAN, JR., M.D.

Lockwood, J. S.: Wartime Activities of the National Research Council and the Committee on Medical Research, with Particular Reference to Team Work on Studies of Wounds and Burns. *Ann. Surg.* 1946, 124 3-4

The mobilization of civilian research for meeting the special problems of military medicine and surgery by the Surgeons General of the Army and Navy in 1940 is described herein.

The Committee on Surgery of the National Research Council held its first meeting on June 15, 1940, under the leadership of Everts Graham. Thirteen subcommittees were organized on surgical infections, neurosurgery plastic and maxillofacial surgery thoracic surgery anesthesia, radiology orthopedic surgery burns, ophthalmology otolaryngology physical therapy urology, and vascular injuries. The subcommittees on surgical infections and burns were combined in December 1943 to form the subcommittee on infected wounds and burns, under the chairmanship of Allen O. Whipple.

The main purpose of this article is to review in broad outline the program of research which was conducted under the advice and sponsorship of the subcommittee, and to present an historical account of a unique experiment in co-operative surgical research on a national basis.

The three main functions served by the National Research Council Committees were to provide opportunities for informal exchange of experience between men with similar problems and interests from civilian life and from the armed services; to draft formal recommendations upon request of the armed forces or other governmental agencies; and to sponsor and review proposals for contracts submitted to the Committee on Medical Research.

Some of the subjects of the C. M. R. contracts for research in the surgical field investigated were the prevention and treatment of surgical infections 26 contracts; studies on the pathology, physiology and treatment of burns, 19 contracts; statistical analysis of wound and burn studies 1 contract; orthopedic problems and prosthetic devices 8 contracts; cold injury (including frostbite and trench foot) 6 contracts; anesthesia and pulmonary physiology 2 contracts; peripheral nerve repair 14 contracts; concussion 10 contracts; absorbable hemostatic cellulose 1 contract; collagen sutures, 2 contracts; wound ballistics 2 contracts; plastic surgery 4 contracts; ophthalmology 4 contracts; radiology 3 contracts; vascular surgery 21 contracts; and protein loss in lung surgery 1 contract.

The subcommittee on surgical infections at its initial meeting in June, 1940 began to make plans for a comprehensive study of chemotherapy in the control of infection in wounds. Chemotherapy, in the most recent bulletin on wound management from the office of the Surgeon General, U.S.A., indicates that the final evolution of prophylactic chemotherapy under combat conditions was not dissimilar from that obtained through the civilian study.

**Chemotherapy** No presently available chemotherapeutic agent can sterilize a contaminated or infected war wound. Neither penicillin nor the sulfonamides can prevent the ultimate septic decomposition of dead tissue or contaminated blood clots. Sulfonamides administered systematically are effective in the prevention and control of invasive hemolytic streptococcal infection but are ineffective in the control of staphylococcal or invasive clostridial infections. Penicillin is effective against hemolytic streptococci and staphylococci and in addition prevents the spread of clostridial infection from a focus of affected tissue. The effectiveness and limitations of chemotherapy are established sufficiently to attribute poor results to errors in surgical technique or judgment, rather than to drug failures.

a. The concomitant use of sulfonamides and penicillin is unnecessary. The use of sulfonamides as a supplement to penicillin therapy contributes only the risk of untoward reactions and complications. There is no clinical evidence of synergism with the two agents.

b. The routine local use of chemotherapeutic agents has been abandoned. Penicillin may be instilled into serous cavities or major joints to complement the initial or subsequent surgical management of injuries in these regions. Repeated dressings solely for the purpose of application of antibacterial agents contribute to persistent wound infection and suppuration with aerobic wound pathogens.

c. Systemic chemotherapy is an adjuvant to the surgical management of a contaminated or infected wound. It does not offset the hazard of residual dead space or improper drainage.

During the second year of the operation of the wound study units there was a gradual transfer of emphasis from the problem of prevention of infection in accidental wounds to the problem of treatment of established infections with the same research units and personnel, but with the addition of special units in large civilian hospitals. It had become apparent that the staphylococcus aureus resisted the action of sulfonamides. By January of 1943 penicillin became available in adequate amounts for research in special units. As a result of this successful venture in Army research the basic principles regarding the selection of cases, dosage, indications for combined surgical treatment and the limitations of the drug could be published.

The evolution of burn treatment during the war led to the gradual abandonment of tanning methods and the substitution of a local treatment consisting in the application of a bland padded pressure dressing and the principle of treating the burn like any other large open wound. Early surgical excision and grafting proved feasible if the burn was of limited extent and if ample quantities of blood were transfused into the patient at the time of operation. However, the most promising technique for general use in third-degree burns appeared to be the employment of the padded pressure dressings of pyruvic acid in starch paste. When the burn slough can be entirely removed in 10 or 12 days after the injury by this method, which is usually the case, complete coverage by skin grafts can be accomplished early and the prolonged phase of suppuration and protein loss is avoided. The further destruction of islands of epithelium through infection is prevented and the development of scar tissue and contracture is minimized.

A large amount of work was carried on in many centers on the physiological aspects of burn treatment with regard to the imbalances in fluid, electrolytes, plasma protein, hemoglobin, nitrogen and vitamins which accompany the severe burn.

JOHN H. MORGAN, M.D.

Florey, M. E., Turton, E. C. and Duthie, E. S. Penicillin in Wound Exudates. *Lancet* Lond. 1946 2 405

The routine prophylactic injection of 100,000 units of penicillin intramuscularly in severe battle casualties prompted the investigation of the penicillin content of the wound exudates, blood and

urine after such an injection. After this the effect of the same dose when instilled locally into the wound was determined.

A technical problem was encountered in the process of assaying the penicillin concentration of the wound exudates. It was found that an inhibitory factor other than penicillin was present in some exudates; some wound exudates inhibited the test staphylococcus even when incubated with penicillinase.

Eleven patients with open wounds were given 100,000 units of penicillin intramuscularly. In every case there was an inhibitory concentration of penicillin in the wound exudate up to 8 hours after the injection, and in 50 per cent of the cases inhibitory concentrations were present 24 hours after the injection. The blood penicillin level fell more rapidly; all cases showed detectable penicillin in the blood up to 4 hours, and 50 per cent of the cases showed detectable levels up to 7 hours after the injection. The penicillin level was elevated for the longest time in the urine; all cases showed penicillin in the urine up to 20 hours, and 50 per cent of the cases up to 24 hours. Thus following intramuscular injection, penicillin disappears from the body fluids in the following order: first from the blood, next from the wound exudate and last from the urine.

The local instillation of 100,000 units of penicillin was then carried out on 8 separate wounds, all of which were over 9 days old, and 7 of which were infected with the *Bacillus coli*. The concentration of the penicillin instilled was 25,000 units per cubic centimeter. In every case there was an inhibitory concentration of penicillin in the wound exudate for 48 hours after the instillation, and in 50 per cent of the cases for from 60 to 72 hours. The blood penicillin levels following local instillation were the same as following intramuscular injections. All cases showed detectable blood penicillin for 4 hours and 50 per cent of the cases for 6 hours. Penicillin was detected in the urine in this group for at least 24 hours and in 50 per cent of the cases for 48 hours. Thus following local instillation, as long as penicillin is excreted in the urine inhibitory concentrations are present in the wound exudate.

Thus, penicillinase producing bacteria do not neutralize the effect of the drug in the wound. Furthermore as a single intramuscular injection produces therapeutic levels in the wound exudate for from 8 to 12 hours, it may be quite feasible to treat purely local infection by a reduced number of injections in 24 hours. One or two injections in an aqueous solution may suffice without recourse to such vehicles as beeswax and peanut oil.

It was a striking fact that when local instillation of penicillin was performed inhibitory concentrations of penicillin were present in the blood for as long as after intramuscular injection and in the urine for twice as long. Thus, in view of its much greater local effect, the local implantation of penicillin in a wound will afford surer protection than intramuscular injection.

F. J. LEEHMAN, JR., M.D.

North, E. A., Christie, R., and Rank, B. K.: Penicillin Resistant Staphylococci in Wounds: A Report Based on a Study of 59 Cases of Infected War Wounds. *Med. J. Australia*, 1945, 1:43

In an earlier investigation the authors discovered that 58 per cent of staphylococci cultured from open war wounds were resistant to penicillin. In the present study the biological and serological characteristics of the penicillin-resistant staphylococci were investigated.

A series of tests were performed for hemolysis a and b for coagulase for fibrinolysis, for mouse pathogenicity for mannitol fermentation, and for pigment formation.

Penicillinfast staphylococci were classified into 4 groups: group A, in which only penicillin-sensitive strains were isolated from wounds; group B in which penicillin-sensitive strains followed by penicillin-resistant strains were isolated; group C, in which only penicillin resistant strains were isolated; and group D in which a mixture of both types of strains were cultured. The organisms of groups B, C, and D were obtained from complicated war wounds in which there was delayed healing.

There was no evidence to indicate that retarded wound healing was due to the presence of penicillin-resistant staphylococci. Rather it was claimed that wounds healed only after surgical methods converted them into simple uncomplicated tissue wounds. Healing was independent of antiseptic treatment or bacteriological sterilization. The staphylococci cultured from wounds classified in groups B, C, and D were of types III, VI, and VIII serologically. These were not obtained from group A organisms.

In 17 out of 30 cases, nose and throat swabs revealed the same strains as were previously identified in the wounds. The authors were never able to demonstrate intermediate strains in those cases in which transition occurred from the penicillin-sensitive state to that of the penicillin-resistant state. It may be hypothesized that the penicillin-resistant strains became dominant as a result of the elimination of the sensitive strains during the course of penicillin therapy, or that wounds became contaminated from self-infection or cross infection. The first assumption should be eliminated since initial cultures failed to show evidence of the production of penicillinase. The possibility of self contamination cannot be denied as a result of the authors' findings. The latter has also been corroborated by Miles and others, who showed that 50 per cent of normal adults were carriers of *Staphylococcus aureus* in the nares, and an additional 15 per cent carried this organism on the skin of the wrist.

Until other studies are completed it is suggested that the high incidence of penicillin-resistant staphylococci be accounted for on the basis of stimulation from penicillin therapy as a result of which a transformation or mutation of the penicillin-resistant variety of bacteria developed in wounds.

BENJAMIN G. P. SULLIVANT, M.D.

## ANESTHESIA

Estes, B., and Hinrich H. E.: *Stages and Signs of Pentothal Anesthesia*; *Physiological Basis of Anesthesiology* 1946 7 536.

A discussion is given of the physiological basis for the classification of the stages and clinical signs of pentothal anesthesia, and a correlation is made between the degree of cerebral metabolic inhibition and the various anesthetic stages. The physiological basis is divided into two parts (1) the symptoms and signs allocated to each layer of the normal unanesthetized brain and (2) an examination of the metabolic rates of the various parts of the brain as well as the influence of barbiturates upon the brain metabolism.

It was found that in every instance pentothal anesthesia induced a depression of the cerebral metabolic rate and in a characteristic manner cortical oxidations are depressed earlier and more definitely than those of the rest of the brain. This depression is a progressively descending phenomenon which may finally envelop the entire brain.

Continuous drip pentothal anesthesia and intermittent pentothal anesthesia were used to obtain deepening anesthesia. The eyelid size of the pupils reflexes, and resistance to various types of painful stimulation were observed during the resting state and during the various stages of anesthesia. Cerebral blood flow determinations were made according to the method of Ketty and Schmidt. The cerebral blood flow when multiplied by the cerebral arteriovenous oxygen difference yielded the cerebral metabolic rate. It was found that in most instances the clinical signs of pentothal anesthesia are related to the metabolic inhibition and may be segregated into 4 stages conforming in general to a definite pattern.

The first stage is that of clouded consciousness. The highest phyletic layer the cerebral cortex, is moderately depressed throughout this stage and one stage is that of hypersensitivity which begins with the loss of consciousness. The functions of the cerebral cortex are suppressed and the second layer is the highest one remaining in function although it is under slight depression, particularly with regard to the hypothalamic activities and those of the subcortical motor nuclei.

The third stage is that of surgical anesthesia and is divided into 3 planes—light, moderate, and deep. They are characterized by alterations in responses as well as to changes in the eyeball movements. The first plane of light surgical anesthesia begins with a depression in response to painful stimulation. At this point not only are the cerebral hemispheres suppressed deeper than in the second stage but is still functional. The second plane of moderate surgical anesthesia is characterized by the abolition of muscular response to painful stimulation, but pupillary

dilatation and respiratory changes are still evoked. Here the midbrain, although somewhat depressed still acts as the highest remaining functional level. The third plane of deep surgical anesthesia is characterized by loss of pupillary and respiratory reactions to various stimuli because the lowest pain center becomes increasingly depressed with the other midbrain mechanisms.

The fourth stage is that of impending failure and is characterized by signs of extreme depression of respiration, diminution of pulse pressure and onset of pupillary dilatation due to anoxia. In this stage the pons and medulla are the highest active cerebral regions.

The evolution of the signs of clinical significance is summarized in a chart. The pupil constricts in the second and third planes of the third stage. The pupillary reaction to light disappears in the second plane of the third stage when the Edinger Westphal nucleus is obtunded. The eyeball movement becomes fixed and centrally placed in the second plane of the third stage. The corneal reflex shows great variability but may disappear in the second stage or in the first and second planes of the third stage. A discussion is given of the effect of the drug on respiration throughout the 4 stages.

Thus, it has been shown that the stages of pentothal anesthesia produce signs which represent a descending neuroanatomic allocation with deepening anesthesia. The earliest clinical changes are associated with the lower phyletic areas of the brain. This conclusion drawn from clinical observations receives support from cerebral metabolic studies.

Barbiturates depress brain metabolism but the role played by them is not the entire story. Observations made both on animals and man reveal that some of the clinical signs are out of proportion to the depth of anesthesia. Electroencephalogram studies show that sensory impulses reach the cerebral hemispheres but motor expression is preferentially depressed with barbiturates. The barbiturates have a specific effect in interfering with the activity of the hypothalamus.

The pattern of pentothal anesthesia is the result of a 2 fold mechanism, a descending depression of the cerebral oxidations starting with the cerebral hemispheres and extending to and including the lower parts of the brain and a specific effect on nerve function exerted in certain cerebral areas.

MARY KAMP M.D.

Johnson, K., and Gilbert C. R. A.: *Intravenous Procaine for Obstetrical Anesthesia*. *Current Res Anesth.* 1946, 35 133

Twenty obstetrical patients were given intravenous procaine for analgesia and anesthesia, and the results are recorded in this article. Two types of continuous procaine infusion for relief of various surgical pains are recommended. In the first, the dosage is such that normal consciousness and other functions are undisturbed for indefinite periods. In the second a state of semiconsciousness or uncon-

sciousness is obtained in which all pain is abolished. In this latter stage the only complication encountered was the occurrence or threat of convulsions in a small minority of cases. This was remedied by the intravenous administration of a barbiturate such as sodium luminal or sodium amylal or by the administration of nembutal before the procaine infusion was started.

A 1 per cent solution of procaine diluted in 5 per cent glucose solution was used in all instances. Tests were made for procaine sensitivity by injecting a drop of 2 per cent solution intradermally and waiting 15 minutes for a reaction. Upon a negative result a drop was then instilled in one eye for further verification.

The 30 cases are described as case reports and added to the 12 previously reported, make up a series of 32 cases without a death or serious accident. The amount of procaine administered varied from 0.4 to 0.7 gm. The simplicity of the method makes it available for every physician and makes it feasible in an environment in which caudal and other complicated anesthetic methods are not available. If the hopes concerning both the efficiency and safety of the procaine method are fulfilled by further careful experience it may be an important and practical procedure for the relief of pain in childbirth.

MARY KARP, M.D.

Gordh, T., and Rydin, H.: The Question of Cerium Oxalate as a Prophylactic against Postoperative Vomiting. *Anesthesiology* 1946, 7, 326.

Cerium oxalate has been used in medicine since the middle of the last century as a prophylactic against vomiting from different causes. There are also some reports of very favorable results from the use of cerium oxalate as a prophylactic against postoperative vomiting.

The literature contains at least 70 reports of the good therapeutic effect of cerium oxalate compounds against vomiting in such cases as those mentioned whereas only a few isolated investigations have produced negative results.

In the course of the last few years a comparatively extensive advertising campaign has been carried on in favor of the use of cerium oxalate for different kinds of vomitings.

Various explanations of the supposed anti-emetic effect of cerium oxalate have been reported. When administered by mouth, cerium oxalate is said to affect the mucosa of the stomach and intestine locally similar to an astringent, or after the resorption of small amounts, to reduce the reflex excitability and thus lessen the state of irritability of the mucosa. After resorption from the intestinal mucosa, or on parenteral administration, the effect is explained as the result of a more central action the cerium oxalate being an elective agent for mitigating parasympathetic states of irritation. As shown by the following survey of the literature, however the pharmacodynamic and therapeutic effects are questioned or repudiated in reliable textbooks.

The investigation was carried out in surgical out-patient departments of hospitals in Stockholm, Sweden, both peroral and intramuscular administration of cerium oxalate being tested as a prophylactic against postoperative vomiting. No other medications were administered. The anesthetics were administered by interns and students under the supervision of the resident anesthetist or the surgeon.

In the first series, every other patient who was to be subjected to some operation requiring ethyl chloride anesthesia or ethyl chloride plus ether narcosis received 20 to 30 minutes before operation, 2.5 gm. of cerium oxalate by mouth in the form of 5 tablets which were called "cerolets A." Alternating patients received the same number of control tablets, called cerolets B, consisting merely of indifferent ingredients. Neither the physicians nor the hospital staff was informed that in some cases the tablet contained merely inactive ingredients.

In series 2 which was carried out a few months after the termination of the tablet series, exactly the same procedure was adopted, with the following exceptions. Instead of peroral administration of cerium oxalate and indifferent control tablets, respectively every other patient received intramuscularly 1 ml. of "peremecin A," containing 0.05 g. of cerium oxalate in a colloidal form, and alternate patients received 1 ml. of "peremecin B," containing merely physiological saline solution, with the addition of fluorescein to obtain the same color.

Of the 82 patients who had received cerium oxalate by mouth 29 (33 per cent) showed effects of the narcosis in the form of either vomiting or nausea, or both. Vomiting occurred in 16 per cent of the patients. Of the 83 controls who received sham tablets, 29 per cent had effects, most of them (30 per cent) in the form of vomiting. No difference was observed between the patients who were given cerium oxalate for prophylactic purposes and those who received control tablets with merely indifferent ingredients, either in the number of patients who showed effects of narcosis or in the nature of these effects. No difference in these respects was observed between the 32 patients who were treated with cerium oxalate intramuscularly and the 35 controls who received the same amount of physiologic saline solution. In the first mentioned group, 19 per cent of the patients showed some reaction. In the controls, 14 per cent were affected.

Thus, contrary to the previously cited reports in the literature the authors could not observe any prophylactic effect of the cerium oxalate on vomiting resulting from narcosis before operation.

MARY FRANCES FOX, M.D.

## SURGICAL INSTRUMENTS AND APPARATUS

Jenkins, H. P., Janda, R., and Clarke, J.: Clinical and Experimental Observations on the Use of Gelatin Sponge or Foam. *Surgery* 1946, 60: 41

The development of absorbable hemostatic agents has been an important recent advance in surgical

technique. The use of fibrin foam and oxidized or soluble cellulose has been well presented in several recent reports. A third hemostatic substance is gelatin sponge or foam.

In a previous article the authors reported on the absorbability of gelatin sponge. It was found to undergo absorption within 5 weeks, when implanted in the liver kidneys spleen omentum or abdominal wall. The tissue response was nominal or minimal as compared with the reaction to absorbable suture material. Subsequent to its absorption no residual inflammatory reaction was present.

Thirty dogs were subjected to laparotomy and wounds of various sizes and types were made in the liver kidneys or spleen. The gelatin sponge was moistened in saline and applied with pressure. Hemostasis was effective. The wounds varied in size from deep scalpel incisions to resection of a portion of a lobe of the liver. Within one-half hour the sponge was so adherent that it was often difficult to remove without tearing. These experiments were done for the most part without the addition of thrombin with the addition of thrombin there appeared to be a more rapid hemostatic action.

Control studies were made with the use of soluble cellulose and fibrin foam. The immediate hemostatic action of the three substances appeared to be approximately the same. The animals were sacrificed at varying periods of time no evidence of secondary hemorrhage was present and complete absorption

was found to be present in a number of instances within from 2 to 3 weeks.

The gelatin sponge was used in 60 patients. It was used to control the bleeding from the raw surface left after removal of the gall bladder in liver biopsies, to control difficult mesenteric bleeding and was particularly valuable in the control of very troublesome bleeding from the under surface of the diaphragm following splenectomy. When used in subtotal thyroidectomies it appeared to cause a somewhat excessive serum accumulation. When used as a rectal pack following hemorrhoidectomies and fistulectomies it was rapidly liquefied and obviated the necessity for a removable pack. This was in contrast to the soluble cellulose which when used in the rectum hardened and had to be removed with difficulty. The gelatin sponge was also used as a vehicle for the application of penicillin locally to granulating wounds, with satisfactory results.

Thus the gelatin sponge has, of itself, marked hemostatic properties which the authors believe is augmented by the addition of thrombin. Thrombin cannot be used with soluble cellulose. Where a large number of ligatures are concentrated in a small area, as in a thyroidectomy this agent should be used with caution in view of the apparent increase in a tendency for serum accumulation in wounds. Gelatin sponge appears to have many useful possibilities in the problems of hemostasis in general surgery.

F J LEXMAN JR. M.D.

# PHYSICOCHEMICAL METHODS IN SURGERY

## ROENTGENOLOGY

Brown S. and Harper, F. G.: A New Roentgen Sign in Extrahepatic Biliary Tract Disease. *Radiol* 1946 47 39.

The authors previously called attention to a new roentgen sign which can be utilized to advantage in the diagnosis of extrahepatic biliary tract disease. Since then many more cases were observed and it was found that the sign is also useful in the differential diagnosis between obstructive and nonobstructive jaundice being present in the former and absent in the latter.

This sign consists of a pressure defect which is produced in the contour of the superior flexure of the duodenum by the dilated extrahepatic biliary tract.

A study of the normal anatomic relationship of the duodenum and the neighboring structures shows that the superior flexure of the duodenum is surrounded by the neck of the gall bladder on the right side, the cystic and hepatic ducts above, and the common duct on the left side. Thus the duodenum is practically encircled by an almost closed ring which is further reinforced by the solid structures of the liver and the pancreas above and below. When the biliary ducts of this ring are expanded by an obstruction due to a stone or tumor within the tubular system or by an extrinsic mass in the vicinity of the duodenum a pressure effect upon the enclosed fixed

duodenal segment develops. This pressure effect, however, cannot be demonstrated roentgenologically in the usual posteroanterior view since the course of the superior flexure of the duodenum is from before backward. The authors found that a right lateral decubitus position permits the visualization of the entire configuration of the duodenal loop. In this view most alterations in position, shape, and contour resulting from intrinsic or extrinsic changes are easily recognizable.

Twelve cases in which the method proved of value are briefly presented and the respective roentgenograms are reproduced for the purpose of illustration.

T. LUTUNA, M.D.

Hinkel, C. L., and Nichols, R. L.: Opaque Myelography in Penetrating Wounds of the Spinal Canal. *Am. J. Roentg* 1946, 55 689.

The authors present a report of 13 cases in which myelography and surgery were carried out following penetrating wounds of the spinal canal. The roentgen findings are reviewed and correlated with the surgical findings. The categories of defects found in the myelograms are classified for the purpose of discussion.

1. Clearly margined indentations. A sharply margined, localized, clearly outlined indentation of the oil column indicates localized external pressure on an intact dura. The defect is almost identical

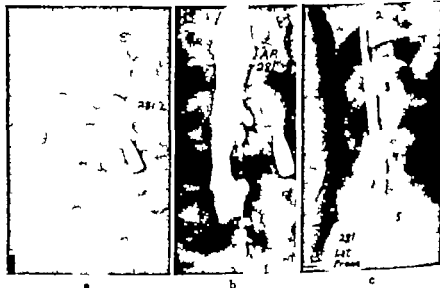


Fig. (Hinkel and Nichols) Example of clear cut, sharply margined indentation. a, the bullet is in the muscles of the back. Arrows indicate multiple hair line fractures of the left lamina of L<sub>4</sub> and left transverse process. b, anteroposterior view of oil showing defect opposite fractured lamina at level of the disc between L<sub>4</sub> and L<sub>5</sub>. c, lateral view. Patient prone. There is no ventral indentation of the oil column. Note that the oil does not outline the dorsal margin of the neural canal in the prone position.

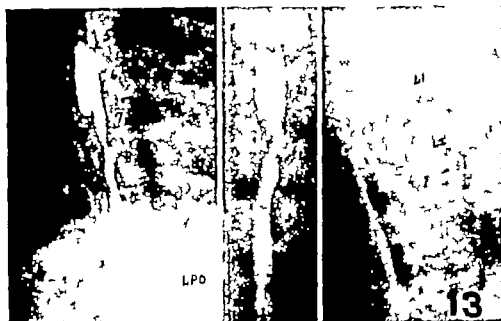


Fig. 2.

Fig. 3a.

Fig. 3b.

Fig. 2. Compression of bone fragments. Supine left posterior oblique view shows an oil puddle at T5 and 6, and narrowing of the column at T7 and 8.

Fig. 3. a. The oil column angulates to the left at the site of the metal fragment. The nerve root on the right was severed. b, prone lateral view. The metal fragment is buried in the body of L5. At L1 and L2 the oil is in apposition to the vertebral bodies but at L3 and L4 the oil is displaced backward several millimeters (arrows). Operation revealed an abscess about the foreign body and a large organising hematoma ventral to the dura at L3 and L4 (arrows).

with the well known defect produced by uncomplicated posterior or lateral protrusion of the intervertebral disc but not necessarily at a disc level. It may be dorsally ventrally or laterally located. This type of defect in the present series was always found associated with fractures and loose bone chips from laminae or one pedicle.

2 Angulation. Angulation of the column requires no definition. It is readily recognised following some through-and-through wound of the dura. The defect, the authors believe is the result of scarring and contraction of the dura and epidural soft tissues in the axis of the missile tract. Another factor in the production of angulation is traumatic unilateral severance of the nerve roots and dentate ligament which normally stabilise the dural tube.

3 Extra-arachnoid oil (near the lesion). Extra-arachnoid oil fills a diverticulum or a short sinus, the long axis of which is parallel with that of the neural canal. This defect should not be confused with faulty injection of extra-arachnoid oil. The above are attributed to the remaining defects from healing tears of the meninges.

4 Displacement of the column of oil. Displacement of the column of oil is occasionally encountered. The arachnoid contents may be displaced either ventrally or dorsally for several millimeters by any thing (usually semifluid) which fills the subdural or epidural spaces in a "layered" manner. The oil column is found to be farther from the bony wall of the neural canal than normal.

5 Feathery irregular filling defects (localised partial obliteration of the subarachnoid space). Frequently because of localised obliteration of the subarachnoid space the oil is prevented from distributing itself evenly or completely about the spinal cord or the fibers of the cauda equina. This uneven spread of the oil produces very striking abnormalities in the myelographic picture. The myelographic appearance is that of single or multiple irregular "feathery" filling defects within the oil column.

6 Altered physical characteristics of the oil. When pantopaque fails to remain in a column or disperses into fine droplets there is found an alteration in the cerebrospinal fluid.

7 Complete subarachnoid block. The myelographic appearance is variable the oil column may taper to a point before stopping or may terminate in a ragged oblique or transverse manner. Anatomically subarachnoid block is obliteration of the subarachnoid space surrounding the cord or filaments of the cauda equina. It may be produced by (a) extrinsic pressure, (b) intrinsic pressure (c) active inflammatory process or (d) scarring as the result of very extensive destruction of nerve tissue.

The authors believe that myelography with possibly some modification should be undertaken in every patient who exhibits neurological signs following a wound involving or suspected of involving the neural canal. The routine myelographic technique must be varied to meet the problem of the patient with a cord injury. After examination the opaque



medium is removed under roentgenoscopic control. Opaque myelography greatly facilitates the establishment of an anatomical diagnosis in spinal injuries. It may reveal a residual remediable lesion even after presumably thorough surgical exploration or lesions which simulate actual destruction of nerve tissue such as extradural abscesses, hematomas, displaced bone fragments or pia-arachnoiditis, which are surgically remediable. FRANK L. HURSEY, M.D.

Murphy, F. Pascucci, L. M., Meade, W. H., and Van Zwafelenburg, B. R.: Myelography in Patients with Ruptured Cervical Intervertebral Discs. *Am. J. Roentg.* 1946, 56: 37

From January 1, 1943 to July 1, 1945 the authors performed 62 pantopaque myelograms of the cervical spine. They were done only after plain films of the spine were taken first. These preliminary films showed abnormal findings in 88 per cent of cases in which the subsequent myelograms were positive for disc lesion and in 52 per cent of the cases with negative myelograms. The following abnormal findings were searched for on these films: scoliosis, straightening or reversal of the normal cervical curve, calcification in the posterior joint space, encroachment of the intervertebral foramen by soft tissue shadow and/or osteophyte and localized arthrosis. Most significant of these findings was the abnormal curvature of the cervical spine. However the authors were aware of the fact that there are other—more frequent—causes for this finding than rupture of the cervical intervertebral disc. Next in importance (with reference to disc lesions) seemed the presence of localized osteoarthritic spur formation.

The myelographic procedure consisted of fluoroscopy and the taking of spot films in the prone and oblique positions. (Lateral films were found to be of little value.) The more common findings encountered were deviation in the direction of flow, delay of passage, and filling defects.

The correlation of the myelographic to the operative findings was as follows:

	Myelogram positive	Myelogram negative
Operation with positive results	17 <sup>1</sup>	0
Operation with negative results	0	3
No operation	11	31
Total	28	34

<sup>1</sup>Includes recurrences.

It is pointed out that the cases were carefully selected for operation on the basis of the clinical findings and that this high correlation is deceptive because of the many nonoperative cases and the impossibility of exploring cases regardless of the findings and indications for surgery.

The distribution of lesions observed myelographically was as follows:

A. Side	Cases	Per cent
Right	21	56
Left	7	44
Total	28	100

B. Level	Cases	Per cent
C 3	2	7
C 4	1	3
C 5	12	32
C 6	21	56
C 7	2	5
Total	28	100

C. Number of lesions per patient	Cases	Per cent
Single lesion	18	64
Bilateral at one level	5	19
Multiple levels	5	15
Total	28	100

The authors conclude that rupture of the nucleus pulposus in the cervical region is relatively common, especially in the lower section where the stress upon the spine is similar to that in the lumbosacral region. The diagnosis can be made clinically in many cases. Plain films of the cervical spine are helpful. Positive myelographic findings proved highly accurate in this small series of operative cases. The significance of negative myelograms in the cervical region is not yet established but is probably greater than that of those in the lumbar region.

The technique of this procedure, which includes prophylactic chemotherapy and asepsis in excess of the measures commonly employed in spinal punctures, is described. GEORGE S. SCHWARTZ, M.D.

Maltby, G. L., and Pendergrass, R. C.: Pantopaque Myelography: Diagnostic Errors and Review of Cases. *Radiology* 1946, 47: 15.

The experience of the authors with 215 pantopaque myelograms, 69 of which were followed by operation is reported.

From 3 to 6 c.c. of pantopaque were injected. If the needle was inserted over what appeared to be a lesion, it was withdrawn and the examination was continued. The table had to allow for at least a 40 degree Trendelenburg tilt in one direction and an upright position of the patient in the other extreme excursion. At least two spot films were taken of any suspicious area to insure constancy of the finding. The patient was rolled onto both of his sides in order to avoid false nonfilling of the root canals. The important filling of the caudal sac was insured by placing the patient into the upright position and occasionally by having him perform the Valsalva maneuver. Oblique views were found helpful. The contrast material was removed after the examination. The final x-ray diagnosis was made only after a conference with the neurosurgeon in each case.

The findings were as follows: of 207 patients with positive myelograms 57 (53%) were operated upon. Of these 51 (89.4%) showed a disc lesion at operation. Exploration was negative in 6 patients (10.6%). Nine patients in whom the x-ray findings were negative were operated upon because of what seemed to be classical clinical findings of a ruptured disc. In 5 (56%) of these 9 patients the findings on exploration were negative, while in 4 (44%) a definite rupture of the nucleus pulposus was observed.

Eight myelograms showed positive findings not frankly characteristic of a ruptured disc. The following x ray diagnoses were made in these cases: myelograms suspicious of ruptured disc but needing clinical confirmation 3; arachnoiditis 1; postoperative scar tissue 1; unsatisfactory, because of extra-arachnoid oil 1; multiple filling defects cause unknown, 1; and block 1. Of the 8 patients 3 came to operation. In the case labeled "postoperative scar tissue" a recurrent disc was found. The one diagnosed simply as "block" showed a small epidural abscess and the one considered as "roentgenologically suspicious of a disc but needing clinical confirmation" showed a ruptured disc.

The authors arrive at the following conclusions: Positive myelographic findings without the usual appearance found in disc protrusion can be caused by extra-arachnoid injection of oil, centrally protruded disc, arachnoid block caused by disc lesion or arachnoiditis varices, adhesions and epidural abscess. A negative myelogram may result despite the presence of a disc prolapse when the column of contrast material is too narrow.

GERHART S. SCHWARTZ, M.D.

Klein, I.: Treatment of Peritendinitis Calcarea of the Shoulder Joint by Roentgen Irradiation; Report of 100 Cases. *Am J Roentg* 1946 56 366

One hundred cases of peritendinitis calcarea of the shoulder were treated with x rays between 1937 and

1945. The cases were divided into 61 acute (duration of symptoms under 1 month) 11 subacute (of 1 to 2 months' duration) and 28 chronic (duration over 2 months). All shoulders were subjected to roentgenography before the treatment. The absence of visible calcifications in the first group was no contraindication to x ray treatments. In this group there was partial or complete resolution of the visible calcium following treatment in 69 per cent of the cases. In the second group this figure was only 36 per cent and in the third group only 32 per cent.

The results were best in the first group in which relief from pain was achieved usually within a few days after the treatments were started. The average disability period (counted from the onset of treatment) was as follows: group I 8.5 days; group II 26 days; and group III, 36 days.

Three cases were referred to surgery. In 1 case which did not respond to x ray treatments operation revealed an osteochondroma as the source of the roentgenographic density in the shoulder.

One treatment course consisted usually of from 6 to 8 treatments of 125 r average each administered within from 7 to 14 days over the affected shoulder region (in part posteriorly and in part, anteriorly) with kV 125 to 200 target-skin distance from 30 to 40 cm. ma. from 5 to 7 and field size 10 by 15 cm. Patients of group I received 1 course; those of the other groups usually 2 courses.

GERHART S. SCHWARTZ, M.D.

medium is removed under roentgenoscopic control. Opaque myelography greatly facilitates the establishment of an anatomical diagnosis in spinal injuries. It may reveal a residual remediable lesion even after presumably thorough surgical exploration, or lesions which simulate actual destruction of nerve tissue such as extradural abscesses, hematomas, displaced bone fragments, or pla-arachnoiditis, which are surgically remediable. FRANK L. HUMBER, M.D.

Murphy, F., Pascucci, L. M., Meade, W. H., and Van Zwilunenburg, B. R.: Myelography in Patients with Ruptured Cervical Intervertebral Discs. *Am. J. Roentg.* 946, 56-57

From January 1, 1943 to July 1, 1945 the authors performed 62 pantopaque myelograms of the cervical spine. They were done only after plain films of the spine were taken first. These preliminary films showed abnormal findings in 88 per cent of cases in which the subsequent myelograms were positive for disc lesion and in 52 per cent of the cases with negative myelograms. The following abnormal findings were searched for on these films: scoliosis, straightening or reversal of the normal cervical curve, calcification in the posterior joint space, encroachment of the intervertebral foramen by soft tissue shadow and/or osteophyte and localized arthrosis. Most significant of these findings was the abnormal curvature of the cervical spine. However the authors were aware of the fact that there are other—more frequent—causes for this finding than rupture of the cervical intervertebral disc. Next in importance (with reference to disc lesions) seemed the presence of localized osteoarthritic spur formation.

The myelographic procedure consisted of fluoroscopy and the taking of spot films in the prone and oblique positions. (Lateral films were found to be of little value.) The more common findings encountered were deviation in the direction of flow, delay of passage and filling defects.

The correlation of the myelographic to the operative findings was as follows:

	Myelogram positive	Myelogram negative
Operation with positive results	71	0
Operation with negative results	0	3
No operation	1	3
Total	72	34

Hachado recurrence.

It is pointed out that the cases were carefully selected for operation on the basis of the clinical findings and that this high correlation is deceptive because of the many nonoperative cases and the impossibility of exploring cases regardless of the findings and indications for surgery.

The distribution of lesions observed myelographically was as follows:

A. Side	Cases	Percent
Right		56
Left	7	44
Total	38	100

#### B. Level

C 3  
C 4  
C 5  
C 6  
C 7

Total

Cases	Percent
3	5
1	
13	32
2	56
2	5
38	100

#### C. Number of lesions per patient

Single lesion  
Bilateral at one level  
Multiple levels

Total

Cases	Percent
18	66
5	19
5	15
27	100

The authors conclude that rupture of the nucleus pulposus in the cervical region is relatively common, especially in the lower section where the stress upon the spine is similar to that in the lumbosacral region. The diagnosis can be made clinically in many cases. Plain films of the cervical spine are helpful. Positive myelographic findings proved highly accurate in this small series of operative cases. The significance of negative myelograms in the cervical region is not yet established but is probably greater than that of those in the lumbar region.

The technique of this procedure, which includes prophylactic chemotherapy and asepsis in excess of the measures commonly employed in spinal punctures, is described. GEORGE H. SCHWARTZ, M.D.

Maltby, G. L., and Pendergram, R. C.: Pantopaque Myelography: Diagnostic Errors and Review of Cases. *Radiology* 1946, 47: 15.

The experience of the authors with 215 pantopaque myelograms, 69 of which were followed by operation, is reported.

From 3 to 6 c.c. of pantopaque were injected. If the needle was inserted over what appeared to be a lesion it was withdrawn and the examination was continued. The table had to allow for at least a 40 degree Trendelenburg tilt in one direction and an upright position of the patient in the other extreme excursion. At least two spot films were taken of any suspicious area to insure constancy of the finding. The patient was rolled onto both of his sides in order to avoid false nonfilling of the root canals. The important filling of the caudal sac was insured by placing the patient into the upright position and occasionally by having him perform the Valsalva maneuver. Oblique views were found helpful. The contrast material was removed after the examination. The final x-ray diagnosis was made only after a conference with the neurosurgeon in each case.

The findings were as follows of 107 patients with positive myelograms, 57 (53%) were operated upon. Of these, 51 (89.4%) showed a disc lesion at operation. Exploration was negative in 6 patients (10.6%). Nine patients in whom the x-ray findings seemed to be classical clinical findings of a ruptured disc. In 5 (56%) of these 9 patients the findings on exploration were negative while in 4 (44%) a definite rupture of the nucleus pulposus was observed.

Eight myelograms showed positive findings not frankly characteristic of a ruptured disc. The following x ray diagnoses were made in these cases: myelograms suspicious of ruptured disc but needing clinical confirmation 3; arachnoiditis, 1; postoperative scar tissue 1; unsatisfactory, because of extra arachnoid oil 1; multiple filling defects cause unknown 1 and block, 1. Of the 8 patients 3 came to operation. In the case labeled postoperative scar tissue a recurrent disc was found. The one dural abscess and the one considered as roentgenologically suspicious of a disc but needing clinical confirmation showed a ruptured disc.

The authors arrive at the following conclusions: Positive myelographic findings without the usual appearance found in disc protrusion can be caused by extra-arachnoid injection of oil, centrally protruded disc, arachnoid block caused by disc lesion or arachnoiditis, varices, adhesions and epidural abscess. A negative myelogram may result despite the presence of a disc prolapse when the column of contrast material is too narrow.

GERHART S. SCHWARTZ, M.D.

Klein, I.: Treatment of Peritendinitis Calcarea of the Shoulder Joint by Roentgen Irradiation; Report of 100 Cases. *Am J Roentg* 1946 56 366

One hundred cases of peritendinitis calcarea of the shoulder were treated with x rays between 1937 and

1945. The cases were divided into 61 acute (duration of symptoms under 1 month) 11 subacute (of 1 to 2 months duration) and 28 chronic (duration over 2 months). All shoulders were subjected to roentgenography before the treatment. The absence of visible calcifications in the first group was no contraindication to x ray treatments. In this group there was partial or complete resolution of the visible calcium following treatment in 69 per cent of the cases. In the second group this figure was only 36 per cent and in the third group only 39 per cent.

The results were best in the first group in which relief from pain was achieved usually within a few days after the treatments were started. The average disability period (counted from the onset of treatment) was as follows: group I 8.5 days; group II 16 days; and group III, 36 days.

Three cases were referred to surgery. In 1 case which did not respond to x ray treatments operation revealed an osteochondroma as the source of the roentgenographic density in the shoulder.

One treatment course consisted usually of from 6 to 8 treatments of 125 r average each administered within from 7 to 14 days over the affected shoulder region (in part posteriorly and in part, anteriorly) with kV 125 to 200 target-skin distance from 30 to 40 cm. ma. from 5 to 7 and field size 10 by 15 cm. Patients of group I received 1 course; those of the other groups usually 2 courses.

GERHART S. SCHWARTZ, M.D.

## MISCELLANEOUS

### CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

McFarlane, R. G., and O'Brien, J. R.: The Relation of the Blood Sedimentation Rate. *Proc R. Soc. Med.*, 1946, 157.

In 1921 Fåhræus first made a practical application of the sedimentation phenomenon by adding anti-coagulant to blood to keep it fluid. With the use of a simple technique he established the range of normal limits and the variations found in disease. Since 1 c.c. of packed red cells weighs about 1.09 grams and a similar volume of plasma weighs only about 1.03 grams, the red cells will naturally sink in plasma. If the cells remain discrete they fall slowly but in certain cases they clump together to form rouleaux in which hundreds or even thousands of cells are packed into a solid mass. The larger the mass is the faster it will fall. For every cell that falls, an equal volume of plasma is displaced upward. Thus the cells fall through an upward current of fluid which slows their fall. The greater the number of cells in a given volume of blood the greater will be the upward flow of displaced fluid and the greater its retarding effect on sedimentation. This factor assumes considerable importance in dealing with the varying red cell counts found in disease.

The formation of rouleaux is the major factor in sedimentation and is the actual index of abnormality. Red cells in blood normally remain separate. However in certain conditions the cells become regularly arranged into columns, or rouleaux, which in turn may adhere to each other to form masses. The cause of rouleaux formation seems to lie in the plasma surrounding the red cells rather than in the cells themselves. Cells from a blood sample showing a high sedimentation rate, if washed free of their plasma and suspended in normal plasma, will show no excessive rouleaux formation. Cells from the normal blood will form rouleaux in the abnormal plasma. No specific substance analogous to an agglutinin, can be shown to exist in the abnormal plasma. The tendency of any plasma to form rouleaux seems to be determined by the balance of its "active and inhibitory proteins. Fibrinogen and euglobulin are the most active proteins. An albumin fraction (globuloglycoid) and nucleoprotein are the most inhibitory. Other fractions are intermediate or neutral in action. Abnormal proteins may be present in plasma as in myelomatosis, and increase the sedimentation rate. Alterations of the balance of plasma proteins tending to increase rouleaux formation and hence the sedimentation rate are liable to occur in any condition involving infection or destruction of tissue.

Several technical factors influence the sedimentation rate. The anticoagulant used should not produce dilution. Blood should be tested within 4 hours

of its withdrawal, for after this period of time its sedimentation decreases. The tube used should be at least 300 millimeters long to minimize the decelerating effect which packing of the cells has on their rate of fall. Its diameter should not be less than 2 millimeters. It should be kept absolutely upright. Before being tested blood samples should be thoroughly agitated, by shaking them for at least 2 minutes, to break up rouleaux already formed.

In sedimentation there are three distinct phases. First, there is a period of about 15 minutes during which aggregation of rouleaux is occurring. Then more rapid sedimentation occurs, at an approximately constant rate. The duration of this period of free fall is determined by the length of the tube. In the third phase the packing of the cells on the bottom of the tube slows the sedimentation until finally it ceases.

The rate of sedimentation can be measured in at least three ways. The time required for cells to fall a given distance may be measured. The sedimentation may be measured at the end of an arbitrary length of time, usually an hour. Or readings may be taken at 5 minute intervals, to avoid the errors introduced by aggregation and packing and arrive at a true maximal rate of fall per minute.

The most important intrinsic factor influencing the sedimentation rate is anemia. In simple acute anemia the cells, reduced in number for a given volume of plasma, fall more rapidly. However it has been found that in chronic anemias a natural compensatory mechanism reduces the capacity of the plasma to form rouleaux. This has minimized the value of Wintrobe's correction chart. Some of the difficulties in evaluating anemic blood samples may be eliminated by reconstituting the blood (by centrifuging removing an appropriate amount of plasma, and remling) to a normal packed cell volume before making observations. Other intrinsic factors affecting sedimentation are the size and shape of the red cells. Variations in cell size, seen in pernicious anemia and other liver factor deficiencies, prevent good rouleaux formation. The spherical cells of acholic jaundice and the varying forms in sickle cell anemia have very little tendency to form rouleaux.

B. F. LOUGHEED M.D.

Murray G. Simpson, J. S., and Watters, N. A.: Treatment of Extremities following Sudden Failure of Circulation. *Surgery* 1946, 30, 3.

There is much evidence to indicate that the orthodox method of the treatment of acute failure of circulation such as occurs in embolism, diabetes, senile or Buerger's gangrene, or injuries to major blood vessels and frostbite, might be revised to advantage.

With the present knowledge of physiology it would seem that the application of rational pro-

ciples might prevent the advance of a pregangrenous condition and might set up conditions which would favor a return of circulation and survival of the part. With impaired arterial flow into an extremity elevation beyond the horizontal position can easily set up conditions under which no blood may reach the periphery. Also in this posture the veins are emptied so that only the proximal capillaries of the extremity have any circulation of blood passing through them. Elevation and arterial spasm may prevent any blood from reaching the vascular tree beyond certain levels. Therefore, if the vascular tree is kept empty there is no available supply of oxygen and as each living cell has a limited number of hours that it can survive without oxygen necrosis and gangrene are inevitable. The absence of oxygen over a certain period causes changes in cells which are irreversible so that even should the circulation be restored, the blood that enters the affected area will clot rapidly and plug up the entire vascular tree which again completely deprives all cells of their oxygen supply and necrosis must be the end result. If an extremity is without blood and becomes desiccated it cannot possibly survive. If it is kept full of blood no matter how venous the blood may be provided it is not allowed to clot, there is some possibility of survival of the cells. If with the dependent position of the extremity cold is also applied, the requirement for oxygen can be cut down to the minimum and with good luck there may be sufficient circulation to provide the necessary oxygen. Intravenous heparin will prevent thrombosis in the peripheral vessels and under these conditions may be of considerable value.

Animal experiments and a report of 3 cases indicates that in extremities with impaired circulation the best prospects for survival can be provided by keeping the extremity dependent by the application of cold and by using methods to effect maximum dilatation of the collateral vessels entering the extremities.

BENJAMIN GOLDMAN, M.D.

Keynes, G. Collins, D. H., Martin, P. Symonds, C., Laurent L. P. E., and Sandifer P. H.: Symposium on the Surgical Treatment of Myasthenia Gravis. *Proc. R. Soc. M.*, Lond. 1946, 39-600.

G. KEYNES summarized his results in 63 patients subjected to thymectomy for myasthenia gravis. There were 9 postoperative deaths, 7 in the first 27 patients and only 2 in the next 43 patients. Four others had died of the disease. 14 were apparently cured and not taking prostigmine. 15 were very much better taking small doses of prostigmine. 3 showed slight improvement and 9 showed no improvement. In the remaining 9 patients operation had been too recent to permit accurate assessment of the results. The best results were obtained in younger patients with short histories of illness. One factor adversely affecting the results was the incidence of thymic tumors. In the 63 patients there had been 7 tumors. The size of the thymus, apart from

the presence of a tumor, bore no relation to the severity of the disease. Keynes believed that the total results justified continuance of the operation. Technical advances had greatly lowered the mortality in the latter part of his series. Early operation before the disease became chronic, carried a low risk and appeared possibly to prevent thymoma formation.

D. H. COLLINS reported that he and Bratton had studied the glands removed from myasthenic patients and compared them with normal glands taken from healthy individuals who had died suddenly because of accidents. They found that the weight of the normal gland is extremely variable but that its shape and qualitative makeup undergo fairly constant change with increasing age. The majority of the myasthenic glands showed no gross anatomical abnormality but about 1 in 7 showed the presence of a thymic tumor. Tissue elements more specific to the thymus, i.e. reticulated medullary epithelium and the Hassall bodies, did not appear to undergo any constant or significant change in myasthenia gravis except in the case of tumors in which both the lymphoid and epithelial elements were concerned in the new growth. Two features distinguished the nontumor gland of myasthenia gravis from the normal thymus—less marked cortical atrophy than in the normal gland and the intramedullary formation of structures apparently identical with the germ centers or secondary nodules of Flemming commonly seen in lymph glands. Whether these changes were related to the cause or to the effects of the disease could not be determined.

P. MARTIN pointed out that on the basis of Keynes' figures, thymectomy was not the complete answer to the problem of myasthenia gravis. In younger patients, in whom the disease has always been more severe, the operation has been a tremendous therapeutic advance, often a lifesaving measure but in older individuals the effects of operation have been less pronounced. He raised the question of whether or not improvement noted only several months after operation should not be attributed to a remission rather than to the operation.

C. SYMONDS suggested a comparison of Keynes' series of cases with a number of cases followed through the preprostigmine years and also with more recent cases given prostigmine but not subjected to surgery. He believed that the average expectation of health and life had been much less than that now offered by surgery.

L. P. E. LAURENT stated that in his experience with some 65 cases of myasthenia gravis over a period of 18 years he had seen some very remarkable remissions and had come to believe that the prognosis was much better than had been generally thought. He cited several cases, in 1 of which the patient had had severe symptoms for 7 years but had now gone 30 years without relapse. It was his opinion that any thymic theory of the causation of myasthenic symptoms would have to be reconciled with M. Walker's experiment in which she showed that

release of a cuff around the arm after exercising the muscles of the forearm caused a rapid ptosis.

P. H. SANDRINI raised the question of radiotherapy to the thymus in myasthenia gravis, asking Keynes whether he had removed glands previously subjected to radiation and if so, what histological changes he had noted. He stated that several of his patients who had received radiation had benefited markedly while others had been benefited little or not at all.

B. F. LOOMIS, M.D.

Millan Gutierrez, J.: Leishmaniasis of the Skin and Mucosae (Leishmaniasis de la piel y de las mucosas) *Med. rev. mex.* 1946, 26: 150.

Millan Gutierrez gives a very good discussion on leishmaniasis.

The clinical forms of the "Boton de Oriente" described are the abortive, dry and squamous, crustaceous, that found in layers, the cheloid verrucous, and the cutaneous.

The clinical forms are divided in 3 main groups: the ulcerous, nonulcerous, and that with secondary ulcerations.

The phlebotomy is found to be the mosquito which transmits the disease.

The different therapeutic measures against the disease are discussed as well as the preventive measures to avoid its propagation.

WILLIAM E. RICKETTS, M.D.

Begnis C. S., and Picena, J. P.: Fibrosarcoma of Darier Occurring after a Bite Wound (Fibrosarcoma de Darier sobre cicatriz por mordisco) *Rev. med. Rosario* 1946, 36: 233.

Begnis and Picena report the case of a 33 year old man who was bitten in a fight with another man 9 years ago. The wound was inflicted in the anterior part of the thorax above the mammary gland. Four years after the fight he developed a tumor in the scar of the bite, which was extirpated surgically. Later this tumor recurred and upon histological examination was found to be a fibrosarcoma of Darier.

WILLIAM E. RICKETTS, M.D.

## DUCTLESS GLANDS

Fontaine, R., and Pilla, P.: Remarks Concerning 39 Interventions on Thymus and Parathyroid Glands (Réflexions à propos de 39 interventions sur le thymus et les parathyroïdes) *Ann. endocr.* Par 1946, 7: 7.

The authors performed 45 operations on the thymus and the parathyroid glands. Six operations were performed on patients with polyarticular deforming rheumatism. The remaining 39 procedures are divided into three groups: 4 thymectomies, 12 thymoparathyroidectomies, 20 parathyroidectomies, and 3 so-called physiologic parathyroidectomies or resections of terminal branches of both lower thyroid arteries.

The diagnoses were as follows: chronic ankylosing polyarthritis, 24 cases; scleroderma, 8 cases; nephro-

lithiasis, 2 cases; Lobstein's disease, myositis ossificans, lipoid granulomatosis, progressive myasthenia, and primary amenorrhea, 1 case each.

In ankylosing polyarthritis, thymoparathyroidectomy proved superior to all other procedures. Bacillary rheumatism responds poorly to operations on endocrine organs; however, better results may be obtained in polyarthritis of endocrine origin. The authors state that a distinction between both forms of rheumatism is not always easy to make. Better results are obtained in spondylitis than in peripheral forms of rheumatism. It is believed that patients with hypercalcemia show a better response to operation than those with a normal calcium level. Of 24 patients with ankylosing chronic polyarthritis, good results were obtained in 11 or 45.8 per cent of the cases.

Parathyroidectomy is a valuable procedure in the treatment of scleroderma if the condition is progressing slowly while forms of the disease having a rapid course with involvement of other endocrine glands respond poorly to the operation.

Operation was unsuccessful in a 6 year old child with Lobstein's disease who continued to sustain fractures after the operation.

A considerable functional amelioration with cessation of pains and further ossifications was obtained by parathyroidectomy in 1 patient with myositis ossificans.

Thymectomy and physiological parathyroidectomy produced relief in a patient with calculi of the urinary bladder. Parathyroidectomy failed to produce good results in a patient with lipoid granulomatosis mistaken for Recklinghausen's disease.

Apparently a favorable effect of thymectomy on myasthenia was noticed in 1 patient.

If a primary amenorrhea does not yield to hormonal therapy a persistent thymus may be responsible for the condition. This hypothesis was confirmed by good results of thymectomy in a 21 year old girl.

JOSEPH E. NARAY, M.D.

Venning, E. H.: Adrenal Function in Pregnancy *Endocrinology* 1946, 39: 203.

The important contributions made in recent years with regard to the metabolic changes produced by the adrenal cortical steroids show that the various functions of the adrenal gland, such as salt and water metabolism, carbohydrate and protein metabolism, and androgenic activity can be correlated with different groups of steroid hormones. Evidence is accumulating to indicate that these various functions are able to exert their influence independently of one another.

The urinary excretion of glyco-genic corticoids, ketosteroids, pregnandiol, estrogens, and gonadotropins has been followed in 9 cases of pregnancy.

The excretion of adrenal metabolites in pregnancy suggests that at least the corticoids, those compounds of adrenal origin which have a specific effect on carbohydrate and protein metabolism, and the 17-ketosteroids can vary independently of one another. The

is seen in Cushing's syndrome in which the urinary corticoids are strikingly increased and the 17-ketosteroids are usually within the normal range. In cases of hirsutism the reverse is found—high 17-ketosteroids with normal corticoid excretion. In children the corticoid excretion has reached the adult level between the ages of 5 and 7 years whereas the 17-ketosteroids do not reach this level until a much later age. In the series of pregnancy cases a marked increase in excretion of corticoids was found with very little change in the 17-ketosteroids.

There is an initial rise in excretion of corticoids in the first trimester of pregnancy which usually returns to normal levels between the 100th and the 120th days. Between the 140th and the 160th days the urinary corticoids increase again and reach relatively high values.

A falling off in excretion usually occurs in the last month and shortly after parturition the values are back to normal again.

The ketosteroids when measured by the Pincus reaction remain at the same level throughout pregnancy. When the same fraction is assayed by the Zimmermann reaction an increase in ketosteroid excretion is seen beginning between the 140th and the 160th days. This increase in ketosteroids is attributed to the increased excretion of 20-ketosteroids. Only a slight increase is observed in the  $\beta$ -OH (beta hydroxy) ketonic fraction.

The high excretions of corticoids observed in pregnancy are surprising as they are in the order of amounts found in the urine of persons after severe damage or of patients suffering with Cushing's syndrome and indicate that the activity of the adrenal gland must be greatly increased at this stage of pregnancy. The well known phenomenon of rapid growth of the fetal adrenal cortex during the last trimester of prenatal life and its subsequent degeneration beginning at or just previous to birth suggest the possibility that the fetal cortex might be contributing to the increased output of corticoids during the latter part of pregnancy. However on examination of the urine obtained from infants in the first 4 days of life little or no corticoid activity can be found. Within 2 to 4 days after delivery the excretion of corticoids in the mother is back to normal values.

Just what the cause and function of this increase in adrenal activity may be is not known.

STEPHEN A. ZUCKERMAN, M.D.

#### EXPERIMENTAL SURGERY

Murphy J. J., Ravdin R. G., and Zintel, H. A.: The Use of Streptomycin in Experimental Peritonitis. *Surgery* 1946 20 445.

Streptomycin is an antibiotic which is relatively nontoxic, and which, following parenteral administration, is widely distributed in the body fluids. Its effectiveness against many strains of organisms of the colon group differentiates it strikingly from penicillin. Since the organisms of the colon group are the types most frequently found in the common

forms of human peritonitis, it seemed logical to substitute streptomycin for sulfonamides and penicillin both of which gave favorable results.

In experimentally produced peritonitis streptomycin was found in significant amounts in the peritoneal fluid. Despite the dosage used in the experiments, which is not the maximum dosage which may be safely administered the survival rate of the streptomycin treated animals was 60 per cent as compared with a survival rate of 30 per cent among the control animals. SAMUEL KAHN, M.D.

Burns, F. J.: Reaction of Tissue to and the Fate of Oxidized Cellulose in the Peritoneal Cavity of the Dog. *Arch. Surg.* 1946 53 348.

Oxidized cellulose appears to be a hemostatic agent which can be left in the tissues without causing untoward effects. Cellulose which occurs in relatively pure form in cotton can be oxidized by the action of nitrogen dioxide. If the oxidation is sufficiently complete the material becomes completely soluble in dilute solutions of alkali. If the oxidation is insufficient to give the material a carboxyl group content of 13 per cent, the material is only partially soluble.

By implanting bits of oxidized cellulose in various parts of the peritoneal cavity of dogs, the author has shown the ultimate fate of the material and the reaction of the tissues to it. Eight-ply pieces of gauze 2 by 1 cm. in size were placed in each of four locations—in the pelvis in the omental bursa, among loops of intestine, and between the liver and diaphragm. The peritoneal cavities of the animals were reopened at varying intervals until such time as the gauze was absorbed and sections from the omental bursa were taken for microscopic study.

As the gauze was being absorbed it formed a brown gelatinous mass, which became smaller until absorption was complete. This required about 28 days, when the gauze was still in the omental bursa. In each of the other sites absorption of the gauze was complete in about 2 days. When larger pieces of gauze were placed among loops of intestine the time for absorption was correspondingly longer—10 days for an eight-ply piece 4 by 3 cm., and 13 days for an eight-ply piece 4 by 4 cm. Although absorption time is governed by the amount of gauze present, other factors are concerned in the process. The nature of the tissue, the amount of peritoneal fluid and its type, the mechanical motility of the tissues surrounding the gauze and the degree of oxidation of the gauze all influence the absorption. In some instances fibrinous adhesions were seen to be present during the process, but in no case did these persist after absorption was complete.

Study of the microscopic sections showed that the tissue juices dissolved the gauze to some extent but that a large part of the absorption was effected by phagocytosis. Early a moderate acute inflammatory reaction was seen, with many neutrophils present. Later large numbers of macrophages were evident, surrounding the gauze fibers and causing



them to disintegrate. Under the attack of the macrophages the fibers became ever smaller until they disappeared completely.

The author suggests the use of oxidized cellulose as a substitute for the hemostatic gauze pack. He suggests that it may be used for hemostasis either by itself or in combination with some blood derivative such as thrombin.

B. F. LOOMIS, M.D.

### HOSPITALS MEDICAL EDUCATION AND HISTORY

Cobb, W. M.: A Graphic Approach to a Complete Anatomy. *J. Nat. M. Ass. N. Y.* 1946 38 155.

In 1489 Leonardo da Vinci began work upon an encyclopedic human anatomy. Although it was never finished, da Vinci's notes outlining the general plan of the treatise show that it was to have been very comprehensive, consisting of 120 books and including correlated subjects of physiology and comparative anatomy. In reviewing da Vinci's work and his truly remarkable grasp of the fundamentals of anatomy, the author stresses the current need for synthesis and simplification in the presentation of that subject.

His approach to this problem has taken three forms. The first was a scheme for organization of the anatomical facts, in which the ovum, the 7-week embryo, and the erect adult were used as focal points for associations. The second was the development of a canon of proportions with which students could prepare outlines of the human figure with skeleton from the ventral, lateral, and dorsal aspects, outlines which could be utilized for review of specific anatomic features. The third was the use of these basic outlines of the human figure as a common frame of reference for presentation of detailed anatomy of all

parts and regions. Marginal notes on clinical variations and developmental features were integrated with the particular outline, detailing the subject to which they were appropriate.

In constructing a basic outline from the ventral aspect, the height of a head is taken as the fundamental unit of measure. Any convenient dimension may be used as a head height. For laboratory work, the head is arbitrarily scaled to 4 inches. Sutures and shoulder breadth are given the classical values of  $7\frac{1}{2}$  and 2 heads, respectively. A rectangular frame  $7\frac{1}{2}$  by 2 heads and subdivided into heads and half-heads is prepared. On this frame 10 constant guide points, such as the suprasternal notch, umbilicus, symphysis pubis, knee joint, are plotted. Since they are fundamental, the locations of the 10 guide points must be memorized. Working from these points the student then develops the human figure and skeleton by adding correlated features through 10 successive stages. In early stages anatomic landmarks are inserted at guide points, first outlines of limb bones are drawn, certain ribs and vertebrae are marked out. Later the surface contours and remaining osseous structures are added. Marginal insertions are restrictive, depicting some features in greater detail and adducing collateral facts. The stages of construction of dorsal and lateral outlines are not described by the author, but the method is the same as for the ventral outline.

The author reiterates the value of studying anatomy from the cadaver, skeleton, and living subject. Excellent illustrations of anatomic outlines prepared by his students, both in the laboratory and in written examinations, show the soundness of his approach. The student need not have any particular artistic aptitude or training to produce good anatomical drawings.

B. F. LOOMIS, M.D.

# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### LIGATION OF THE INFERIOR VENA CAVA IN THROMBOEMBOLISM

#### Report of 36 Cases

BEN R. THEBAUT M.D. and CHARLES S. WARD M.D. Atlanta, Georgia

MUCH has appeared in the medical literature during the past several years on venous thrombosis and pulmonary embolism. The high incidence of thrombosis in the deep veins of the lower extremities and the dangers attending such a process have been stressed. It is the purpose of this presentation to re-emphasize the importance of this disease, to discuss its surgical management once pulmonary infarction has occurred, and to report on 36 patients whom we have treated by ligation of the inferior vena cava within the past 3 years. To date no authors have advocated routine ligation of the inferior vena cava in cases of pulmonary embolism from venous thrombosis of the deep veins of the lower limbs, or from a clinically hidden source. It is our belief that this procedure will offer the patient with pulmonary embolism the best prognosis for both immediate and ultimate results.

#### IMPORTANCE AND SIGNIFICANCE OF THROMBOEMBOLISM

Despite the abundance of material in the literature on the subject of venous thrombosis and pulmonary embolism, the importance of the disease is as yet not fully appreciated.

Welch and Faxon in a group of 250 cases at the Massachusetts General Hospital found

that the ratio of fatal embolism to recognizable phlebitis without regard to the type or duration of the disease was 1 to 25 (4 per cent). If these figures were adjusted to show the incidence of fatal embolism in cases of recognizable phlebothrombosis alone, the ratio undoubtedly would be much higher. Welch and Faxon found moreover that 1 patient out of 3 (33 1/3 per cent) with phlebitis suffered pulmonary infarction at some stage of the disease.

Barker and others (2) in a statistical study of 1665 cases of postoperative venous thrombosis and pulmonary embolism at the Mayo Clinic have concluded that if nonfatal embolism has occurred, the chance that a fatal embolism will follow is slightly less than 1 in 5 (20 per cent) and that the chances of subsequent embolism, fatal or nonfatal, are about 3 in 10 (30 per cent). They state that if all fatal embolisms preceded by clinically diagnosed sublethal emboli could be prevented, the total number of fatal embolisms would be reduced more than one third.

McCartney in a study of 25,771 autopsy records found 4,070 deaths which he considered to be postoperative mortalities. Among this group thromboembolism was present in 471 instances (11.5 per cent) and death was believed to have been caused by pulmonary embolism in 216 (5.3 per cent).

Death from pulmonary embolism may be due to a large clot which occludes the main

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pulmonary artery or its left and right branches it may also result from asphyxia when large areas of the lungs are infarcted from failure of the right side of the heart in the face of rapidly rising pulmonary arterial pressures proximal to the embolic occlusions, or from peripheral circulatory failure due to an insufficient venous return to the left atrium. Perhaps equally as important are the deaths which result from very small emboli as a result of various autonomic reflexes. DeTakats and Fowler state that they have shown that patients may die from a small embolus which occludes a vessel to an insignificant area of the lung. On the basis of animal experiments they believe that a widespread radiation of autonomic reflexes predominantly vagal occurs during embolism. These produce bronchoconstriction, increased bronchial secretion, inhibition of the heart, depression of blood pressure and other effects through smooth muscle spasm, including intestinal colic.

Pulmonary embolism which does not produce death may result in serious lung complications including necrosis, cavitation, abscess and fibrosis.

Pathological demonstrations have shown that a very high percentage of all pulmonary infarctions, even in patients with heart disease, result from emboli which have their origin in the deep veins of the lower extremities. Allen Linton and Donaldson state that Castleman found this to be true in approximately 95 per cent of cases studied at autopsy.

In the female a rather frequent source of pulmonary emboli is thrombosis in the pelvic veins complicating postpartum or postabortal sepsis or operative procedures upon the pelvic viscera. These thrombi may be bland or septic. In the case of bland thrombosis, propagation into the hypogastric vein with breaking off of a portion of the clot will produce pulmonary infarction. In this instance ligation of the inferior vena cava will completely protect against further pulmonary emboli from this source since it is thought that the ovarian veins will not yield emboli of significant size in bland thrombosis (17). If the thrombi are infected or septic, fragmentation of the clot with discharge of septic emboli may produce not only pulmonary infarction but

pyemia. In this case ligation of the inferior vena cava alone may not suffice since small, bacteria laden emboli may continue to enter the general circulation through the ovarian veins. Simultaneous ligation of these veins is therefore to be recommended.

Nelson, Jones, and Collins found a mortality rate of 100 per cent in 30 cases of pelvic thrombophlebitis not operated upon, but state that in general the literature accredits the disease with a 50 per cent mortality. These authors had ligated the inferior vena cava in 8 cases at the time their paper was published. The ovarian veins were interrupted simultaneously in 3 cases. One death occurred following operation in a moribund patient who was offered her only chance of recovery through surgery. The mortality rate was 12.5 per cent in the cases operated upon or one-eighth as high as in those not operated upon.

Thus in cases of pulmonary infarction with no apparent source for emboli, ligation of the inferior vena cava will protect from two very important sources, namely the veins of the lower extremities and the pelvic veins, except the ovarians.

#### VARIOUS METHODS OF TREATMENT

We have been discouraged by the results of heparin and dicoumarol therapy in patients in whom pulmonary embolism has occurred. This is true in respect to cases which we have personally observed as well as those reported in the literature.

The majority of reported cases which have been treated with these agents are those patients to whom the drugs were given prophylactically to prevent extension of a pre-existing thrombus, or to prevent clotting in patients believed to be susceptible to intravascular thrombosis. The results of treatment in these cases have been good. Nevertheless, there are still too many patients who develop hemorrhagic complications and too many who discharge emboli to the lungs during and after conclusion of the therapy. Results in patients who were started on treatment following pulmonary infarction have been less encouraging because of the failure of these agents in many instances to prevent subsequent infarctions. We are in agreement

with Ochsner and DeBaKey (16) who feel that the use of heparin and dicoumarol in the treatment of pre-existing thrombosis is likely to give the physician a false sense of security. This is particularly true in the treatment of a patient already the victim of pulmonary embolism. However as a prophylactic measure before thrombosis has occurred and in the treatment following ligation of the inferior vena cava these drugs may help to prevent thrombus formation or an extension of the thrombotic process into unaffected vessels. Their value in other conditions associated with intravascular coagulation of blood is acknowledged.

We have also been disappointed in treatment of the disease by proximal venous ligation at levels below the common iliacs. We have personally seen a few patients continue to discharge emboli after ligation was performed bilaterally and have noted many other examples mentioned in the literature. Veal and Hussey reported 9 cases of postligation embolism. In 4 of these the origin of the embolus was a point in the femoral vein proximal to the site of ligation. Allen and co-authors advocate bilateral femoral vein ligation with phlebectomy and aspiration of the thrombus if one is present in the segment of vein to be interrupted. They state however that about 5 per cent of their 464 patients had infarcts following this procedure. Some of these were multiple and a few resulted in fatalities. Loewe reported 1 case of fatal embolus after sequential femoral vein ligation and mentioned 4 other patients who continued to throw pulmonary emboli following ligation. Moses, in a very recent report, stated that 2 of his 35 patients with vena caval or iliac vein interruptions were operated upon because of recurrent emboli following bilateral femoral vein ligations. One of these patients died.

Proximal venous ligation at higher levels is apparently the favored procedure at this time over femoral phlebectomy with aspiration of the thrombus. This is due to a greater realization of the danger in leaving even a small portion of thrombus or an area of roughened intima in the vein proximal to the site of its interruption. Such a nidus may become the source of a new propagating thrombus and

pulmonary emboli. There seems to be little doubt that the higher the level of the venous ligation the smaller the risk of recurrent pulmonary embolism. Homans insists that interruption of the femoral vein should always be carried out proximal to the profunda in order to prevent embolism from a thrombus in this vessel. He further states that ligation of the common femoral vein is not as safe as an interruption at a still higher level. He believes that there is usually no thrombus of importance above the external iliac vein and states that this is an important consideration in common iliac and vena caval interruptions.

Fine and Starr in commenting upon the effectiveness of venous ligation in preventing embolism state that, while emboli do occasionally occur following ligation proximal to the thrombus this phenomenon may be explained in almost every instance on the basis of unilateral ligation or ligation performed at too low a level. For this reason they predict that 'vena caval ligation may come to occupy a significant place in the prophylaxis of embolism.

In the surgical treatment of thromboembolism interruption of the major venous channel from both lower extremities is demanded in the light of present knowledge.

It has been demonstrated pathologically that venous thrombosis in the deep veins of the lower extremities occurs probably more often bilaterally than unilaterally. Fine and Starr state that there is little doubt that in at least half of the patients with the disease both extremities are involved. Hunter and co-workers on the basis of findings in 351 cases published in 1941 found bilateral deep leg vein thrombosis in 110 cases as compared to unilateral involvement in 75 cases. Treatment by proximal venous ligation at any level below the inferior vena cava requires operation bilaterally in order to intercept emboli from both lower limbs. However in vena caval interruption a single operation offers protection not only from emboli arising in the veins of both lower extremities but from a pelvic source as well. Although ligation of the vena cava is a procedure of greater magnitude than femoral vein ligation we feel that it is often of lesser magnitude than a unilateral iliac vein

ligation. The one major advantage of femoral vein ligations is the fact that local anesthesia may be used satisfactorily whereas a spinal or general anesthetic is necessary for interruptions of the iliac veins or vena cava. However the added protection of vena caval ligation against further pulmonary embolism makes it the favored procedure except in very exceptional cases. Moses has entirely abandoned the iliac approach during the past year in favor of ligation of the vena cava. He states that vena caval interruption is comparable to ligation of either iliac vein requiring no more anesthesia exposure technical skill or time indeed it requires less of each of these factors than does ligation of the left iliac vein which is short and lies under the aorta.

#### COLLATERAL CIRCULATION

Second in importance to saving the life of the patient with pulmonary embolism is the consideration of circulatory disturbances in the lower extremities following interruption of their major channels of venous return. Homans has demonstrated anatomically that the collateral circulation following interruption of the common femoral or external iliac vein is far less satisfactory than that following ligation of the common iliac. His own clinical observations and published reports by others are almost uniformly in accord with these anatomic considerations *viz.* edema of the extremity is less severe and of shorter duration following common iliac vein ligation than after interruption of the external iliac or common femoral veins. Moses feels that whenever edema has followed ligation of the vena cava or iliac veins there has been unequivocal evidence of either persistence or recurrence of the disease process. It has been pointed out by Homans and more recently emphasized by O'Neil that in collateral venous circulation there is no significant choice between placing the ligation about the two common iliac veins or a few centimeters higher about the inferior vena cava.

O'Neil and Weinstein divide the available collateral pathways into three groups which they call the superficial the deep and those of the ascending lumbar trunks. The superficial

group is composed of the superficial circumflex iliac and superficial epigastric veins which connect the saphenous with the superficial thoracic veins and those of the upper abdominal wall. The deep group is made up of the deep circumflex iliac superior epigastric and lumbar veins which connect the external iliac with the internal mammary and ascending lumbar veins. The ascending lumbar trunks beginning on either side of the sacral promontory communicate with the sacral, common iliac hypogastric and ilio-lumbar veins, and at higher levels with the lumbar veins the inferior vena cava and right renal vein. The right and left lumbar trunks become the azygos and hemiazygos veins respectively and ultimately the veins of the azygos system drain into the superior vena cava.

Northway and Buxton (14) have demonstrated the more important collateral channels which function following vena caval obstruction. This was done by means of roentgen studies and dissection following injections of red lead into the femoral veins of cadavers in which the vena cava had been occluded just above the bifurcation. They found that the superior vena cava filled rapidly by way of the ascending lumbar, the segmental veins which associate directly with the vertebral plexuses through the spinal veins, and above the diaphragm by the azygos system which receives the segmental veins and terminates in the superior vena cava. Important communications between the inferior vena cava and the vertebral systems of veins were found. In all cases there was rapid filling of the inferior vena cava above the obstructed point at the bifurcation. The large internal vertebral plexus on the surface of the dura was well filled with the injected material at the time of laminectomy.

In the light of these findings it was feared that an increased blood flow through the para-vertebral venous plexus following ligation of the inferior vena cava might lead to varices in this system with neurological symptoms and signs. However there have as yet been no cases reported to indicate that this has occurred. Furthermore Northway and Buxton (14) reported no abnormal findings following



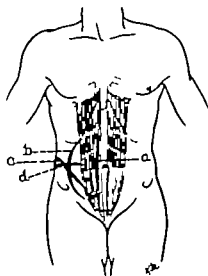


Fig. Incisions commonly used in ligation of the inferior vena cava: *a*, right paramedian, for transperitoneal approach; *b*, *c*, and *d*, incisions for extraperitoneal approach.

#### THE OPERATION

Ligation of the inferior vena cava is not a difficult operation for those experienced in abdominal and vascular surgery. The primary objective is completely and promptly to interrupt the blood flow from the more distal parts through the vena cava so that emboli arising in these distal veins may not bypass the point of ligation.

The site of election for ligation is at the level of the aortic bifurcation. This point is immediately above the junction of the left and right common iliac veins to form the inferior vena cava. It is easily found by palpation through the use of the pulsations of the aorta and of the left and right common iliac arteries.

The approach to the inferior vena cava may be either transperitoneal or extraperitoneal. The transperitoneal approach is preferred in cases in which simultaneous ligation of the ovarian veins is indicated, as in pelvic vein thrombophlebitis with pulmonary infarction or pyemia, or in which simultaneous bilateral interruption of the lumbar sympathetic chain seems advisable. Otherwise the extraperitoneal approach is the method of choice. The extraperitoneal procedure is less shocking to the patient and more easily and quickly executed in the majority of patients, and postoperative complications are less frequent than with the transperitoneal approach. Interrup-

tion of the right lumbar sympathetic chain may be easily accomplished if desired, when this approach is used.

**Technique.** In the transperitoneal approach, a 5 to 6 inch right paramedian incision is preferred (Fig. 1*a* and Fig. 3). It is made with its midpoint at the umbilicus. The operator in his early experience is usually inclined to make the incision too low unless this landmark is kept in mind. When the peritoneal cavity is entered it is helpful to place the patient in a deep Trendelenburg position. The small bowel is displaced into the upper abdomen and the posterior parietal peritoneum overlying the origin of the inferior vena cava is identified and opened parallel to the course of the vessel for about 2.5 inches. The vena cava is freed from its surrounding connective tissue by careful blunt dissection. Care is taken not to injure tributary lumbar segmental veins which enter the vena cava at its posterolateral aspect on either side. An ordinary blunt nosed gall bladder clamp serves admirably for the dissection around the lateral and posterior aspects of the vessel. Two umbilical tape ligatures, placed about 1 centimeter apart, are then passed beneath the vena cava, and the vessel is doubly ligated in continuity.

When there is doubt as to the presence of a thrombus within the vena cava at the point of ligation, this vein may be opened between the two umbilical tape ligatures before they are tied—provided it is clear that no tributaries enter this segment of the vena cava, or if they do that they are ligated prior to incising the vessel. Traction is maintained on these ligatures to prevent bleeding from below and aspiration of air from above. If a thrombus is found the patient is placed in a reverse Trendelenburg position and upon releasing tension on the proximal umbilical tape ligature, suction by means of a glass drinking tube is applied and the clot aspirated. The proximal ligature is then immediately tied. The tension is released momentarily from the distal umbilical tape ligature and the distal portion of the thrombus or as much of it as possible is removed by aspiration. This ligature is then likewise tied securely. Transfixion ligatures of braided silk may be placed between the umbilical tape ligatures as security against the





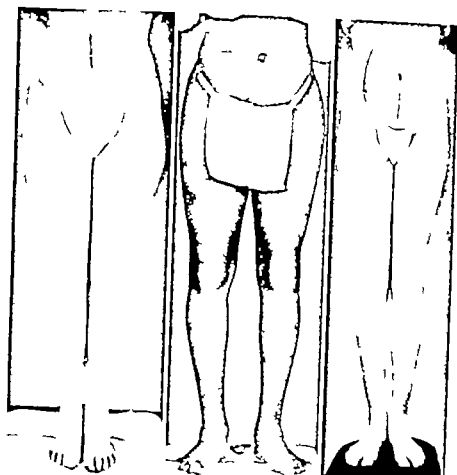


Fig. 3

Fig. 4

Fig. 5

Fig. 3. Case showing the scar of right paramedian incision. Note the absence of edema months following ligation of the inferior vena cava.

Fig. 4. Case 24, showing the scar of transverse incision used in an extraperitoneal approach to the vena cava. Photograph showing slight ankle edema as taken 4 months after operation. Six weeks later the edema had cleared completely.

Fig. 5. Case 30. Note the semilunar incisional scar. This patient had left femoral iliac thrombophlebitis with edema and right deep calf vein thrombosis at the time of pulmonary embolism. Note complete absence of edema months after ligation of the inferior vena cava.

parallel to the natural skin creases leaves a more pleasing scar. It is made at or slightly above the level of the umbilicus from a point just medial to the lateral edge of the rectus muscle to the midaxillary line (Fig. 2). The incision is extended down to the external oblique. The aponeurosis is incised at the border of the rectus muscle and the incision is extended about an inch laterally at which point as a rule the muscle fibers can be split further outward and slightly upward to give adequate exposure of the internal oblique muscle (Fig. 2B). The internal oblique and transversus abdominis muscles are then split

parallel to the course of their fibers, and the peritoneum is exposed. Should the 10th and 11th intercostal nerves be encountered, they are retracted to avoid injury. The peritoneum is bluntly dissected posteriorly and medially until the vena cava is exposed.

The ureter is identified as the dissection proceeds and is retracted medially being dissected up with the peritoneum (Fig. 2C). The psoas muscle, the genitofemoral nerve, and the right lumbar sympathetic chain are seen during the course of the dissection.

The point at which the aorta bifurcates is identified by palpation and at this level the

inferior vena cava is bluntly dissected from surrounding connective tissues, and ligated as described in discussion of the transperitoneal approach.

If indicated, the right lumbar sympathetic chain (Fig 2C) can be interrupted at this time.

When retractors and packs are removed from the wound, the peritoneum falls back and resumes its normal position, and the split transversus and internal oblique muscles come together to leave very little defect in the abdominal wall.

The incision is closed in layers using non absorbable sutures, preferably black silk.

*Postoperative care.* As with any postoperative patient, treatment following vena caval ligation varies with the problem of the individual. In general postoperative care is given as for any abdominal surgery.

The pulmonary status of the patient may require oxygen, penicillin or other special attention if there is a considerable area of lung infarcted.

Otherwise, we have found the following measures to be helpful in the postoperative care of these patients:

1. Elastic bandages applied snugly to both lower limbs. These should extend from the base of the toes to the groins with only the tips of the heels exposed, until the active process in the deep veins subsides. Later the elastic bandages need extend only as high as the tibial tuberosities. They should be worn continuously while the legs are dependent until the patient is ambulatory without edema. In patients who have extensive involvement of the veins of the lower limbs, support may be necessary for from 6 to 12 months. In others with little involvement except in some of the deep calf veins the use of support for only a few weeks may suffice. Nevertheless elastic bandage support should be maintained until the patient without them reveals no detectable edema following dependency for from 1 to 10 hours.

2. Elevation of the foot of the patient 8 to 12 inch elevation of the foot of the patient is required immediately after operation aids in returning venous blood via the collateral system of veins from the lower extremities. By speeding up the return flow of blood this measure may be of value in keeping down ex-

tension of the thrombotic process beyond segments of veins already involved. It is helpful in preventing early postoperative edema.

3. Paravertebral lumbar sympathetic blocks with novocain solution. This procedure is of definite benefit if signs of phlebitis or flex vasospasm develop postoperatively. It is performed unilaterally or bilaterally as indicated and is repeated daily until all evidence of vasospasm disappears.

4. Prostagmin 1:2000 solution. We have used this drug in doses of 1 cubic centimeter subcutaneously every 3 hours to prevent abdominal distention, to aid voluntary urination and to help prevent further intravascular clotting of blood (4).

5. Heparin and dicoumarol. These drugs may be used postoperatively preferably in combination as prophylaxis against propagation of thrombi in the veins of the lower limbs or in the branches of the pulmonary artery. In this series we have used them in only 1 patient (Case 34) who had recurrence of pleuritic pain 48 hours after operation.

(We have consistently noticed that all patients in our series who had severe pleuritic pain for varying periods of time prior to ligation of the vena cava were completely relieved of this pain upon reacting from the anesthetic. This fact has led one of us (BRT) to feel that perhaps the pleuritic pain produced by a single pulmonary embolus is of rather brief duration, possibly 1 to 6 hours, and that many patients in whom the pain persists for longer periods are actually having repeated pulmonary embolizations. Two patients in this series had postoperative recurrence of pleuritic pain. In these cases the pain was probably due to peripheral propagation of thrombi from points of previous embolic occlusions of branches of the pulmonary artery.)

6. Ambulation. The patient is encouraged to become ambulatory as soon as possible after operation. The length of time depends upon the degree of pulmonary damage and clearing of the infarcted areas upon the status of the phlebitis and/or edema of the lower extremities and upon the general condition of the patient. In the absence of infection and the presence of a positive protein balance the operative wound is not considered as a factor

SURGERY GYNECOLOGY AND OBSTETRICS

TABLE I

[illegible]

# THEBAUT, WARD LIGATION OF INFERIOR VENA CAVA

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TABLE I.—Continued

Remarks

Later effects

Immediate effects

Length followed up

Witcham-like

Pain

Edema

None

None

None

None

None

None

None

None

Thrombophlebitis

Edema

None

None

None

None

None

None

None

None

None

None

None

Postoperative complications

Edema

None

None

None

None

None

None

None

None

None

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None

Symptomatic thoracic region

Edema

None

None

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Approach

Edema

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Date of operation

Edema

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Site of thoracic lesion

Edema

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Approach

Edema

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Date of operation

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Site of thoracic lesion

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Approach

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Date of operation

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Site of thoracic lesion

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Site of thoracic lesion

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Site of thoracic lesion

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Date of operation

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Site of thoracic lesion

Edema

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Approach

Edema

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Date of operation

Edema

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None

Site of thoracic lesion

Edema

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None

None

None

TABLE I.—Continued

Case No. Patient's Hospital No.	Age Race Sex	Site of thrombo- sism	Date of opera- tion	Approach	Spinal theor- eic upper region	Postoperative complications	(Immediate effects)	Length follow-up period Months	Later effects		Remarks
									Phle- bitis	Ulcer	
L 17 A 114	41 White Female	Bilateral deep calf	4-4-46	Extraperitoneal	No	None	Thrombo- sism None	3	None	None	Patient has (slight dependent) ankle edema after prolonged standing. Edema not ap- parent in the early morning.
M 18 A 115	41 White Female	Bilateral femoro- femoral	4-27-46	Extraperitoneal	N	Severe phlebo- toma and edema medial	None None	3	None	None	Prior to operation respiratory rate 40 per minute. Patient had almost constant cough and sputum. Patient had been treated for in mild cardiac failure. Died during labor due to anastomosis. No autopsy
L 19 A 116	41 Colored Female	Left femoro-femoral	6-20-46								Prior to operation respiratory rate 40 per minute. Patient had almost constant cough and sputum. Patient had been treated for in mild cardiac failure. Died during labor due to anastomosis. No autopsy
L 20 A 117	41 Colored Male	Right	6-20-46	Extraperitoneal	No	None	Increased phle-				
M 21 A 118	41 White Male	Right femoro-femoral above point of perforation in femoral vein	7-6-46	Extraperitoneal	No	None	Increased None				Patient had recurrence of pulmonary embol- ism following ligation of both femoral arteries. Patient died of pulmonary embolism 10 days after operation. Autopsy showed thrombosis.
M 22 A 119	41 Colored Male	Bilateral femoro- femoral	7-9-46	Extraperitoneal	No	Died as subject after operation					Patient died as subject after closure of he- morrhage. Autopsy showed the following condition: Patient had been treated for artery. Pathologist's opinion was that this occurred prior to operation.
M 23 A 120	41 White Male	Left	7-18-46	Extraperitoneal	No	None	None None				
M 24 A 121	41 White Male	Bilateral deep calf	7-24-46	Extraperitoneal	Right	None	Increased Right				Patient continued having claudication and very marked edema of extremities of extremities after operation. Treated with heparin and aspirin.
M 25 A 122	41 Colored Male	Left	8-7-46	Extraperitoneal	No	None	None None				
M 26 A 123	41 White Male	Left	8-8-46	Extraperitoneal							Patient continued having claudication and very marked edema of extremities of extremities after operation. Treated with heparin and aspirin.

# THEBAUT, WARD LIGATION OF INFERIOR VENA CAVA

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in determining when to permit the patient to leave his bed

## PRESENTATION AND DISCUSSION OF CASES

Of the 36 cases reported, 34 were treated for pulmonary embolism by ligation of the inferior vena cava. The pertinent data on these patients are recorded in Table I. The other 2 died on the operating table before the vena cava was ligated.

One incisional hernia and 2 intestinal obstructions, 1 complete and 1 incomplete developed postoperatively. In these 3 cases the transperitoneal approach was used. Other postoperative complications consisted of 1 wound infection and 1 case of pharyngitis and titis media.

No attempt has been made to differentiate between thrombophlebitis and phlebothrombosis, since the purpose of the paper is to treat only the matter of procedure once pulmonary embolism occurs from the legs or pelvis regardless of the primary disease. All of the patients had had at least one episode of pulmonary embolism and some more than one. Prophylactic ligation before embolism was not done in any case.

Seventeen of the patients were colored and 19 were white. Seventeen were females and 19 were males. The age incidence showed the majority to be between 21 and 40 years of age. It is noteworthy that 3 of these patients were between 10 and 20 years of age, 10 between 21 and 30 and 5 above 50 years of age.

In this small series little correlation between the clinical location of the thrombosis and the occurrence of pulmonary embolism was apparent. Eight patients were afflicted with bilateral femorohiatic disease, 6 with bilateral deep calf vein thrombosis, 3 with femorohiatic disease on one side and deep calf vein thrombosis on the other, 5 with femorohiatic disease on one side and no clinical evidence of disease on the other, 5 with only unilateral deep calf vein thrombosis and 9 patients showed no clinical findings suggestive of disease in either lower extremity.

Results have been classified under two general headings: immediate effects and late effects. Immediate effects should be taken to mean the changes occurring within 10 days

after the operation. Within this period, 14 showed no effect on the thrombophlebitis; neither pain, temperature, nor tenderness was increased. Eighteen showed definite aggravation of the disease. Immediately after operation the edema increased in 20 but 12 showed no increase. These findings are especially interesting in view of the fact that vena caval ligation has been performed therapeutically for chronic thrombophlebitis with edema.

All patients were seen for later follow up studies. The length of time elapsing between operation and last observation varied between 33 months and 2 months. Late effects on some of the living patients have not been recorded since the time lapse has been too short. Twenty-six patients have no pain. One patient has occasional cramping pains in the calves of the legs. Twenty-seven patients have no varicosities. No edema is apparent in 19 patients (Figs. 3 and 5). 6 patients have slight dependent edema after standing all day and 2 patients have slight persistent edema. In none is the edema incapacitating. It is doubtful whether the edema in this series of cases is any greater than would have been anticipated had not vena caval ligation been performed.

Lumbar sympathectomies were done at the time of vena caval ligation on 7 of the cases. Four of these operations were performed bilaterally and 3 were confined to the right side. In 6 of these cases the disease intensified clinically as evidenced by an increase in pain or tenderness or there was an increase in edema. It is interesting to note that in Case 34, with bilateral deep calf vein thrombosis there was a transient increase in calf pain on the side upon which the lumbar sympathetic chain was interrupted.

Four patients died. Of these Patient 5 died 5 hours after the operation. Autopsy revealed an acute cor pulmonale and multiple bilateral pulmonary infarcts. Patients 29 and 36 died on the operating table before vena caval ligation was effected. Patient 29 was a cardiac in mild failure at the time of operation and both patients had had several episodes of pulmonary embolism. Autopsies were not obtained on these 2 cases. Patient 32 died 20 minutes after closure of the incision. Autopsy

revealed a large embolus completely occluding the left pulmonary artery. Apparently these patients do not tolerate surgery well if operation is delayed until after massive pulmonary infarction has occurred. Vena caval ligation is advocated as soon as possible therefore, after the first embolism has occurred. Case summaries with brief comments on the patients who died are given below.

Forty-eight hours after operation Patient 34 experienced increased chest pain. Patient 26 had a similar episode of pain 48 hours postoperatively. She recovered completely without specific therapy. It was assumed that there had been an extension of an embolus lodged in a branch of the pulmonary artery prior to operation in both of these cases. In Case 34 it is interesting to note that although the patient was placed on heparin and dicoumarol at the time of recurrence of the pain 7 days later he again suffered from an acute exacerbation of pain in spite of a decrease in prothrombin to a level ranging between 15 and 30 per cent of normal. This gradually subsided and since that time he has had no further chest pain. X-ray studies confirmed the impression that no new areas of pulmonary infarction were present. None of the patients showed evidence of any new pulmonary embolism after vena caval ligation.

Since many writers are advocating bilateral ligation of the femoral veins above the site of thrombosis as treatment of pulmonary embolism, Patient 31 merits special note. Both femoral veins were simultaneously ligated after pulmonary embolism had developed with evidence of bilateral deep calf vein thrombosis. Subsequently the patient suffered a new embolus. The vena cava was ligated and the patient made an uneventful recovery. During the past year the writers have had 2 patients (unreported) die from fatal emboli subsequent to bilateral femoral vein ligations for deep calf vein thrombosis with pulmonary embolism.

#### SUMMARIES OF FATAL CASES

CASE 5 J. C., Hospital No. 261066 a 35 year old colored male was admitted to the Medical Service of Grady Memorial Hospital on March 29, 1945 for severe congestive heart failure. One year previously he had developed cardiac decompensation and treat-

ment was given in the out-patient department. Despite treatment he became severely decompensated in March, 1945. Response to bed rest, diuretics, and the removal of 900 cubic centimeters of clear amber fluid from the right pleural cavity in addition to digitalis was good. The patient's weight dropped from 177 to 155 pounds by the 5th hospital day. On April 4, 1945 the 7th hospital day, he suddenly developed severe pain in the lower right anterior chest. This pain was inadequately relieved by intercostal nerve block with novocain solution. An x-ray film of the chest on the following day revealed a density in the right cardiophrenic angle consistent with a pulmonary infarction. The lower extremities were negative for any signs suggesting phlebitis until April 8, 1945 the 11th hospital day when both calves became tender to pressure and Homans' sign became positive bilaterally. Femoral vein tenderness was also noted at this time. By this time the patient's general condition had gone rapidly downhill from repeated episodes of pulmonary embolism. Since it was obvious that death was certain unless the emboli were interrupted, the patient was prepared and with the use of spinal anesthesia (15 cc. of pontocaine) the inferior vena cava was ligated following a transperitoneal approach. The patient stood the procedure well, but 5 hours after completion of the operation he died suddenly. An autopsy was performed, and pathologic studies revealed multiple bilateral pulmonary infarctions, acute or pulmonary lentic aortitis and valvulitis with aortic insufficiency. It is believed that the patient's death resulted from acute failure of the right side of the heart due to massive embolic obstructions of the pulmonary arterial tree.

Several mistakes in the management of this patient are now obvious. No treatment, except symptomatic, was given for pulmonary embolism until 4 days after its onset. Vena cava ligation was carried out transperitoneally in a patient critically ill. It is interesting to note that this cardiac patient had no signs of venous disease in the lower limbs until almost dead of pulmonary infarctions and that when signs developed in the calves, the femoral veins were noted to be tender as high as the inguinal ligaments, indicating that thrombi had already propagated to the external iliac veins.

Should we face the same problem today we would ligate the inferior vena cava extraperitoneally as soon as the diagnosis of pulmonary infarction had been made, irrespective of an absence of signs of venous disease in the lower limbs and regardless of the comparatively small possibility of the heart itself serving as a source for the pulmonary emboli. If,

following ligation, there should be recurrence of pleuritic chest pain in the same or in a different location heparin and dicoumarol would be started immediately. It is possible that this patient would be living today had this plan of treatment been followed.

CASE 29. G. McC. Hospital No 56477 & 45 year old colored female was first seen in the surgical outpatient clinic, Grady Memorial Hospital, on June 6 1946. She complained of pain and swelling in the left upper thigh. Examination revealed edema and tenderness in the region of the femoral vessels in the upper left thigh. There were no signs of phlebotrombosis in either leg. A diagnosis of cellulitis was made by the examining intern. Bed rest at home and sulfadiazine were prescribed. The patient returned on June 20 1946 and was admitted to the hospital on the surgical service. She stated that on the previous night she experienced a sudden severe pleuritic pain in the right chest which persisted the morning of admission she developed hemoptysis. Examination revealed an acutely ill patient who was dyspneic and coughing up large amounts of bright red blood. Temperature was 98.6 pulse 110 respiration 40 blood pressure 180/120. The heart was moderately enlarged to the left. Physical signs of consolidation of the lower lobe of the right lung with friction rub were present. X ray examination of the chest suggested pulmonary infarction of both lower lobes. There was a 2 plus pitting edema of both legs and feet, and tenderness along the course of the left femoral vein was noted. There was no calf tenderness, and Homans sign was negative bilaterally. Upon the recommendations of the medical consultant, rapid digitalization to the ward and was started 2 hours after admission to the ward and a mercurial diuretic was given intravenously. One hour later the patient was transported to the operating room for ligation of the inferior vena cava. Within 5 minutes after beginning the administration of nitrous oxide and oxygen to induce anesthesia the patient had a sudden respiratory arrest which could not be overcome. Autopsy permit was refused.

The cause of death in this patient was probably a massive pulmonary embolus which occurred during induction of the anesthesia since respirations ceased so abruptly and preceded cardiac standstill by a few moments. However, we cannot definitely rule out anoxia as playing an important rôle in view of the large area of pulmonary tissue already disabled by previous infarctions plus the limited amount of oxygen permitted with nitrous oxide induction.

Obviously this patient needed emergency treatment in an effort to save her life. She had been throwing emboli for less than 24 hours at

the time of her death and this fact, plus the physical and x ray findings upon admission to the hospital, suggested that large emboli were being discharged probably from a left femoral iliac venous thrombosis. Femoral ligations therefore were felt to be out of the question. Since local anesthesia is unsatisfactory for either of these procedures, a general or a spinal anesthetic was necessary. Because of the marked hypertension a general anesthetic was preferred.

It seems that inhalation anesthetic agents with which adequate oxygen is given will prove to be the safer for vena caval ligation especially in patients with extensive pulmonary infarction.

CASE 32. W. R. Hospital No 214204 & 45 year old colored male was admitted to the medical service of Grady Memorial Hospital on July 9, 1946. Three weeks previously the patient had developed superficial ulcerations on both shins accompanied by edema of the legs, feet and ankles. The ulcers had healed and the swelling had almost completely subsided. The history did not suggest the cause of the ulcerations but since the patient was totally blind it was believed that they were traumatic in origin. The patient was otherwise well until 2 days prior to admission when he developed a dull aching pain in the lower left anterior chest which soon came to resemble pleurisy. The onset of pain was accompanied by a cough which was productive of mucoid sputum. Both symptoms persisted. On the day of admission he began coughing up bright red blood. Physical examination revealed temperature to be 102.6 pulse 120, respiration 42 blood pressure 105/70. The patient was orthopneic and appeared acutely ill. There were signs of lung consolidation in the left lower lobe posteriorly and some evidence of free fluid in the left pleural space. Thoracentesis yielded 50 cubic centimeters of old and fresh serous sanguinous material. The lower extremities revealed a 1 plus pitting edema of the legs and feet. The left calf was slightly larger than the right. There was no tenderness along the course of the femoral or popliteal veins nor tenderness to compression of the calf muscles. Homans sign was negative bilaterally. An x ray study of the chest showed a pleural effusion on the left with shift of the mediastinum to the right. For reasons unknown, the patient received no treatment whatever until 12 hours after admission to the hospital when a preoperative hypodermic was administered. Shortly thereafter he was taken to the operating room. Under spinal anesthesia supplemented with local infiltration of 1 per cent novocain and sodium pentothal intravenously the inferior vena cava was ligated through a right lumbar incision by an extraperitoneal approach. The



patient went into shock as the muscle layers of the abdominal wall were split for exposure of the peritoneum. In spite of blood plasma and other measures to combat the circulatory collapse he failed to respond and died a few minutes after conclusion of the operation.

It was the clinical impression at the time that the patient's circulatory collapse resulted from a large pulmonary embolus which was thrown off prior to interruption of the inferior vena cava.

Autopsy revealed a large embolus completely occluding the left main branch of the pulmonary artery and massive infarction of the lower lobe of the left lung. Small adherent thrombi were found in the prostatic plexus of veins. No premortem clots were demonstrated in the iliac veins. Permission for exploration of the large veins below the inguinal ligaments was not granted.

Had operation been carried out promptly upon admission to the hospital it is possible that this patient would have survived since his death was apparently the result of recurrent pulmonary embolism. Although the source of the emboli was not demonstrated at autopsy it is probable that they arose from thrombi in one or both femoral veins.

CASE 36 J J Hospital No. 161-625 a 71 year old white male was first seen in February 1946, complaining of dyspnea and retrosternal fullness of sudden onset. Examination revealed a blood pressure of 130/80. The heart was slightly enlarged and there was a harsh systolic murmur at the apex. Numerous moist rales were heard in the lower lobe of the right lung. There was a slight edema of both feet. The dyspnea disappeared following an intravenous injection of a mercurial diuretic. X-ray examination of the chest 4 days later revealed a small pleural effusion on the left and a small area suggestive of infarction in the left lower lobe.

His condition remained satisfactory until April 8, 1946 when there was an acute recurrence of dyspnea. Examination revealed moist rales at the left lung base distention of the neck veins and cardiac fibrillation. He responded as before to the same treatment. Four days later the dyspnea recurred, and he developed a cough productive of mucopurulent sputum. He continued to have dyspnea intermittently. The lower extremities remained conspicuously negative for signs of phlebitis.

On June 15 1946 the patient developed hemoptysis. X-ray examination of the chest showed a partial atelectasis of the right upper and lower lobes. It was the clinical impression at that time that the patient had a bronchogenic carcinoma. He was hospitalized for roentgen therapy. There was roentgenological evidence of improvement of the atelectatic process after several weeks.

On August 8 1946 he developed areas in the left lung suggestive of pulmonary infarctions. A surgical

consultation was requested at this time. In view of the x-ray evidence of pulmonary infarctions, it was decided to ligate his inferior vena cava although his lower extremities remained negative.

He received 0.75 gram of sodium pentothal intravenously as an induction agent. Following this he was given nitrous oxide, oxygen, and ether. A transverse skin incision was made and the external oblique muscle was divided. At this point, respiration and pulse stopped suddenly and the patient failed to respond to stimulants and artificial respiration. Permission to perform an autopsy was not obtained.

The cause of death in the patient remains unexplained. It is possible that he had a massive pulmonary embolus on the operating table. On the other hand, he had been sick for 6 months and was a poor surgical risk. This case serves to emphasize the suggestion that if the vena cava is to be ligated, it should be done as soon as possible after the first embolus is recognized.

In retrospect the question has arisen as to whether or not this death was due to a poor choice of anesthetic agents. It is felt that sodium pentothal is not the safest anesthetic for elderly or poor risk patients.

#### SUMMARY AND CONCLUSIONS

- 1 The importance and significance of thromboembolism and the various methods of treatment are discussed.
- 2 The advantages of ligation of the inferior vena cava are presented.
- 3 The operative technique of vena caval ligation is described in detail.
- 4 Thirty-six cases of thromboembolism are reported. In 34 patients ligation of the inferior vena cava was performed. Two patients died on the operating table before ligation could be accomplished. There was no known recurrence of pulmonary embolism in any of the patients operated upon.
- 5 Follow up studies are presented.
- 6 Ligation of the inferior vena cava is recommended as the treatment of choice in patients with thromboembolism.

#### REFERENCES

1. ALLEN, A. W., LINTON, R. R., and DONALDSON, G. A.  
J. Am. M. Ass., 945 28397
2. BARKER, N. W., NYGARD, K. L., WALTERS, W., and  
PRIESTLEY, J. T. Proc. Staff Meet. Mayo Clin  
945 16 33.

# THEBAUT WARD LIGATION OF INFERIOR VENA CAVA

401

3. BUCKTON R. W. and COLLIER, F. A. Surgery 1945, 18:663
4. DETAKATS, G., and FOWLER, E. F. Surgery 1945, 17:153
5. FINE, J., and STARR, A. Surgery 1945, 17:233
6. GASTON, E. A., and FOLSON, H. N. England J. M. 1945 233:129.
7. HOMANS, J. Surg. Gyn. Obst., 1944 79:70
8. HUNTER, W. C., KRYGIER, J. J., KENNEDY, J. C. and SKIDDEN, V. D. Surgery 1945 17:178.
9. KROM, H. M., and BERMAN, E. Am. J. Surg. 1945, 69:190.
10. LOEWY, LEO. J. Am. M. Ass. 1946 130:386
11. MCCARTHEY, J. S. Surgery 1945 17:191
12. MORSE, W. R. N. England J. M. 1946, 235:1
13. NELSON, E. W., JONES, J. R. and COLLINS, D. G. N. Orleans M. & S. J., 1942-43, 95:373.
14. NORTHWAY, R. O. and BUCKTON R. W. Surgery 1945 18:85
15. OCHSNER, A. Surgery 1945 17:240.
16. OCHSNER, A., and DEBAKEY, M. Lewis' Practice of Surgery Vol. 12, Chap. 5 B Hagerstown Md. W. F. Prior Co. Inc., 1945
17. O'NEIL, E. E. N. England J. M., 1945 233:641
18. REAL, J. R. and HUMERY, H. H. Surgery 1945 17:218.
19. WARREN, J. V., and WHEENS, H. S. Venographic studies following ligation of the inferior vena cava. To be published.
20. WEINSTEIN, B. B. In discussion of Collins, C. G. Jones, J. R., and Nelson E. W. N. Orleans M. & S. J. 1942-43 95:324.
21. WELCH, C. E. and FAXON, H. H. J. Am. M. Ass. 1941 117:1502.

# TOTAL GASTRECTOMY

## Report of 89 Cases

FRANCES H SMITH M.D., Boston Massachusetts

SINCE the first report of a total gastrectomy in 1884 more than 300 have been reported in the literature. In 1943 Pack and McNeer collected all of the published reports, of which there were 283 operations, and added 20 of their own. In this study the outstanding facts were the high operative mortality and the few instances of long survival. That these should be the outstanding features was to be expected from the nature of the lesions for which this procedure is required and the relative inexperience with which surgeons of necessity operated.

In 1927 the first total gastrectomy was performed at the Lahey Clinic and 88 additional operations had been done by October 1, 1945. Since there have been few reports (2-3) of a large number of cases from any one clinic, the information gained from these 89 operations seems worthy of presentation.

### CRITERIA FOR SELECTION OF CASES

The history of the patient was more or less nonspecific and offered little assistance in determining the need for total gastrectomy. In every case, however, there was roentgenologic evidence of a lesion involving the stomach. In many the lesion was extensive in others although localized the cardia or the lower end of the esophagus or both were known to be involved preoperatively. A fixed lesion or involvement of additional sites in the small intestine or colon demonstrable by roentgenologic examination, a mass palpable in the epigastrium, palpable nodules in the liver, a supraclavicular node, or a rectal shelf were considered to be contraindications to exploration (1).

In some instances the necessity for total gastrectomy was not realized until the stomach was examined at the time of operation. Careful exploration under the direct vision of

an abdominal approach provided the most satisfactory determination of the extent of the lesion, the presence of local or distant abdominal metastases and consequently the advisability of attempting the operation. The paper by Lahey and Marshall gives detailed indications for total gastrectomy.

### AGE AND SEX DISTRIBUTION

In this series there were 51 male patients and 38 female patients. The youngest was 23 years of age and the oldest 75. The age distribution is shown in Table I. There were 2 patients in the third decade and 11 who were 70 years of age or over, of whom 3 were 75. In this latter group 5 patients survived the operation, 1 of whom lived for 2 years and 1 is still alive 18 months after operation. Although the largest number of patients fell within the age range of 40 to 70 years, it is important to remember not only that patients less than 40 years of age (10 per cent in this series) may develop lesions necessitating total gastrectomy but also that an age of 70 or greater is not a contraindication to this extensive procedure.

### SYMPTOMATOLOGY

The duration of symptoms from the time of their onset until the patient was first seen at the Clinic is shown in Table II. In more than half of the patients this was 6 months or less and in one-fourth it was 3 months or less. This should serve to emphasize the necessity for prompt and thorough investigation of any patient with gastrointestinal complaints and to condemn the far too prevalent practice of symptomatic treatment until the patient develops unmistakable evidence of disease.

The most common presenting symptoms in these patients are listed in Table III. Examination of this table shows that there is no suggestive symptom or syndrome. Unexplained loss of weight in patients with digestive con-

From the Department of Gastroenterology The Lahey Clinic, Boston.

TABLE I.—AGE DISTRIBUTION—89 PATIENTS

Age, years	No. patients
20-29	2
30-39	7
40-49	10
50-59	26
60-69	24
70-79	11

TABLE II.—DURATION OF SYMPTOMS WHEN FIRST SEEN

No. months	No. patients
3 or less	23
4 to 6	23
7 to 9	8
10 to 12	13
13 to 18	5
19 to 24	5
25 to 36	5
37 to 48	2
Over 48	1
Unspecified	4

plants suggests a malignant lesion in the gastrointestinal tract. Loss of weight occurred in 66 patients of this series (Table IV). In 28 the loss was more than 20 pounds. Twenty two had gastric fullness and pressure, 8 had an ulcer syndrome, 8 diarrhea, 6 dysphagia, indigestion, and heartburn. All of these symptoms indicated disturbance in gastrointestinal function but none could be considered specific for a gastric lesion. These self-evident facts are mentioned to stress the point that although a careful history may in some instances lead to a correct diagnosis in many the complaints are so nonspecific and even apparently unimportant that the diagnosis may be missed or delayed until too late for successful surgical intervention unless the insidious symptomatology is constantly borne in mind.

#### CLASSIFICATION OF LESIONS

There were 88 malignant tumors, 2 benign tumors which were leiomyomas, and 3 non-neoplastic lesions, of which 2 were chronic gastritis and 1 showed multiple ulcers. The malignant tumors consisted of 81 carcinomas of which 48 were carcinoma simplex and 25 adenocarcinoma. 4 sarcomas of which 3 were lymphosarcomas and 1 a leiomyosarcoma, and 3 lymphomas. Of the latter 2 were classified as Hodgkin's disease and 1 as malignant lymphoma. The pathologic classification of all the lesions is given in Table V.

TABLE III.—PRESENTING SYMPTOMS

	No. patients
Loss of weight	66
Pain	47
Anorexia	27
Nausea and/or vomiting	26
Weakness and fatigability	25
Epigastric fullness and pressure	23
Constipation	14
Ulcer syndrome	8
Melena	8
Diarrhea	8
Dysphagia	6
Intercapular pain	6
Dyspepsia indigestion heartburn	5
Regurgitation	5
Gaseous distention	5
Hematemesis	4
Belching	3
Pallor	2
Chest pain	2
Back pain	2
Other complaints—Ribbon-like stools intolerance to liquids ankle edema, atrophobia depression, tetany headaches, and numbness of feet	1 each

As has been pointed out by Lahey and Marshall carcinoma of the stomach may be readily divided into two types one the localized type which rapidly metastasizes to adjacent lymph nodes and the other the linitis plastica or leather bottle type in which the carcinomatous infiltration spreads through the muscle bundles in the gastric wall and makes a rigid but comparatively rarely metastasizing lesion which is appropriate for total gastrectomy.

The infiltrative and slowly metastasizing properties of lymphosarcoma also make the patient with this malignant growth a good risk for total gastrectomy. Patients with low grade malignant and benign lesions causing esophageal obstruction at the cardia also have yielded good results with this operation.

#### PREOPERATIVE BLOOD STUDIES

Much has been written about the effect of malignant disease of the stomach on the blood.

TABLE IV.—WEIGHT LOSS PREOPERATIVELY

No. pounds	No. patients
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41 to 50	6
Over 51	1

Fifty per cent of patients on whom information is known lost 20 pounds or more.

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Fifty per cent of patients on whom information is known lost 20 pounds or more.

TABLE V—CLASSIFICATION OF LESIONS

	No. cases	Total cases
<b>Malignant tumors</b>		
Carcinoma—81		
Adenocarcinoma	25	
Adenocanthoma	2	
Carcinoma simplex	48	
Epidermoid carcinoma	2	
Adenocarcinoma with mucinous foci	1	
Unclassified	3	
<b>Sarcoma—4</b>		
Lymphosarcoma	3	
Leiomyosarcoma	1	
<b>Lymphoma group—3</b>		
Lymphoma	1	
Hodgkin's disease	2	
<b>Total malignant tumors</b>		88
<b>Benign tumors</b>		
Leiomyoma	2	
<b>Total benign tumors</b>		2
<b>Nonneoplastic lesions</b>		
Chronic gastritis		
Multiple peptic ulcers		
<b>Total nonneoplastic lesions</b>		3

picture. Since the majority of these lesions were malignant, the findings of the preoperative blood studies are presented as a whole in Table VI. In 78.8 per cent the red blood cells numbered 4,000,000 or more. In 59.5 per cent the hemoglobin was 13 grams or less. It is of interest to note that in a significant number of

TABLE VI.—PREOPERATIVE BLOOD STUDIES

<b>Red blood cell counts</b>		
to 1 million		
to 3 million		
3 to 4 million	3	
4 to 5 million	14	
5 to 6 million	49	
	4	
<b>Hemoglobin determinations†</b>		
Less than 6 grams		
6 to 8 grams	1	
8 to 9 grams	4	
9 to 10 grams	3	
10 to 11 grams	5	
11 to 12 grams	5	
Over 12 grams	26	
<b>White blood counts‡</b>		
Less than 5,000		
5,000 to 7,000	7	
7,000 to 9,000	7	
9,000 to 11,000	17	
Over 11,000	16	
	14	

78.8% of counts were 4 million or greater  
 †40.4% of determinations were 3 grams or greater  
 ‡1% of counts are less than 6,000 42% are between 6,000 and 9,000 37% are greater than 9,000.

TABLE VII.—DEGREE OF ACIDITY IN PREOPERATIVE ANALYSES

No free hydrochloric acid	No. cases
Less than 25 degrees	41
25 to 50 degrees	11
Greater than 50 degrees	6
68.9% of analyses showed acidity	1
89.6% of analyses showed acidity of 25 or less	

cases no anemia, or anemia of a mild degree was present. The general trend was toward hypochromia and even in those cases in which severe anemia was present a macrocytic by perchromic type was a rarity.

There was no characteristic picture in the number of white blood cells. The count varied from 3,050 to 16,800. In 21 per cent the counts were less than 6,000, in 42 per cent between 6,000 and 9,000, and in 37 per cent they were greater than 9,000.

## PREOPERATIVE GASTRIC ACIDITY

The degree of gastric acidity preoperatively is shown in Table VII. No free acid was found in 68.9 per cent and in 89.6 per cent it was 25 units or less. A comparison of this series with a group of Lahey Clinic patients subjected to subtotal gastrectomy for carcinoma of the stomach shows a greater incidence of anacidity or low acidity in patients requiring total gastrectomy. On the other hand it is important to realize that an acidity of 50 units or greater is not incompatible with a lesion for which total gastrectomy is necessary. Unless this is constantly borne in mind, a sense of false security may result from the finding of an elevated acidity and operation may be delayed.

## CAUSES OF DEATH

**Immediate postoperative death.** Twenty-six patients did not live to leave the hospital. The primary and contributing causes of death in so far as could be determined are listed in Table VIII. The postoperative deaths in the entire group are 26 or 29.1 per cent. From 1927 to January 1, 1942 there were 46 cases, with an operative mortality of 41.3 per cent. In the following 3 years and 9 months almost as many operations were performed (43) as in the previous 15 years. In this latter period, that is from January 1, 1942 to October 1, 1945 the

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TABLE VIII.—CAUSES OF DEATH FOLLOWING TOTAL GASTRECTOMY

Immediate postoperative deaths	
Abdominal conditions	
Peritonitis	
Separation of suture line	
Colitis	
Subdiaphragmatic abscess	
Heus	
Wound abscess	
Pulmonary conditions	
Bronchopneumonia	
Mediastinitis	
Pulmonary infarction	
Atelectasis	
Tracheitis	
Cardiovascular conditions	
Peripheral circulatory failure	
Cardiac failure	
Thrombosis of splenic artery and vein	
Other conditions	
Parotitis	
Total number of postoperative deaths	
Specified—	24
Unspecified—	3
Subsequent deaths	
Metastases	
Inanition	
Intestinal obstruction	
Stricture	
Jejunocolic fistula with obstruction	
Acute cardiac dilatation	
Total subsequent deaths	
Specified—	35
Unknown—	8

TABLE IX.—SIGNS AND SYMPTOMS IN 57 PATIENTS FOLLOWING DISCHARGE FROM THE HOSPITAL

Dysphagia	16
Abdominal pain	14
Diarrhea	10
Nausea or vomiting or both	9
Failure to gain weight	7
Regurgitation	7
Fullness and abdominal distress	5
Weight loss	5
Heartburn	5
Weakness	4
Hypochromic anemia	4
Belching	3
Anorexia	3
Sore tongue	3
Anemia (unspecified)	3
Normochromic anemia	3
Intestinal obstruction	2
Other complaints	2
Sitophobia, burning in the throat, cough, cachexia, belching mental depression, pleural effusion (with out cancer cells) pernicious anemia salivation, and cheilitis.	1 each
	26

## SIGNS AND SYMPTOMS FOLLOWING DISCHARGE

The signs and symptoms occurring in 57 patients following discharge from the hospital are shown in Table IX. Dysphagia is the most frequent difficulty encountered in patients who have undergone total gastrectomy. In this series it was reported in 28 per cent of those who survived the operation. In the majority of cases this is caused by scar tissue at the site of the jejunoesophageal anastomosis and is easily remedied by dilatation. In some instances 1 or 2 dilatations suffice to control the situation while in others 8 or more have been required at varying intervals. In some cases this symptom indicates a recurrence but of our cases it is thought that the patient died prematurely because her local physician felt that since the symptom very probably indicated recurrence dilatation was useless and the result that the patient died of starvation. Diarrhea was noted in 17 per cent. In several instances this symptom has been well controlled by adding hydrochloric acid to the diet. In others bismuth subcarbonate powder has been equally successful. This complaint in our experience is usually short lived and as the jejunal pouch enlarges, gradually disappears. Nausea and vomiting usually are early symptoms. The most frequent causes are nar-

operative mortality was 16.3 per cent. This phenomenal decrease is the result primarily of four factors: (1) the increase in surgical skill arising from familiarity with the various techniques as well as the different problems encountered at operation; (2) better selection of cases; (3) the introduction of new bacteriostatic agents chiefly the sulfonamides and penicillin; and (4) better preoperative and postoperative care of the patient especially as to nutritional requirements and management of pulmonary and cardiovascular emergencies.

**Subsequent deaths.** Of the 63 patients who left the hospital 43 were known to have died by March 1, 1946. The causes which are known in 35 of these are given in Table VIII. Recurrence developed in 85.7 per cent. This is interesting in view of the fact that the metastases in only 69.5 per cent. The discrepancy is probably more apparent than real.



## SURGERY GYNECOLOGY AND OBSTETRICS

TABLE X.—SURVIVAL CHANCE

Calculations based upon all patients who survived operation but have subsequently died (43 patients)

Less than 3 months	8
3 to 6 months inclusive	19
7 to 12 months inclusive	10
13 to 18 months inclusive	4
19 to 24 months inclusive	2
25 to 36 months inclusive	2
37 to 48 months inclusive	1
Over 48 months	

Estimated chance of survival based upon 43 patients who survived operation but have subsequently died

50% have a chance of living 3 months
28% have a chance of living 18 months
16% have a chance of living 34 months
9% have a chance of living 36 months

Survival period of 4 patients who are still living

6 to 3 months inclusive	2
3 to 6 months inclusive	2
9 to 24 months inclusive	0
25 to 36 months inclusive	3
37 to 48 months inclusive	1
Over 48 months	5

Estimated chance of survival based upon 57 patients who survived operation, whether now living or dead

59.7% have a chance of living 12 months
38.6% have a chance of living 18 months
29.8% have a chance of living 24 months
21.1% have a chance of living 36 months

rowing at the anastomosis which may be the result of edema or spasm or of the small initial capacity of the jejunal pouch. These symptoms yield frequently to antispasmodics and small and frequent feedings. The patient should be cautioned to eat slowly and to avoid any considerable amount of fluid with the meals. By systematically increasing the caloric intake over succeeding weeks, the capacity of the 'new stomach' increases to a point at which three meals a day may be taken with comfort.

The failure to gain weight, which has been thought to be an almost inevitable sequela of total gastrectomy has not been conspicuous in our series. It appeared in only 12 per cent. When recurrence is the cause, any relief will of necessity be temporary. From our experience, however this difficulty may be avoided in a large number of cases by dilatation and careful postoperative dietary management.

Fullness and abdominal distress, like nausea and vomiting are early symptoms and disappear with stabilization of the new physiological processes.

In our series insufficient blood studies were made postoperatively to generalize about the effect of the procedure except to state that a pernicious anemia like picture was very rare.

## SURVIVAL CHANCE

The most important factor in determining the validity of an operative procedure is the chance which it provides the patient for survival in contrast to his life expectancy without surgical intervention. The operative survival in this series has already been discussed. The determination of the survival chance of those individuals who do not succumb to the operation is complicated by the facts that many individuals were subjected to this surgical procedure at a time when it had not been entirely perfected and that others have undergone operation too recently to be of statistical significance. For this reason, the survival chance has been calculated in two ways (1) based upon all the patients who have survived operation but have subsequently died, and (2) based upon all the patients who have survived operation whether now living or dead. The former calculations tend to give an underestimation of the probable present survival chance by virtue of the inclusion of operations performed during the early period. On the other hand the latter possibly also tends to give an underestimation because a number of cases are included in which the operation has been performed at a recent date and also because there is no way of predicting with certainty the survival chance of individuals who are still alive.

Table X lists the life expectancy of patients who have survived the operation. It is apparent that at least 50 per cent of the patients will survive for 12 months, 28 to 38.6 per cent will survive 18 months, 16 to 29.8 per cent will live 24 months, and 9 to 21.1 per cent have a chance of living 3 years or more.

In our series 12 patients have survived for 3 years or more. Eleven of these had a total gastrectomy performed for a malignant lesion of which 1 was a leiomyosarcoma, 1 a malignant lymphoma, and 2 lymphosarcomas. Of these 11 patients with malignant lesions, 5 had regional metastases at the time of operation as evidenced by the finding of invasion of the regional lymph nodes removed at opera-

# SMITH TOTAL GASTRECTOMY

TABLE XI.—DATA ON 12 PATIENTS WHO SURVIVED 3 YEARS OR LONGER

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Age and sex	Date of operation	End result		Metastasis	Diagnosis
		Dead	Living		
56 F	9-14-30	3 1/2 years Carcinomatosis		Present	Carcinoma simplex
37 F	10-18-37		8 yrs 5 mo W 11 7 yrs	Unknown	Leiomyosarcoma
50 M	-70-38	4 yrs 3 mo. Recurrence		Present	Adenocarcinoma
45 F	2-25-30			Present	Lymphosarcoma
61 M	11 10-40		7 yrs 1 mo No recurrence Ills pernicious anemia	Present	Carcinoma simplex
4 F	5-10-41		5 yrs 4 mo Feels fine	Present	Malignant lymphoma
60 F	11-14-41		4 yrs 10 mo Excellent Works hard	Unknown	Unclassified carcinoma
63 F	1-24-4	3 yrs Lung metastases	4 yrs Falling	Unknown	Carcinoma
64 F	6-4-43			Absent	Carcinoma simplex
51 M	10-27-42		3 yrs 0 mo Excellent	Present	Lymphosarcoma
57 M	4-2-43	3 yrs 8 mo Well 7 yrs 8 mo Carcinomatosis	3 yrs 5 mo Excellent Works hard	Present	Carcinoma simplex
50 F	4-1-43			Present	Carcinoma simplex
			3 yrs Excellent Active	Absent	Chronic gastritis

tion The longest survival was that of a 29 year old woman operated upon in 1937 for a leiomyosarcoma, who was living and well 8 years and 5 months after operation. Another patient, a 35 year old white woman was operated upon in 1939 for a lymphosarcoma with involvement of the regional lymph nodes and was living 7 years and 1 month after operation. She has recently been examined at an other hospital for a severe anemia character istic of pernicious anemia, and no evidence of recurrence was found. A third patient, a 64 year old white man with carcinoma simplex with microscopic metastases in the regional lymph nodes, was alive and in excellent health 5 years and 4 months after operation. A summary of all the patients surviving 3 years or more is given in Table XI.

## POSTOPERATIVE NUTRITION

It is impossible to overemphasize the importance of nutritional care in the postoperative period of patients subjected to total

gastrectomy. In many instances if not in most, anorexia of varying duration has been a prominent symptom so that the patient is in negative nutritional balance at the time of operation. Consequently his intake has not been sufficient to maintain his daily requirements nor to build reserve for the operative period. In addition there may have been acute or chronic blood loss. Because operation must be performed as soon as the need for it is recognized the nutritional care in the postoperative period must provide adequate resources with which to promote wound healing ward off infection and preserve anatomical relationships which in tissues lacking normal tone owing to undernutrition and toxic effects are precarious.

In order to put the gastrointestinal tract as completely at rest as possible and so avoid stress at the suture lines nothing is given by mouth for at least 3 days. During this period whole blood is given as indicated. If shock threatens or intervenes plasma is given if

whole blood is not available or if hemoglobin and red blood counts show that whole blood is not required

A total of 1500 cubic centimeters of 10 per cent glucose, with 1 or 2 ampules of soluble vitamin B complex and 500 milligrams of vitamin C, is given on the first day with 1000 cubic centimeters of a protein digest. Approximately 3000 to 4000 cubic centimeters of fluid is given in the first 24 hour period depending on the patient's state of hydration. The difference between this requirement and the 2500 cubic centimeters already cited may be blood plasma, or 10 per cent glucose

The importance of limiting chlorides to actual requirements cannot be too frequently stressed. Although it is generally recognized that in the absence of vomiting, diarrhea, draining sinuses or profuse diaphoresis, the average daily requirement of sodium chloride is 5 grams, patients all too frequently receive from 12 to 25 grams during the early postoperative period. Such therapy often leads to localized or generalized edema, wound disruption and renal insufficiency

With the recent advent of protein hydrolyzates for parenteral administration there has become available a valuable addition to the postoperative nutritional care especially of patients undergoing gastrointestinal surgical procedures. The routine postoperative use of such preparations is of great importance in the promotion of wound healing, resistance to infection and prevention of edema. We advocate the administration of one of the available digests in amounts equivalent to at least 50 to 100 grams of protein daily until the patient is able to take adequate protein orally

It is extremely important to maintain the caloric intake during the period in which the patient is fed parenterally. This is provided by the liberal use of 10 per cent glucose. A daily regimen of 1000 cubic centimeters of a daily regimen of 1000 cubic centimeters of a protein digest in 5 per cent glucose and 2000 cubic centimeters of 10 per cent glucose with 500 cubic centimeters of normal saline solution provides 1200 calories, the approximate equivalent of 50 grams of protein and 85 grams of sodium chloride. This is continued

until the patient has been transferred to an oral dietary regimen. Also the patient is given parenteral vitamins as indicated previously

On the fourth postoperative day 1 ounce of water is given by mouth every hour. On the following day 1 ounce of malted milk or gel made with water is given hourly in addition to the water so that the patient takes something by mouth at half-hourly intervals. On the sixth and seventh days the amounts are increased by 1 ounce a day. On the eighth day a single feeding of soft solid food, such as soft egg cereal or custard is added. On succeeding days small additional feedings of soft solid foods are given until the patient is eating 6 meals a day of a high protein, high carbohydrate, low fat, and low residue diet. If the amounts of this diet are increased by approximately 300 calories a week, the jejunal pouch adapts itself in many instances so that within 6 months the patient is able to maintain weight and strength with 3 meals a day

#### SUMMARY

1. Eighty nine cases of total gastrectomy performed at the Lahey Clinic between 1947 and October 1, 1945 in patients ranging from 23 to 75 years of age, have been reviewed.
2. The postoperative mortality for the entire group is 29.1 per cent.
3. The postoperative mortality during the last 3 years and 9 months of the study during which 43 operations were done is 16.3 per cent.
4. Twelve patients have survived the operation for 3 years or more.
5. Calculation of life expectancy of patients surviving the operation shows that 50 per cent will survive 12 months or more, 28.6 per cent will survive 18 months, 16.3 per cent will live 24 months and 9 to 21 per cent will live 3 years or more.
6. A plan for postoperative nutritional care is presented.

#### REFERENCES

- LAHEY, F. H., and MARSHALL, S. F. *Ann. Surg.* 1944, 119: 300-320.
- PACK, G. T., and McNEER, G. *Surg. Gyn. Obst.*, 1947, 44: 265-299.
- WATSON, J. M., and FARLEIGH, G. T. R. *Surg. Clin. N. America*, 1945, 5: 903-917.



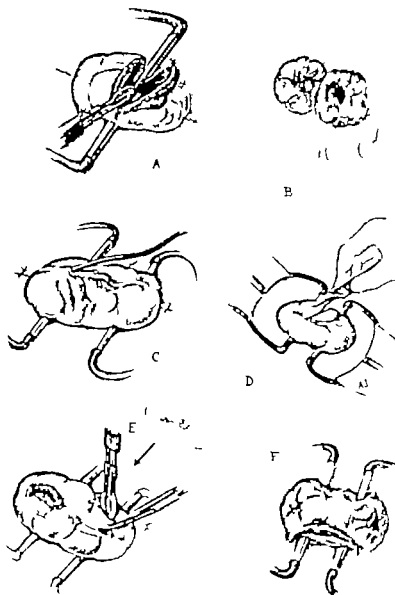


Fig. 1—Achieving complete fecal diversion with a loop colostomy (A to F—steps employed in making the loop colostomy). A, The conventional way of dividing the exteriorized loop transversely to achieve fecal diversion. B, The result after complete division; the lumens of the proximal and distal loops are separated only by the thickness of the walls of the two apposed loops. C, The technique described here: employing glass rods and exteriorizing somewhat more generous segment. A slit has already been made in the gut wall, proximal to the first glass rod. In the presence of acute obstruction and distention, needle aspiration at this same site is performed on completion of operation and again in 6 hours, at which time a slit is made

in the bowel wall with cautery (usually) or knife to permit the introduction of a catheter as is shown here. In the absence of obstruction, the exteriorized gut orduously is not opened until about 7 hours after operation, allowing the wound to become sealed more effectively. D, The all-heave fastening of the rubber tube engaged over the end of the glass rods is shown. This maneuver insures adherence of the exteriorized loop throughout the length of the inclusion. E, Unroofing the proximal orifice by a diagonal incision; more of the roof overlying the proximal orifice is removed than the distal. F, Following removal of a portion of the anterior wall of the exteriorized segment, the mucosa everts and becomes adherent to the skin.

porary colostomy warrants. Madelung achieved complete diversion by dividing the colon and

inverting the distal end. Kausch recommended placing an inflatable cuff in the distal segment,

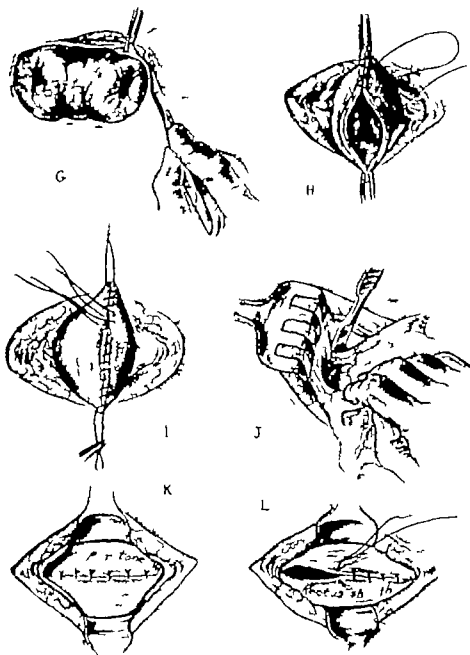


Fig. (Continued—G to L—steps employed in closing the colostomy). G It is obvious that the separation of the proximal and distal orifices of the exteriorized segment is far better than that achieved by the conventional method of dealing with the loop colostomy. An incision is made in the skin 2 to 3 millimeters from the mucosal edge. H A running suture of fine catgut is employed to close the opened bowel transversely. I The wound's edges are painted with a local antiseptic and the wound is redraped. After the gut is freed up adequately, a single row of interrupted fine silk sutures (No. 0000) is placed to invert the

initial closure with catgut. J The bowel is dissected completely free from the parietal peritoneum, permitting return of the bowel to the peritoneal cavity. This same procedure gives assurance that the peritoneum and posterior rectus sheath can be sutured satisfactorily. K Suture of the posterior rectus sheath and peritoneum with interrupted sutures of silk (No. 000). L, Closure of the anterior rectus sheath (silk No. 000). After closure of the peritoneum (K), the wound is washed out with liberal quantities of saline solution and again after closure of the anterior rectus sheath (L).

a method with which the writer too has toyed but without achieving complete diversion consistently. Baggio uses a pedicled strip of fascia

from the upper end of the wound which he pulls through the mesentery and ties about the ascending colon in making a cecostomy



Fig. 2. A, Photograph of an exteriorized transverse colostomy loop; a catheter has been placed in the proximal loop for decompressive purposes. B, Another similar loop colostomy after unroofing; note how effectively the colic

orifices are separated. C, A sigmoid loop colostomy for the purpose of complete fecal diversion, which was made by the writer in a patient 9 years ago (D. B. University Hospital No. 623722).

#### TECHNIQUE OF THE PROCEDURE

*The making of the colostomy.* Inasmuch as complete fecal diversion is achieved regularly when the method is performed properly, the colostomy may be employed as a temporary or even as a permanent measure. The usual temporary colostomy is made ordinarily in the right transverse colon as was described for acute colic obstruction a number of years ago. For irremovable cancers of the rectum presenting obstruction, the same type of colostomy is performed on the sigmoid colon.

The technique of colostomy described previously (1936) is followed save in two particulars: (1) Two glass rods are drawn through the mesentery and placed beneath the exteriorized colon instead of one, the intent being to insure that the exteriorized segment of colon lies above skin level. (2) The colon is opened in the axis of the bowel and *not* transverse to its axis as is ordinarily done. Finally the proximal orifice is unroofed by cutting away an elliptical portion of the anterior wall (Fig. 1E).

Following this maneuver the two orifices of the bowel come to lie at opposite ends of the incision, separated by the posterior bowel wall. Care should be observed not to cut away too generous a portion of the anterior wall lest thereby the subsequent closure of the colostomy be made difficult. The margins of the opened bowel evert and become adherent to the skin edges. Maintenance of the two glass rods in position at opposite ends of the wound until it is healed precludes retraction of the orifices of the bowel. The usual circumstance

is that shown in Figure 1G and Figure 1A. When the exteriorized segment of colon remains at skin level the two orifices remain at opposite ends of the wound. It is partial retraction of the colostomy within the abdomen which causes the orifices to remain patent and permit dumping from the proximal into the distal orifice. Similarly employment of one glass rod in the middle of the exteriorized loop causes the orifices to become fixed in the wound at a lower level than is desirable as a consequence of which fecal diversion is not complete. Patients with this type of colostomy are dismissed from the hospital 8 to 10 days after operation, ordinarily the general condition of the patient permitting, with one or both glass rods still in place. Both glass rods usually are removed by the 14th postoperative day.

The skin incision is made parallel to the run of the transverse colon and directly over it. In the patient with acute obstruction of the colon, our practice is to tape a nickel over the umbilicus when the scout x-ray film is taken. This marker on the film serves as a landmark for the level of the incision. A transverse incision 10 to 12 centimeters in length directly over the right rectus muscle through all the layers of the abdominal wall permits even a distended colon to herniate out. Some surgeons have learned to their dismay that a distended transverse colon cannot be delivered through a vertical incision. When acute colic obstruction and distention are not present, a shorter skin incision will suffice. The two

glass rods are drawn through avascular areas in the mesentery. The omentum is freed from the loop to be exteriorized and dropped back into the abdomen. The parietal peritoneum and posterior rectus sheath are approximated to fatty tags at the margins of the bowel with a number of interrupted sutures of fine silk (No 0000). No sutures are tied till all are placed. A smaller number of similar sutures are placed in the anterior rectus sheath approximating it to fatty tags at a higher level on the bowel. Finally a few sutures are placed similarly in the skin. If the bowel is acutely obstructed and distended a needle is inserted to measure intraluminal tension followed by aspiration. The exteriorized segment is covered with vaseline strips. In the presence of acute obstruction the bowel is aspirated again in approximately 6 hours. In any case every colostomy should be inspected for color and evidence of satisfactory viability 4 to 6 hours after completion of the operation. When obstruction is present a catheter is inserted into a small hole made proximal to the most proximally placed glass rod. Complete diversion usually is achieved even at this stage. A linear incision 3 to 3.5 centimeters in length is made in the axis of the exteriorized bowel with a bedside cautery 3 or 4 days after operation. The unroofing of the proximal orifice may be done at the same time or a few days later. The details of the operation are shown in Figure 1. The usual measurements of the colostomy opening when healing has occurred are 5 centimeters in length and 3 centimeters in width. Two centimeters of bowel wall intervene between the adjacent margins of the proximal and distal orifices. When the ordinary loop colostomy is divided completely in a transverse direction the two resultant orifices lie side by side. In patients with acute colic obstruction and distention the ultimate measurements of the exteriorized segment obviously are greater.

*Closure of the colostomy* The closure of such a colostomy is obviously simple. An incision is made in the skin adjacent to the bowel edges leaving a tiny rim of skin approximately 2 millimeters in width attached to the bowel. A running suture of catgut (No 000) closes the bowel transversely. The wound is pre-

pared again and the surgeon dons a new gown and gloves. The wound is enlarged and the peritoneal cavity is opened care being observed to separate the bowel from the margins of the wound all around and without injury to the bowel wall. A row of interrupted silk sutures placed over the catgut suture completes the closure.<sup>1</sup> The wound is then closed with two layers of interrupted fine silk suture (No 000). After the peritoneum and posterior rectus sheath are closed the wound is washed out with a generous quantity of saline solution and again after closure of the anterior rectus sheath.

In the making of the colostomy as well as in its closure the patient routinely has an indwelling duodenal tube to which suction is attached. When the colostomy is opened the tube is withdrawn and after closure of the colostomy the nasal tube is withdrawn 48 to 72 hours after operation. The patient can be dismissed from the hospital ordinarily 5 or 6 days after operation. The writer does not consider succinylsulfathiazole or similar preparations a necessity for surgery of the colon. In primary reactions if the anastomosis is made properly such preparations are unnecessary as are also external diversionary decompressive vents. And if the anastomosis is made improperly all the drugs of the pharmacopoeia usually will not rectify the situation. If in the closure of the colostomy any surgical house officer feels strongly upon the subject of the virtues of succinylsulfathiazole in mitigating the effects of surgery imperfectly performed I am not averse to meeting his suggestion with an agreeable gesture. If he does not insist on it this refinement is omitted. It is important to know that it is the satisfactory closure of a colostomy that makes return of the colon to the peritoneal cavity a safe procedure a practice which this writer has followed routinely since 1929. A nice toilet of

When the bowel is ready for final closure, the surgeon may snip out the temporary catgut suture. For 2 years, in making primary gastrointestinal anastomoses the writer has employed only a single row of interrupted silk sutures. Most of the surgeons in this clinic have adopted this technique as standard procedure in the making of anastomoses from the stomach to the cecum. A single row inversion made with interrupted sutures, without an inner row of continuous catgut assures wide and patulous orifices. Employment of a running suture for the lower row causes puckering and consequent narrowing of the stomas.



the wound with the liberal use of generous quantities of saline solution makes it safe to effect primary wound closure with a reasonable assurance of the achievement of satisfactory healing

#### SUMMARY

A simple loop colostomy may be employed to secure complete fecal diversion. Employment of 2 glass rods, drawn through the mesentery beneath the bowel and maintained in position until the wound is healed, fixes the exteriorized loop in the wound above skin level. The colon is opened by a slit in the axis of the bowel and the proximal orifice is unroofed by cutting away a small portion of the anterior wall. Such a colostomy is easy to make as well as to close and presents all the

advantages of the more formal procedures in achieving complete fecal diversion.

#### REFERENCES

1. BAGGIO G. J. *Chir.* 1940, 55, 327.
2. BERRY FRANK R. *Bull. U.S. Army Med. Dep.*, 1946, 6, 40.
3. DEVIDY H. *Surgery* 938, 3, 164.
4. FALLIS, L. S. *Surgery* 946, 20, 242.
5. GREY TURNER, G. *Mod. Oper. Surg.*, 1934, 707.
6. HAMILTON J. E., and CATTANACH, L. M. *Surgery* 1946, 20, 237.
7. HORSLEY G. W. and MICHAUX, R. A. *Surgery* 196, 19, 845.
8. KAUSCH W. *Handb. prakt. Chir.* 1921, 3, 150.
9. MADDELMUND. Quoted by Kausch.
10. SANDERS, G. B., and HALPERIN, P. H. *Surgery* 1946, 20, 83.
- WANGENSTEEN O. H. *Surg. Gyn. Obst.* 1926, 45, 1020.
11. Idem. *Intestinal Obstructions*. 2d ed. Springfield Ill. Charles C Thomas, 941.
12. Idem. *Surgery* 1943, 14, 403.
13. Idem. *Surg. Gyn. Obst.*, 1945, 8, 11.

# THE HYPERFUNCTIONING SINGLE ADENOMA OF THE THYROID

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IT is accepted that hyperfunction of an endocrine gland is associated with either a neoplastic or hyperplastic anatomic change. Neoplasia and hyperplasia, clearly differentiated by definition, have proved difficult to distinguish pathologically in disorders of the thyroid gland associated with hyperfunction. The debate as to whether the lesion of nodular goiter with hyperthyroidism is truly adenomatous or merely represents a late and lumpy stage of diffuse hyperplasia has long raged. The debate exists perhaps because there is no true difference between neoplasia and hyperplasia of the thyroid gland but more likely because the pathologist has lacked tools by which the differentiation can be made.

In disorders of certain other endocrine glands associated with overactivity, the problem of differentiating pathologically between neoplasia and hyperplasia is less confused. The division of the parathyroid system into four separate glands renders the gross recognition of the distribution of anatomic disease simpler than in the thyroid. The common type of anatomic change of the parathyroids encountered in hyperparathyroidism is that localized to but one of the four glands. The diseased tissue is then considered to be neoplastic and is called an adenoma. The distinct separation of the adrenal cortical gland into two parts offers a similar advantage.

The existence of a single adenoma of the thyroid causing hyperfunction comparable to that found in patients with hyperparathyroidism has been suggested (11), questioned (16) and not proved. Certain it is that the commonest type of anatomic disorder of the thyroid gland associated with hyperthyroidism, whether it be called hyperplasia, nodular or adenomatous goiter, diffusely involves the

thyroid gland. So usual for the thyroid is this diffuse involvement that when a single adenoma is found in a patient with hyperthyroidism, one must be certain that smaller adenomas are not hidden elsewhere in the thyroid gland.

It might be of academic interest only to establish whether a single adenoma of the thyroid is ever associated with hyperthyroidism as it is in the parathyroid with hyperparathyroidism, but its establishment should prove of practical value since it would offer a chance to learn about the functional capacity of adenomas and improve the judgment in therapy. With the advent of the two medical therapies, thiouracil (1) and radioactive iodine (2, 7), it is imperative to know not only whether the early relief of the hyperfunction of neoplasia is the same as of the hyperplastic type of the disease but more especially whether eventual malignant degeneration, about which apprehension is proper, will prove unequally evil in the two types.

Since the pathologist, using the conventional histologic methods, has not been able to tell us the degree of functional activity of the thyroid cell, we need criteria to establish the existence of a single adenoma of the thyroid with hyperfunction.<sup>1</sup> Clinically, we should take for granted symptoms of hyperthyroidism and an elevated metabolic rate which are relieved by operative removal of the adenoma. There is in addition anatomic and biologic evidence which the surgeon can divulge and two laboratory tests which can be applied. The laboratory tests include inactivation of thyroid stimulating hormone of explanted thyroid tissue and radioactive iodine absorption by the thyroid gland.

<sup>1</sup>Certain special cytologic methods demonstrating the Golgi apparatus, mitochondria, and secretory droplet have been introduced which are believed by many to indicate the functional activity of the thyroid cell. These methods require techniques which have proved not feasible in the routine pathological laboratory.

From the Thyroid Clinic of the Massachusetts General Hospital.

TABLE I—TEN PATIENTS WITH SINGLE ADENOMAS AND HYPERTHYROIDISM

Case number Year of operation	Sex Age	Duration of disease Preoperative	Eye signs	Metabolic Rate				Iodine effect	Wt. of adenoma, gms.	Pathologist's diagnosis	Remarks
				Initial	Pre-operative	Postoperative 4 mos.	Eventual				
936	F 60	3 yrs	Lid lag Stare	+60	+20	-	- 5	?	3	Involution	Fig. Chart
940	M 48	3 yrs	None	+51	+14	-30	-14	?	36	Hypertrophic involution	Figs. 3a and b Chart
941	F 57	6+ yrs	None	+60	+57	+	- 6	0*	3	Involution	Figs. 3a and b Chart
944	F 53	3 yrs	None	+	+27	-	-		70	Involution ?Hyperplasia	F. Chart 3a and b
3 945	F 47	0 yrs	Lid lag	+27	+	- 6	- 6	700	20	Hyperplastic adenoma	
6 945	F 70	8 mos.	None	+12	+	Died at resection of gastric polyp			20	Struma nodosa, micro- macro follicular	
9 945	F 6	8 mos.	Lid lag	+	+	N follow up		?	120	Hyperplasia—slight involution	
8 945	F 65	6+ mos.	Lid lag	+	- 3	- 6	- 8	?	8	Hyperplasia involution	Charts 5 and 6 Diagram
9 945	F 67	3 yrs	Lid lag Stare Exoph.	+76	+51	+	+ 3	0***	3	Involution hypertrophy	
10 946	F 8	3 yrs	None	+	+ 9	No follow up		?	10	Struma, nodular, micro- macro follicular	

\*Patient also received X-ray treatment; there was no effect on the metabolic rate.

\*\*Patient also received and responded to thionin.

\*\*\*Patient developed toxic reaction to thionin. Also received X-ray treatment without effect.

If an adenoma involving only one portion of the thyroid apparatus, is hyperfunctioning and is the sole source of the hyperfunction then theoretically the remainder or uninvolved portion of the thyroid should not be normal but functionally resting and anatomically atrophic. Attention has already been called to the atrophy of the uninvolved parathyroids in hyperparathyroidism associated with an adenoma (3) and of the contralateral adrenal cortex in the patient with an adrenal cortical adenoma with hyperfunction. Such an atrophy of the thyroid gland has been shown to occur in animals which have been rendered thyrotoxic by large doses of thyroid extract and has been observed by us in one patient<sup>1</sup> who had taken large doses of thyroid extract and whose thyroid gland was exposed at operation under the mistaken diagnosis of Graves

disease. Such atrophy of a gland has been called an atrophy of disuse.

#### OBSERVATIONS

During the past 10 years 10 patients have been cared for in the Thyroid Clinic at the Massachusetts General Hospital whose thyroid glands fulfill the anatomic and biologic criteria of an hyperfunctioning single adenoma of the thyroid. Data regarding the nature of the disorder of these 10 patients are given in Table I. The patients were of varying ages, but one of the patients was male. All had symptoms and metabolic evidence of hyperthyroidism: a positive lid lag and stare were present in 5. In only one was there any suggestion of exophthalmos. The severity of the disease varied from crippling to a mild disability.

The 40-year-old daughter of a woman's college, as cared for in this hospital, was brought to our attention because of increasing nervousness. She reported that she had been concerned about her obesity and some months previously had succeeded in losing weight by strenuous dieting. Examination disclosed the signs typical of hyperthyroidism: goiter of moderate severity except for the absence of palpable nodules. She had bright staring eyes with positive lid lag, fine tremor, rapid pulse and increased pulse pressure. Her basal metabolic rate was +60 in spite of the absence of palpable goiter. Diagnosis of Graves disease was made, believing it to have been induced by the rapid loss of weight. I was advised that the goiter was hidden

behind the macrosternum. She was placed on potassium iodide which she apparently made prompt response, her basal metabolic rate on the 4th day was 7. At operation she proved not to have gone to the contrary, small soft avascular thyroid contained nodules. The portion of each lateral lobe removed had dimensions of 1.5 x 1.5 x 1.5 cm. "Involution" by the pathologist. Confirmed with this report of involution, postoperatively the patient continued with this response of the fact preoperatively in having taken for some months previous large doses of desiccated thyroid to which she had access in the main laboratory.

CASE 4 (See Fig 4 and Charts 4a and b) A 33 year old woman was admitted to the hospital complaining of a gradually enlarging goiter of 7 years duration. Although the patient had no difficulty in swallowing she was constantly aware of a sensation of pressure in the neck. During the months immediately prior to admission she had noticed slight trembling of her hands and pounding of her heart when she lay on her left side at night. Hungry all the time she had gradually been gaining weight for several months. She had not experienced nervous irritability, heat intolerance, dyspnea, or change in bowel habit.

On examination the patient displayed a slight tremor of the extended fingers. The hands were warm but not excessively moist. There were no eye signs. A firm nontender rounded nodule, 5 centimeters in diameter was palpable in the upper portion of the left thyroid lobe. The isthmus and right lobe of the thyroid could not be felt. Basal metabolic rates of plus 19, 21 and 24 were obtained. A diagnosis of thyrotoxicosis probably due to a hyperfunctioning adenoma was made. Saturated solution of potassium iodide 5 drops twice daily was prescribed and the patient discharged home to be readmitted for operation.

When readmitted 2 weeks later she stated that the only symptomatic change was a decrease in the sensation of pressure in the neck. Her weight had remained stationary. At operation the left lobe of

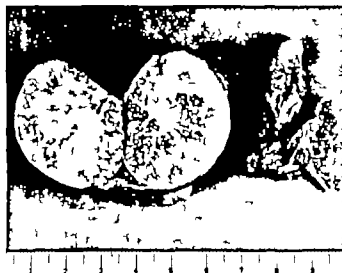


Fig 1 The hyperfunctioning adenoma and atrophic uninvolved thyroid tissue in Case 1. The encapsulated adenoma is considered to have been the source of the excessive hormone production because the uninvolved tissue was grossly and evenly atrophic. There was a bit of the uninvolved thyroid tissue at both upper and lower poles of the adenoma, all that remained of the right thyroid lobe. The separate, shriveled piece of tissue represents the entire isthmus and anterior half of the left thyroid lobe. (For the effect of the adenoma on metabolic rate, see Chart 1.)

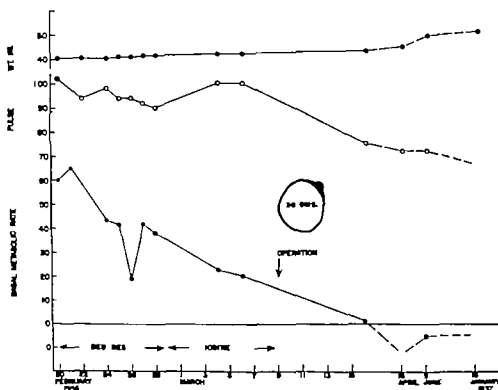


Chart 1 The effect on metabolic and pulse rates and weight of extirpation of the single adenoma of Case 1 (Fig. 1). Bed rest, but probably not iodine, was followed by partial subsidence of the thyrotoxicosis immediately before the operation. The depressed metabolic rate found soon after operation proved to be transient.

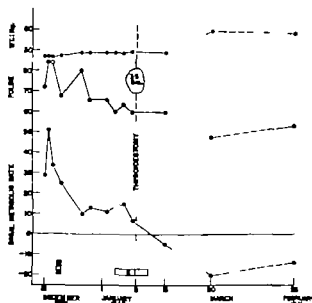


Chart The effect on metabolic and pulse rates and weight of excision of the single adenoma of Case 2 (Figs. 2a and b). It is possible that iodine and bed rest together induced the partial remission of the hyperthyroidism prior to operation.

the thyroid was found to consist largely of a solid tumor measuring 5 by 4 by 3 centimeters. At the posterior portion of both the upper and lower poles, there was a small mass of uninvolved atrophic tissue. There was also a rim of atrophic thyroid on the medial side of the adenoma and on the anterior surface of the trachea. The isthmus tissue was so thin as to be hardly recognizable. The right lobe was also atrophic, measuring 3 by 2 by 1 centimeter. Microscopically the adenoma showed hyperplasia and involution. Biopsies of the uninvolved tissue on the left side and of the right lobe were consistent with involution.

Postoperatively the patient was less restless than before and no longer conscious of the beating of her heart. Her appetite was less voracious but her

weight remained stationary. The basal metabolic rate 6 weeks after operation was minus 14; 12 months later minus 14.

In Table II for comparison with the patients having single adenomas and hyperthyroidism are given the data on one patient with a large adenoma and two small satellite adenomas associated with hyperthyroidism and three patients with single adenomas but no hyperthyroidism. These latter three have been selected from a group of 15 patients with single nodules and no hyperthyroidism in whom radioactive iodine studies have been carried out.

**Gross anatomy.** At operation on the patients with single adenomas and hyperfunction the anatomic lesion was found to be circumscribed. In 8 patients the lesion was confined within a clearcut capsule involving only one part of a lateral lobe as in Cases 1 and 2 (Fig. 1 and 2b). In the other 2 patients, Cases 3 and 4, (both elderly and with longstanding disease), the lesion involved the entire lateral lobe, there being no uninvolved tissue recognizable on that side (Fig. 3b). In all 10 patients the uninvolved tissue was grossly consistent with atrophy. The uninvolved residual of the lateral lobe of the 8 cases, and the isthmus and the contralateral thyroid lobe of all 10, were smaller than the expected normal and in some cases were shrivelled (Fig. 1 and 2b). In all cases the uninvolved tissue varied from the normal, it was softer and more pliable, the surface convolutions were less prominent or absent, the color was a little paler and speckled with white, the vessels were less prominent, and on cut sections the tissue was judged to be less

TABLE II—FOUR PATIENTS WITH FINDINGS IN CONTRAST TO THE TEN PATIENTS IN TABLE I

Control Case number Year of operation	Sex Age	Duration of disease Preoperative	E. signs	Metabolic rate				Iodine effect	Wt. of adenoma, gms.	Pathologist's diagnosis	Illustration
				Initial	Preoperative	Postoperative 2-4 mos.	Eventual				
C 943	F 43	8 mos.	hot lag	+56	+	+14	+	+	35	Involution	
C 945	F 53	37	None	—	—	—	—	—	45	Involution Hypertrophy	Chart 5, diagram 1 Chart 6, diagram 1
2C 945	M 43	20 yrs.	None	—	—	—	—	—	33	Involution Hypertrophy	Chart 6, diagram 1
C 945	F 48	3 mos.	None	—	—	—	—	—	—	Involution Hypertrophy	Chart 6, diagram 1



Fig. 2a. Case 1. There is no exophthalmos or stare. Loss of weight is apparent. The displaying of the lower end of the right sternomastoid muscle by the adenoma in the left lobe of the thyroid is visible. (The thyroid adenoma removed and its effect on the metabolic rate are shown in Figure 2b and Chart 2.)



Fig. 2b. The hyperfunctioning adenoma and rim of atrophic uninvolved tissue of Case 1. The adenoma was encapsulated, firm, fleshy and brown while the uninvolved thyroid tissue was soft, diffusely shrivelled and avascular. The adenoma is considered to have been the source of the excessive hormone production because of the gross atrophy of the uninvolved portions of the thyroid gland and because its removal resulted in relief of the hyperthyroidism. (See also Fig. 2a and Chart 2.)

vascular. So soft was the gland in 1 or 2 cases that the thyroid and cricoid cartilage could be felt through the thyroid tissue. In no instance was a second nodule seen or felt at operation.

In the 4 control patients the anatomic findings at operation differed significantly. The first patient whose data are summarized in Table 11. Case 1C was believed preoperatively to be one whose hyperthyroidism was due to a single adenoma. The hyperthyroidism was definite and but one nodule was palpable on physical examination in the region of the thyroid gland. At operation the uninvolved tissue however was not atrophic. The isthmus and lobe contralateral to that containing the preoperatively palpable nodule were fully as large, firm and vascular as normal and further scrutiny disclosed two small nodules in the posterior position of the contralateral lobe. The large nodule was excised *in toto* and a small portion only of the contralateral lobe was taken for microscopic section and thyroid stimulating hormone inactivation study.

CASE 1C. A 23 year old woman was admitted to the hospital complaining chiefly of nervousness of 12 months' duration. She had been well until about one year prior to admission when without obvious cause she became irritable and easily upset. Six months before admission she first noticed a swelling in her neck which slowly increased in size. Three months prior to entry she began to experience palpitation, exertional dyspnea, increased frequency of bowel movements and excessive perspiration. She felt increasingly fatigued and gave up bowling, swimming and dancing. Her weight remained stationary despite a noticeably increased appetite.

On examination she appeared warm, sweaty and flushed. There was a slight tremor of the extended fingers. No eye signs could be elicited. The left lobe of the thyroid was replaced by a soft nodule measuring 5 by 7 centimeters which displaced the trachea to the right and extended down to the sternal notch. A small amount of tissue was palpable to the right of the trachea in the thyroid region. The pulse was 110 and bounding in character. Basal metabolic rates of plus 38, 24, and 30 were obtained. A diagnosis of thyrotoxicosis possibly due to a hyperfunctioning adenoma was made. After 2 weeks of therapy with potassium iodide 15 drops a day the basal metabolic rate had fallen to minus 6 and the patient's weight had increased 2.5 kilograms. She was discharged home on iodine therapy to be followed in the out-patient clinic.

Five months later she was readmitted for excision of the nodule because of its increase in size. She had taken the iodine faithfully and felt less nervous. Her tremor and frequent bowel movements continued.



Fig. 3a. Case 3. The calm expression belies the presence of hyperthyroidism. The unilateral goiter subsequently removed is shown. In Figure 3b and its effect on the metabolic rate in Chart 3.



Fig. 3b. The left-sided goiter and biopsy specimen of the atrophic right thyroid lobe of Case 3. The entire left lobe of the gland was involved in the anatomic disorder but a section the disorder proved to be uneven. In the upper left was a smooth nodule, the tissue of which is comparable to the homogeneous adenomas illustrated in Figures 1, 2b, and 4. The remainder of the goiter was made up of irregular whorls of cellular thyroid tissue; the septa were indistinct. The entire isthmus and right thyroid lobe were atrophic. A similar, irregular and unilateral goiter with atrophic uninvolved tissue elsewhere was encountered in Case 6. The adenomas of the 8 other cases are of the homogeneous type. (See also Fig. 3a and Chart 3.)

and her weight remained approximately stationary. The physical findings were essentially unchanged except that the nodule in the left lobe of the thyroid seemed larger, measuring 7 by 7 centimeters. Basal metabolic rates of plus 46, 43 and 35 were obtained. After a month's bed rest the rate had fallen to plus 12. At operation the left lobe was found to contain a large nodule and the otherwise normal appearing right lobe to contain two small nodules. The nodule in the left lobe was resected in entirety leaving about 4 grams of uninvolved, apparently normal tissue. A biopsy specimen was taken of the uninvolved normal appearing tissue of the right lobe. Microscopically all sections of the left lobe nodule showed involution. The tissue removed from the right lobe was consistent with normal.

Postoperatively the patient gained 5 kilograms in weight and was entirely relieved of her symptoms. The basal metabolic rate 10 days after operation was minus 10.

The remaining 3 control patients of Table II whose thyroid function is considered to have been within normal limits were each found at operation to have a single adenoma. The uninvolved tissue was considered to be consistent with normal but in the last Case 4C the note was made at operation that the uninvolved parts of the gland were on the small side of normal and unusually soft; partial atrophy was considered possible. The results of the radioactive iodine determinations in this case were therefore not surprising (see below under Radioactive Iodine Uptake).

**Microscopic anatomy.** The tumors of all 11 cases, that is including the control cases, were variously classified and without any correlation with function by our pathologists as involutonal nodules involution and hyperplasia, hyperplastic adenoma and struma nodosa, micro et macro folliculare. The biopsy of the uninvolved tissue was described as either normal or involution, there being no correlation with the gross finding of atrophy.

**Operative relief.** All 10 of the patients with single adenomas and hyperfunction were relieved of the thyrotoxicosis by operation. Operation in each case consisted of total excision of the adenoma and resection of a certain amount of the atrophic uninvolved tissue. In the first 2 cases, the isthmus and approximately half of the contralateral lobe were resected (Fig. 1 and 2b) in the others only a small portion of the atrophic tissue was removed as a biopsy (Fig. 3b and 4).

There was a transient drop in metabolic rate to subnormal levels immediately following operation in 3 of the 7 patients in whom an adequate number of determinations were made (Charts 1, 2 and 4a). In a fourth Case 6, the

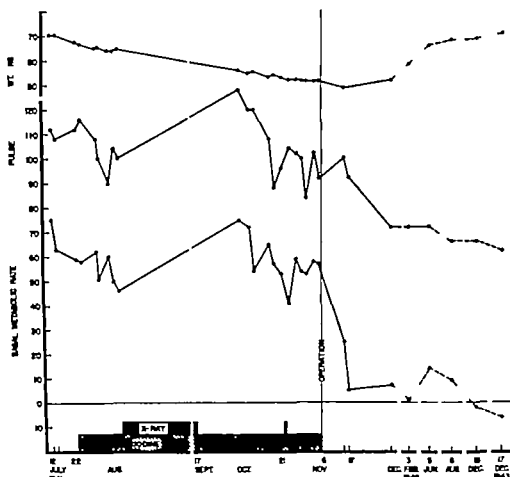


Chart 3 The effect on metabolic and pulse rates and weight of extirpation of the unilateral goiter of Case 3 (Figs. 3a and b). Both iodine and roentgen irradiation failed to induce a remission of the thyrotoxicosis.

metabolic rate remained subnormal but there were no signs or symptoms of hypothyroidism.

The transient period of hypometabolism following operation suggests that there may have been functional inactivity of the uninvolvement tissue. Permissible in Cases 1 and 2 in whom the more radical resection was done the fall should not have occurred in the other if the uninvolved tissue was normal physiologically. Removal of one of two normal lateral thyroid lobes at parathyroid exploration which had been carried out in several of our hyperparathyroidism cases has not been followed by any such decrease in thyroid function. The ultimate return of the metabolic rate suggests capacity of the uninvolved tissue to recover and retain normal function. This is in support of the view that such atrophic tissue is not diseased but suffers only from disorder of function.

*Thyroid stimulating hormone inactivation*  
The adenomatous and uninvolved atrophic

tissues of 2 patients with single adenomas and hyperthyroidism (Cases 4 and 7) and of the one patient with multiple adenomas with hyperthyroidism (Case 1C) have been studied for their ability when explanted to inactivate the thyroid stimulating hormone of the anterior pituitary gland. This action has been used as a test by Rawson, Graham and Riddell to differentiate between normal and various pathologic human thyroid tissues (13, 14). A slice of thyroid tissue weighing approximately 150 milligrams is incubated for 24 hours in a substrate containing 7.5 units of thyroid stimulating hormone (Junkman and Schoeller guinea pig units). Upon removal of the thyroid tissue the residual activity of thyroid stimulating hormone is measured by the effect of the substrate upon the mean cell height of the thyroid gland of the injected baby chick.

It has been found that an explant of normal human thyroid tissue inactivates 3.5 units (14) (Chart 3, diagram 1). (The normal thyroid



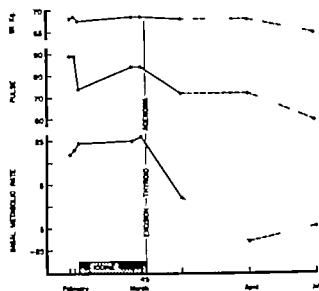


Chart 4a. The effect on metabolic and pulse rates and weight of removal of the single adenoma of Case 4 (Fig. 4 and Chart 4b). Iodine failed to produce a remission of the thyrotoxicosis.

tissue was removed from 7 patients undergoing parathyroid exploration for hyperparathyroidism). The portions of diffuse hyperplasia resected from 20 patients with hyperthyroidism who were prepared for operation with iodine inactivated all of the thyroid stimulating hormone present in the bathing fluid (Chart 5 diagram 2).

A portion of the adenoma removed from Case 4 (patient with a single adenoma and hyperthyroidism) was found to inactivate all of the thyroid stimulating hormone (Chart 5 diagram 3). The piece of the uninvolved atrophic thyroid tissue resected from the same patient was found to inactivate none of the hormone (Chart 5 diagram 4). Similar findings were obtained in the tissues removed from Case 7.

The failure of the grossly atrophic, uninvolved tissue found in the presence of a single adenoma in the patients with hyperthyroidism to inactivate thyroid stimulating hormone suggests that there has been a prolonged absence of the stimulus to produce thyroid hormone. The site of inhibition of anterior pituitary stimulation of the thyroid gland by an excess of thyroid hormone has been discussed elsewhere (15).

The results on the tissues resected from the patient with the multiple adenomas with hyper-

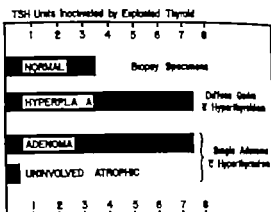


Chart 4b. Inactivation of thyroid stimulating hormone by explanted thyroid tissue. The thyroid tissues tested were: (1) normal, being pieces of glands removed at post thyroid exploration from 7 patients with normal metabolic rates; (2) hyperfunctioning hyperplastic, consisting of portions of diffuse goiter resected for hyperthyroidism in 20 patients prepared for operation with iodine; (3) hyperfunctioning adenomatous; and (4) its associated grossly atrophic uninvolved tissue from Case 4. The patient was relieved of the hyperthyroidism by resection of the adenoma and biopsy only of the uninvolved tissue. (See also Fig. 4 and Chart 4a.) The patient received iodine before operation. Explants were sliced and trimmed to weigh approximately 50 milligrams. Beef antuitrin-T was used.

thyroidism (Case 1C) showed complete inactivation by the large adenoma but only normal inactivation by the nonadenomatous tissue from the contralateral thyroid lobe. This lobe was not grossly atrophic. The finding of normal inactivation by the grossly normal tissue of a patient with active hyperthyroidism indicates either that all normal tissue is not put at physiologic rest and therefore does not undergo atrophy in the presence of an hyperfunctioning adenoma or that what was grossly compatible with and believed to be normal tissue in this patient was really diseased. The presence of the two small satellite adenomas in the contralateral lobe is in favor of the latter.

**Radioactive iodine uptake.** The second laboratory method of judging objectively the physiologic or secretory activity of thyroid tissue is the measurement of the amount of uptake of radioactive iodine (4, 5, 6). As might be anticipated the amount of the radioactive isotope absorbed in the thyroid is proportional to the secretory activity of the gland. It has been found that the thyroid gland of a normal person given a small or tracer dose of radioactive iodine will absorb approximately 40 per cent

of this iodine in the first hours and that the other 60 per cent will appear in the urine with in 48 hours. It has also been established that the avidity for iodine is increased in the hyperplastic thyroid of a patient with exophthalmic goiter.<sup>1</sup> In such hyperplasia associated with increased activity 80 to 90 per cent of the administered iodine is collected in the thyroid substance and only 10 to 20 per cent is excreted in the urine in the first 48 hours. In contrast in a patient with a hyperplastic goiter and hyperthyroidism under treatment with thiouracil the absorption of iodine is partially blocked. Less than 20 per cent of the radioactive iodine injected is held by the thyroid while more than 80 per cent passes out through the kidney in the first 48 hours (17). The initial observations of such iodine absorption by the thyroid determined by Geiger counter scrutiny of the neck and measurements of the actual urinary excretion have been checked recently by direct measurement of the radioactive iodine content of thyroid tissue surgically removed as a biopsy (8 to 17).

The radioactive iodine absorption by thyroid tissue has been measured in one patient with a single adenoma and hyperthyroidism (Case 8) and in 15 patients with single nodules without thyrotoxicosis. The radioiodine content of both the tumor and uninvolved tissues has been measured. The radioactive iodine has been given to the patient by mouth 1 to 7 days before operative extirpation of the glandular tissue. The adenoma of the case with hyperthyroidism showed an avidity for iodine comparable to that found in untreated hyperplastic goiter with hyperthyroidism while the uninvolved grossly atrophic tissue failed to take up any measurable quantity of radioactive iodine (Chart 5, diagram 4 and Chart 6, diagram 4). These findings strongly suggest that indeed on present knowledge indicate that the entire output of hormone was from the adenoma and that the adenoma therefore must have been responsible for the thyrotoxicosis.

Study of the 15 adenomas not associated with hyperthyroidism indicates that adenomatous tissue varies in its functional activity.

The tracer dose of iodine contains approximately 50 micrograms of iodine, an amount known to be too small to influence the function of the gland. This amount is a small portion of the daily excretion of iodine and an even smaller proportion of the content of iodine of the gland.

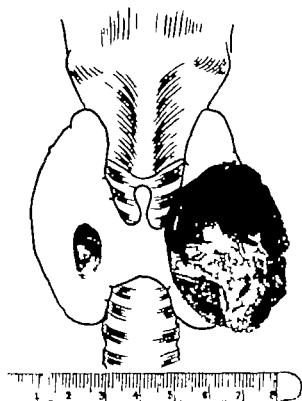


Fig. 4. The hyperfunctioning adenoma of the left thyroid lobe and biopsy specimen from the atrophic right lobe of Case 4. The adenoma was sectioned a piece removed from the anterior half and then the halves were replaced. The exposed cut surface of the posterior half shows the adenoma to be of the homogeneous cellular type with a single clearly demarcated capsule. There is a small remnant of shrivelled uninvolved thyroid tissue on the lateral surface of the adenoma. The effect on metabolic rate of its removal, the inactivation of thyroid stimulating hormone by it and the atrophic uninvolved tissue are shown in Charts 4a and b.

Three examples have been chosen from the 15 patients to illustrate the distribution in activity and are shown together with the case with hyperthyroidism in Chart 6. In the first labelled 3, the uptake of radioactive iodine and therefore the hormonal secretory activity is minimal while that of the uninvolved tissue is normal. The ratio of the uptake of uninvolved to adenoma is 23:1. In the second case with normal hormonal output the ratio of uptake of the uninvolved to adenoma is but 7:1. The avidity of the uninvolved is near the minimal amount expected of normal tissue. The activity of the adenoma is still below that of normal tissue. This case is labelled 3A. The diagram labelled 3B depicts a reversal of the ratio of uptake of iodine in a patient with overall normal thyroid activity. In this case the uptake of iodine per gram of thyroid tissue was considerably more in the adenoma than in



Chart 5. Proportionate size configuration, and radioactive iodine uptake of normal and diseased thyroid glands. The intensity of the shading indicates the avidity of the tissue for a tracer dose of iodine. Diagram 1 represents normal gland. Diagram 2 is that of a patient with diffuse hyperplasia with hyperfunction (Graves' disease). It is therefore drawn diffusely larger than the normal and colored blacker because of an increased avidity for iodine. Diagram 3 represents a single adenoma with but little iodine uptake in a patient with normal thyroid function, the uninvolved gland is normal in size and iodine uptake (Case 3C, see also Chart 6 diagram 3). Diagram 4 represents the findings in Case 5. It is a single hyperfunctioning adenoma. The adenoma absorbs an increased amount of iodine while the uninvolved takes up none. The uninvolved tissue is atrophic and shrunken. (See also Chart 6 diagram 4).

the uninvolved tissue. The ratio of uninvolved to adenoma was 1:23. This finding coupled with the gross appearance of the uninvolved tissue which was consistent with partial atrophy suggests that the adenoma was secreting the large part of the hormone requirements of the patient and that the uninvolved tissue was at partial rest. The findings in these 3 cases are to be contrasted with diagram 4 which depicts the patient with hyperthyroidism (Diagrams 4 of Charts 5 and 6 are of the same patient.) In this case the given ratio of 1:715 is arbitrarily set by the sensitivity of the method since there was no measurable radioactivity in the uninvolved tissue.

Comparison of these 4 cases suggests first that secretory activity of an adenoma is not all or none but that there are many gradations second that if the secretory activity of the adenoma is high and the size of the adenoma sufficient hyperthyroidism results and third that such hyperthyroidism is accompanied by depression of the activity of the uninvolved gland.

**Responses to iodine, thiouracil and irradiation.** It is not clear that the hyperthyroidism of any of the patients was alleviated as a result of the administration of iodine. The metabolic rate fell in 6 patients following iodine but it is possible that the fall was the result of contin-

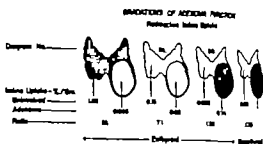


Chart 6. Gradations of function of thyroid adenomas indicated by their absorption of a tracer dose of radioactive iodine. The intensity of the shading is proportionate to the avidity of the tissue for the iodine. The numerical uptake of each tissue is given below the diagram. The figures represent the per cent of the dose of iodine found per gram of tissue. The ratio of iodine uptake of uninvolved tissue to adenoma is given in the lowest line of figures. In the first three diagrams (3A and 3B) the overall thyroid function was normal yet the activities of the adenoma and uninvolved tissues differed. In diagram 3C the findings in Case 3C (see also Chart 5, diagram 3), in diagram 3D those of Case 3D, and in diagram 3E those of Case 3E. With increasing adenoma function there is decrease in the function of the uninvolved tissue. In 3E overall decrease in size or partial atrophy in diagram 3B as compared with diagram 3. Diagram 4 represents the finding in Case 4 (see also Chart 5, diagram 4) with a hyperfunctioning adenoma, there was no uptake of iodine by the atrophic uninvolved tissue.

ued bed rest or other cause (Charts 1 and 2). Certain it is that there was no response in the other four (Chart 4A).

The adenomas of 2 patients, Cases 3 and 4, were exposed to roentgen irradiation before operation. In neither case was this treatment followed by any change in the metabolic rate.

Only one of the 10 patients was treated with thiouracil, Case 5. Neither the inactivation of thyroid stimulating hormone nor radioactive absorption was measured in this patient's gland. The thiouracil was accompanied by a drop of 23 per cent of the metabolic rate in 14 days. A response to thiouracil is to be anticipated part of the fall in this patient may have been due to rest. The patient at a previous hospital admission had made an apparent response to iodine which had then been omitted for some months prior to the thiouracil treatment.

#### FURTHER COMMENT

The gross anatomic findings and the tests of function, inactivation of thyroid stimulating hormone and collection of radioactive iodine, have delineated the single adenoma with hyperfunction as a disease entity of the thy-

roid gland. Not only does the adenoma inactivate an excess of the anterior pituitary hormone but it has been shown to be the only part of the thyroid gland which absorbs iodine. Since iodine is a chemical requisite of the thyroid hormone, the adenoma is the only part forming hormone and must therefore be responsible for the excess. The uninvolved tissue which collects no iodine and inactivates no pituitary stimulating hormone is apparently at physiologic rest and is anatomically atrophied. Thus, the term adenoma used to denote a benign neoplasm has been given a physiologic as well as an anatomic meaning. Strictly neoplasia means an abnormal growth of tissue which takes place without regard to the laws governing the normal portions of the gland. In these cases the excessive function has been assumed by the adenoma indicating a disordered secretory activity in addition to the pathologic cell growth. In contrast the uninvolved tissue obeys physiologic laws and rests in the presence of an excess of the hormone; its disorder of function is secondary and the tissue is not in itself diseased.

The single adenoma is a rare cause of hyperthyroidism. It is best considered as a pathologic type at the extreme from the diffuse hyperplasia which is the common type associated with hyperfunction. The disease types in the thyroid and parathyroid glands are thus reversed.<sup>1</sup> As with hyperparathyroidism due to adenoma, hyperthyroidism may also be associated with more than one adenoma. We have encountered 2 cases with two adenomas each. That the neoplasms or adenomas were the cause of the hyperfunction is indicated by the accompanying atrophy of the uninvolved tissue comparable to that found in the cases with the single hyperfunctioning adenomas described in this paper. Doubtless cases will be found in which there are multiple adenomas.

OF 8 cases of hyperparathyroidism proved by operation, 1 the Massachusetts General Hospital, 75 have had the localized form of autonomic disorder. 1 of 75, one gland only has shown anatomic abnormality and in none of these not even the whole gland has been involved. The disease process, small run of uninvolved parathyroid tissue has surrounded the diseased tissue. In 5 of the 75 cases, 10 glands, rather than only one, have shown changes; the other two glands of each patient are not involved. Because of the localized nature of the disease, these 75 cases the lesion has been considered neoplastic and has been called an adenoma.

In 7 of the 81 cases of hyperparathyroidism the disease process has involved all of the tissue of 11 of the parathyroid glands and has been termed hyperplasia by some and hyperplasia by others. That the disease process is considered different from that of the localized neoplasia or adenoma is strengthened by the fact that the type of arrangement of the hyperplastic glands differs by distinguishable from those of the cells found in the adenomas.

all hyperfunctioning. The differentiation of the lumps as true neoplasms will depend upon the demonstration of physiologic rest of the uninvolved tissue in contrast to hyperfunctioning paranodular tissue of nodular goiter with hyperthyroidism (12). Indeed henceforth distinction between lumpy diffuse goiter with hyperthyroidism and true neoplastic or adenomatous goiter must be made by simultaneous scrutiny of all the nodules and the uninvolved or paranodular tissue.

The observation that the disease process in the thyroid is localized to one part of the gland suggests that the origin of the disease is different from that of the diffuse hyperplasia type in which all of the tissue is acting beyond normal physiologic control. Our studies give no clue as to the nature of the initiating process. It is of interest that the clinical disease produced by the hyperfunctioning single adenoma did not differ significantly from Graves disease with the diffuse goiter. There is a suggestion that eye signs, particularly exophthalmos, were less frequently encountered but the number of cases is too small to be sure that this difference was not due to the age of the patients. That the function of the majority of the adenomas was not affected by iodine is certain.

Of significance to the surgeon is the finding that the uninvolved tissue obeys physiologically the law of supply and demand as far as function is concerned and is therefore not diseased. Nothing is to be gained by excising it. Indeed it would be better to leave all of it behind, the better to insure more prompt and complete return of function. If the surgeon is familiar with tissue atrophied by disuse, little difficulty will be encountered in recognizing it.

We have not had an opportunity to test the efficacy of radioactive iodine in therapeutic doses in reducing the secretory activity of a hyperfunctioning adenoma. Presumably it should prove effective though the failure of roentgen irradiation in the 2 cases in which this latter agent was employed suggests that larger doses of radioactive iodine might be needed than in Graves disease with diffuse hyperplastic goiter. It is not surprising that thiouracil was effective in lowering the metabolic rate in the patient in whom this drug was



Chart 5 Proportionate size configuration, and radioactive iodine uptake of normal and diseased thyroid glands. The intensity of the shading indicates the avidity of the tissue for tracer dose of iodine. Diagram represents normal gland. Diagram 2 is that of a patient with diffuse hyperplasia with hyperfunction (Graves disease). It is therefore drawn diffusely larger than the normal and colored blacker because of an increased avidity for iodine. Diagram 3 represents a single adenoma with but little iodine uptake in a patient with normal thyroid function, the uninvolved gland is normal in size and iodine uptake (Case 2C, see also Chart 6 diagram 3). Diagram 4 represents the findings in Case 8 with a single hyperfunctioning adenoma. The adenoma absorbs an increased amount of iodine while the uninvolved takes up none. The uninvolved tissue is atrophic and shrunken. (See also Chart 6, diagram 4)

the uninvolved tissue. The ratio of uninvolved to adenoma was 1:23. This finding coupled with the gross appearance of the uninvolved tissue which was consistent with partial atrophy suggests that the adenoma was secreting the large part of the hormone requirements of the patient and that the uninvolved tissue was at partial rest. The findings in these 3 cases are to be contrasted with diagram 4 which depicts the patient with hyperthyroidism. (Diagrams 4 of Charts 5 and 6 are of the same patient.) In this case the given ratio of 1:715 is arbitrarily set by the sensitivity of the method since there was no measurable radioactivity in the uninvolved tissue.

Comparison of these 4 cases suggests first that secretory activity of an adenoma is not all or none but that there are many gradations; second that if the secretory activity of the adenoma is high and the size of the adenoma sufficient hyperthyroidism results and third that such hyperthyroidism is accompanied by depression of the activity of the uninvolved gland.

**Responses to iodine, thiouracil, and irradiation.** It is not clear that the hyperthyroidism of any of the patients was alleviated as a result of the administration of iodine. The metabolic rate fell in 6 patients following iodine but it is possible that the fall was the result of contin-

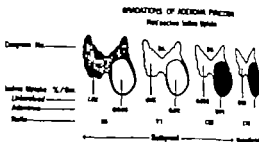


Chart 6 Gradations of function of thyroid adenoma indicated by their absorption of a tracer dose of radioactive iodine. The intensity of the shading is proportional to the avidity of the tissue for the iodine. The measured iodine uptake of each tissue is given below the diagram; the figures represent the per cent of the dose of iodine found per gm of tissue. The ratio of iodine uptake of uninvolved tissue to adenoma is given in the lowest line of figures. In the first three diagrams (3A, and 3B) the overall thyroid function was normal yet the activities of the adenoma and uninvolved tissues differed. In diagram 3B are given the findings in Case 2C (see also Chart 5 diagram 3). In diagram 4B those of Case 3C, and in diagram 3B those of Case 2. With increasing adenoma function there is a decrease in the function of the uninvolved tissue. Its overall decrease, size or partial atrophy in diagram 3B as compared with diagram 3. Diagram 4 represents the findings in Case 8 (see also Chart 5, diagram 4) with a hyperfunctioning adenoma; there was no uptake of iodine by the atrophic uninvolved tissue.

ued bed rest or other cause (Charts 1 and 2). Certain it is that there was no response in the other four (Chart 4a).

The adenomas of 2 patients, Cases 3 and 4, were exposed to roentgen irradiation before operation. In neither case was this treatment followed by any change in the metabolic rate.

Only one of the 10 patients was treated with thiouracil. Case 5, neither the inactivation of thyroid stimulating hormone nor radioactive absorption was measured in this patient's gland. The thiouracil was accompanied by a drop of 23 per cent of the metabolic rate in 14 days. A response to thiouracil is to be anticipated; part of the fall in this patient may have been due to rest. The patient at a previous hospital admission had made an apparent response to iodine which had then been omitted for some months prior to the thiouracil treatment.

#### FURTHER COMMENT

The gross anatomic findings and the tests of function, inactivation of thyroid stimulating hormone, and collection of radioactive iodine, have delineated the single adenoma with hyperfunction as a disease entity of the thy-

roid gland. Not only does the adenoma inactivate an excess of the anterior pituitary hormone but it has been shown to be the only part of the thyroid gland which absorbs iodine. Since iodine is a chemical requisite of the thyroid hormone, the adenoma is the only part forming hormone and must therefore be responsible for the excess. The uninvolved tissue which collects no iodine and inactivates no pituitary stimulating hormone is apparently at physiologic rest and is anatomically atrophied. Thus the term adenoma used to denote a benign neoplasm has been given a physiologic as well as anatomic meaning. Strictly neoplasia means an abnormal growth of tissue which takes place without regard to the laws governing the normal portions of the gland. In these cases the excessive function has been assumed by the adenoma indicating a disordered secretory activity in addition to the pathologic cell growth. In contrast the uninvolved tissue obeys physiologic laws and rests in the presence of an excess of the hormone; its disorder of function is secondary and the tissue is not in itself diseased.

The single adenoma is a rare cause of hyperthyroidism. It is best considered as a pathologic type at the extreme from the diffuse hyperplasia which is the common type associated with hyperfunction. The disease types in the thyroid and parathyroid glands are thus reversed.<sup>1</sup> As with hyperparathyroidism due to adenoma, hyperthyroidism may also be associated with more than one adenoma. We have encountered 2 cases with two adenomas each. That the neoplasms or adenomas were the cause of the hyperfunction is indicated by the accompanying atrophy of the uninvolved tissue comparable to that found in the cases with the single hyperfunctioning adenomas described in this paper. Doubtless cases will be found in which there are multiple adenomas.

<sup>1</sup>Of 8 cases of hyperparathyroidism proved by operation, 1 the Massachusetts General Hospital, 7½ have had the localized form of anatomic disorder. 1 of one gland only has shown an anatomic abnormality and in some of these not even the whole gland has been involved in the disease process; a small rim of uninvolved parathyroid tissue has surrounded the diseased tissue. In 5 of the 7½ cases, two glands, rather than only one, have shown changes. The other two glands of each patient were not involved. Because of the localized nature of the disease in these 7½ cases the lesion has been considered neoplastic and has been called an adenoma. In 7 of the 8 cases of hyperparathyroidism the disease process has involved all of the tissue of all 4 of the parathyroid glands and has been termed hyperplasia by some and hypertrophy by others. That the disease process is considered different from that of the localized neoplasia or adenoma is strengthened by the fact that the cell type and arrangement of the hyperplastic glands is clearly distinguishable from those of the cells found in the adenomas.

all hyperfunctioning. The differentiation of the lumps as true neoplasms will depend upon the demonstration of physiologic rest of the uninvolved tissue in contrast to hyperfunctioning paranodular tissue of nodular goiter with hyperthyroidism (12). Indeed henceforth distinction between lumpy diffuse goiter with hyperthyroidism and true neoplastic or adenomatous goiter must be made by simultaneous scrutiny of all the nodules and the uninvolved or paranodular tissue.

The observation that the disease process in the thyroid is localized to one part of the gland suggests that the origin of the disease is different from that of the diffuse hyperplasia type in which all of the tissue is acting beyond normal physiologic control. Our studies give no clue as to the nature of the initiating process. It is of interest that the clinical disease produced by the hyperfunctioning single adenoma did not differ significantly from Graves disease with the diffuse goiter. There is a suggestion that eye signs, particularly exophthalmos, were less frequently encountered but the number of cases is too small to be sure that this difference was not due to the age of the patients. That the function of the majority of the adenomas was not affected by iodine is certain.

Of significance to the surgeon is the finding that the uninvolved tissue obeys physiologically the law of supply and demand as far as function is concerned and is therefore not diseased. Nothing is to be gained by excising it. Indeed it would be better to leave all of it behind, the better to insure more prompt and complete return of function. If the surgeon is familiar with tissue atrophied by disuse, little difficulty will be encountered in recognizing it.

We have not had an opportunity to test the efficacy of radioactive iodine in therapeutic doses in reducing the secretory activity of a hyperfunctioning adenoma. Presumably it should prove effective though the failure of roentgen irradiation in the 2 cases in which this latter agent was employed suggests that larger doses of radioactive iodine might be needed than in Graves disease with diffuse hyperplastic goiter. It is not surprising that thiouracil was effective in lowering the metabolic rate in the patient in whom this drug was

tried. From a chemical point of view thiouracil should block formation of the thyroid hormone by any cell neoplastic, as well as hyperplastic and normal (9). The ultimate fate of the adenomatous cell after both radioactive iodine and thiouracil therapy remains to be established.

#### SUMMARY

The single adenoma of the thyroid gland causing hyperthyroidism is established as an entity. It is the rare type of pathologic anatomy found in patients with thyrotoxicosis. 10 cases have been encountered in the Thyroid Clinic at the Massachusetts General Hospital in the last 10 years. Proof of its existence in a patient depends upon the absence of other diseased thyroid tissue, the presence of gross anatomic atrophy and of physiologic inactivity of the uninvolved thyroid tissue and relief of the excessive function upon its removal.

The atrophy of the uninvolved thyroid tissue can be suspected on physical examination but should always be recognized at operation and undue resection of it avoided.

The physiologic activity of the adenoma and uninvolved thyroid gland has been compared by the ability of explanted thyroid tissue to inactivate thyroid stimulating hormone and by the avidity of the thyroid for tracer doses of radioactive iodine. Both tests have shown activity of the adenoma comparable to that found in the hyperplasia of the common type of thyrotoxicosis and absence of function of the uninvolved tissue.

The absorption of tracer doses of radioactive iodine by single adenomas not associated with hyperthyroidism suggests that the secretory activity of adenomatous tissue varies over a wide range and that the presence of thyrotoxicosis in a patient depends upon the degree of activity and size of the adenoma. The activity of the accompanying uninvolved tissue varies inversely and is depressed when that of the adenomatous approaches an excessive amount.

The relative effectiveness of thiouracil and radioactive iodine compared with surgery in relieving the hyperfunction associated with this pathologic type, and the eventual fate of the localized neoplastic process when these two drugs are employed has not been established.

**ADDENDUM.**—Since this manuscript was submitted for publication the distribution of radioactive iodine in the adenoma compared with that in the atrophic uninvolved tissue has been observed in 3 additional patients with thyrotoxicosis due to a hyperfunctioning single adenoma. The first patient, a girl of 7 years, had mild degree of thyrotoxicosis; the adenoma contained 8.3 per cent per gram of the radioactive iodine given, the uninvolved thyroid tissues 0.030 per cent per gram and a lymph node .04 per cent per gram. The second patient, a woman of 33 years, had a moderate but crippling degree of thyrotoxicosis; the adenoma contained .88 per cent per gram of the radioactive iodine; the uninvolved tissues .37 per cent per gram. Removal of the single adenoma and resection of gram only of the uninvolved tissue for analysis, resulted in relief of the thyrotoxicosis in both cases.

#### REFERENCES

- ASTWOOD E. B. *J. Am. Med. Ass.* 1944, 12: 76.
- GRAHAM E. M. and EVANS R. D. *J. Am. Med. Ass.* 1946, 131: 86.
- COPE O. *Ann. Surg.* 1941, 14: 706.
- HAMILTON, J. G. and SOKLEY M. H. *Am. J. Physiol.* 1939, 32: 557.
- HERTZ, S., ROSENBERG, A., and EVANS R. D. *Proc. Soc. Exp. Biol. N. Y.* 1948, 35: 50.
- HERTZ, S. *Am. J. Roentg.* 1941, 46: 467.
- HERTZ, S., and ROSENBERG, A. *J. Am. Med. Ass.* 1946, 14: 8.
- LEBLOND, C. P., PUFFEL, I. D., RILEY, E., ROSENBERG, A., and CURTIS G. M. *J. Biol. Chem.* 1944, 154: 275.
- LEITER, L., SKIDMORE, S. M., MARSHALL, L. D. and BAUMANN E. J. *J. Clin. Endocrinol.* 1946, 6: 217.
- MCAURTHUR, J. W. and COPE, O. *Proc. Am. Soc. Clin. Invest.* 1946, 35: 939.
- PARRISON, W. B., JR. *Ann. Surg.* 1927, 85: 107.
- PUFFEL, I. D. The surgical significance of the fractionating activity of the nodular and perinodular tissues of nodular goiter. Presented at meeting of American Association for the Study of Goiter, June, 1946.
- RAWSON, R. W., STERCKE G., and ARA, J. C. *Endocrinology* 1944, 30: 240.
- RAWSON, R. W., GRAHAM, R. M., and KIDWELL, C. B. *Ann. I. C. M.* 1943, 2: 403.
- RAWSON, R. W. and CORTELL, R. *Endocrinology* 1944, 35: 482.
- REICHGOTT, W. F. JR., and LEWIS, D. *Arch. Surg.* 1938, 6: 70.
- Thyroid Clinic, Massachusetts General Hospital. Unpublished data.

# RESECTION OF THE COMMON HEPATIC DUCT FOR PAPILLARY ADENOCARCINOMA

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**A** PRIMARY carcinoma of the extra hepatic bile ducts especially if those of the ampulla of Vater are excluded is an extremely rare finding. Pathologically there are two types the nodular and the papillary and of these the latter is most infrequent comprising only about 10 per cent of the total. All writers agree that papillomatous growths in the bile ducts will obstruct the lumen before penetrating the wall of the duct in brief they probably remain as a local lesion long enough to produce definite symptoms before metastases take place. Marshall found 4 papillary carcinomas of the extra hepatic ducts in a series of 49 carcinomas of these structures and stated that most papillary growths in this region would prove malignant on section.

Males (60%) more often than females are affected with carcinoma of the bile ducts but females are more often affected with carcinoma of the gall bladder (80%) (1). The average age of individuals with bile duct carcinoma is 55.5 years. Carcinoma of the gall bladder is said to be four times as common as carcinoma of the bile ducts.

In the series presented in Table I (1) if one includes under one heading all the tumors arising from the common bile duct including the ampulla then the common bile duct is the most frequent site with 210 next is the junction of the three ducts—cystic, common and hepatic duct with 124. The hepatic ducts right left and common present the next most frequent site with 87 and the cystic duct is the least frequent site. We were able to find only 21 cases in which the common hepatic duct alone was involved, 19 reported by Rolleston and McNee and 2 by Marshall but this figure may not be accurate.

**Symptoms.** Jaundice is present in 100 per cent of cases. Complete biliary obstruction is present in over 90 per cent. The onset is acute in almost 90 per cent. Loss of weight and

strength also occurs in nearly all if not all, patients. Pain is present in about 52 per cent. Chills, elevation of temperature vomiting diarrhea and pruritis are common. Ordinarily no mass is palpable in region of primary tumor the liver is enlarged in 68 per cent and the gall bladder in 26 per cent, and about 50 per cent have ascites.

## CASE REPORT

Mr C S C white aged 73 years entered Heights Hospital February 2 1946. His chief complaints were marked jaundice widespread itching loss of 20 to 30 pounds in weight persistent diarrhea. His present illness began about 8 weeks before admission with indigestion and a mild burning and bubbling in his stomach. After a week of this he began to develop a yellow color and his stools became rather light in appearance. The jaundice was first noted December 20 1945 and gradually became more pronounced. At no time was there any definite pain in the abdomen. There was no fever no chills no nausea or vomiting. Three weeks after jaundice appeared itching was rather marked. Until admission to hospital he had a rather continuous diarrhea and lost considerable weight probably 20 to 30 pounds but felt hungry and ate all types of food during the present illness.

He had usual childhood diseases and typhoid at 27 years. He had had an appendectomy 10 years before and 5 years before had had 18 skin lesions stated to be skin cancers removed from back of neck and right ear. None of these had recurred.

His father died at 82 years cause unknown. Mother died at 69 of hypertension. One brother died at 58 of heart attack and two sisters ages unknown, living one sister with tuberculosis. No history of cancer or tuberculosis otherwise in family.

Physical examination revealed a thin emaciated white man with marked icteric tint to skin and sclera, many skin abrasions as result of scratching. Patient was mentally alert, not toxic, very cooperative in all respects. His blood pressure was 140/90 the heart action was a little irregular there was no cardiac enlargement but there was a rather loud systolic murmur at the apex. The lungs were clear. The abdomen was markedly scaphoid and the liver was enlarged about three fingers breadth below the costal margin. The spleen was not palpable. No other masses other than the enlarged liver were noted. Rectal examination was essentially negative.



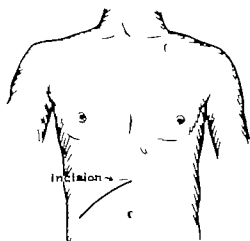


Fig. 1. The upper oblique incision (Singleton)

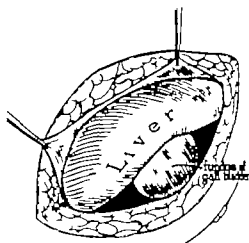


Fig. 2. Greatly enlarged liver and distended gall bladder

no nodules on rectal shelf. The temperature was 98 degrees pulse good volume slightly irregular.

Laboratory examination on February 4, 1946 showed urine—dark amber clear alkaline specific gravity 1022 albumen 0 sugar 0 blood 0 epithelium cells rare casts granular rare bile present. Blood—red blood count 4,040,000, hemoglobin 80 per cent Sahli white blood count 5,800 polymorphonuclears, 58 lymphocytes, 40 juveniles 2 icterus index, 100.

He was seen in consultation February 3, 1946 by Dr. E. K. Donk, whose impression was that it was a malignant condition causing obstruction of the biliary tract and advised a gastrointestinal series. This was done by Dr. B. T. Vanzant and was essentially negative except for a large number of diverticula in the lower sigmoid. His report is as follows: "February 4, 1946 G. I. Series. Fluoroscopically the upper half of the stomach is a mere tube with greatly thickened longitudinal mucosal folds. The material passes immediately into the duodenum and on into the small intestines."

At the end of four hours stomach is practically empty. Residue shows an extremely ragged lake-like residue with all the opaque material in the isthmus and first portion of duodenum.

Six hour plate terminal ileum and the first portion of ascending colon contains all material.

Twenty four hour plate colon is empty except for small amount in the transverse colon. A small retention pocket in the caecum, a slightly larger retention pocket in the splenic flexure with only a moderate amount in the sigmoid.

In the six hour plate we notice in the right lower quadrant, a very large number of shot-like pockets, evidently in the wall of the small intestine and in the twenty four hour plate, the lower sigmoid shows a large number of diverticulae.

"The case is apparently one of generalized hypermotility and general spasticity. Unable to detect any definite anatomical lesion."

"Would suggest the possibility of a very mild avitaminosis of the pellagra type."

We believed that it was most likely a case of carcinoma of the head of the pancreas and so advised our patient. It was decided that the abdomen should be explored in the hope that his condition could be improved, and he was therefore prepared for surgery. He was given daily doses of vitamins K with bile salts, large amounts of vitamins A and D and B complex, also 2 cubic centimeters of crude

TABLE I.—LOCATION OF EXTRABILIARY DUCT TUMORS IN 484 PATIENTS

Author	Date	Hepatic	Cystic	Junction of ducts	Suprapancreatic	Pancreatic	Duodenal
Demon	1905		1	37		45	11
Redfem and McVee	1920	3	7	20			1
Shepley and Lufvendahl	1923				3		
Judd and Gray	1929	8	7			20	
Walters and Olson	1935		7			33	13
Dick	1930		3				
Stewart, Larber and Morgan	1940	15		48		31	17
Marshall	1939	7	5				
Total		27	6	122	24	70	22



Fig 3 Tumor shown in common hepatic duct extending almost to bifurcation of duct.

liver intramuscularly. He was also given digitals for 3 days before operation plus two transfusions of 500 cubic centimeters each. Operation was done February 15, 1946. Pentothal was used for induction.

An upper oblique incision was used (Fig 1) transecting the right rectus muscle. When the abdomen was opened the liver was seen to be greatly enlarged with rounded edges, greenish black in color and the gall bladder to be enormously distended (Fig 2) at least four or five times normal size but of a rather normal color and thickness. We then examined the pancreas, which we fully expected to find hard and enlarged but to our amazement it felt entirely normal. This fact was so astonishing that we could hardly believe it and we incised the peritoneum lateral to the duodenum mobilized the duodenum and carefully explored the entire retroduodenal portion of the common duct and found it, as well as the adjacent pancreas entirely normal in all respects. Then a small oblong mass about the size of a large pecan (Fig 3) was noted up toward the fissure of the liver. We decided that it must be a stone or tumor in the common hepatic duct. A small nick was made in it and confirmed the fact that it was the duct and that a tumor was present therein.

No nodules could be felt in the liver or adjacent structures, and it was decided to resect

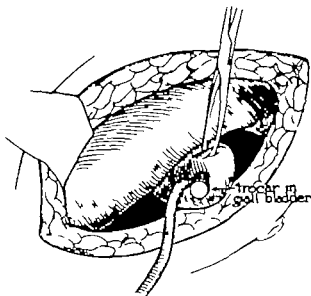


Fig 4. Aspiration of distended gall bladder: black bile obtained.

the tumor bearing section of the duct. To facilitate exposure the gall bladder was aspirated through the fundus (Fig 4) and a large amount of black bile was removed. Then the duct was cut across transversely as far above the tumor as possible this was right against the liver (Fig 5). It was then cut through below the tumor and the distal end closed over with a continuous stitch of No. 6 chromic plus an ordinary tie below this suture line (Fig 6). A lymph node adjacent to the tumor was also removed for examination.

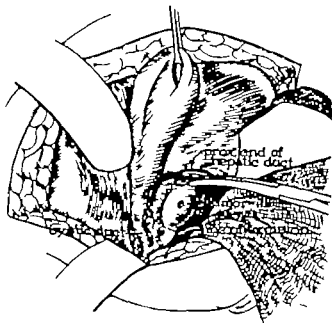


Fig 5. Common hepatic duct sectioned near proximal end. Distal line of section indicated by dotted line.

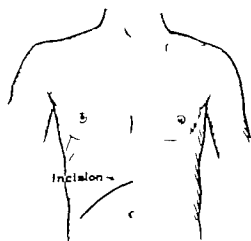


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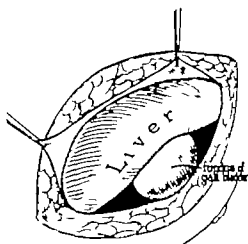


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Wahner and Others	1915	10	7			33	
Dick	1930		3				3
Stewart, Lamber and Morgan	1940	33		48		21	15
Marshall	1933	7	5			10	15
Total		87	61	21	24	100	35



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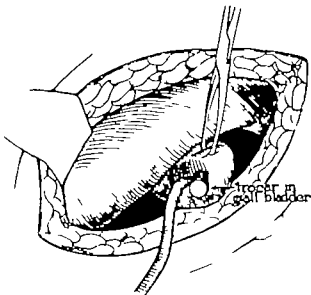


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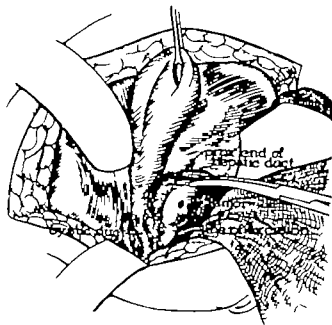


Fig 5 Common hepatic duct sectioned near proximal end. Distal line of section indicated by dotted line.

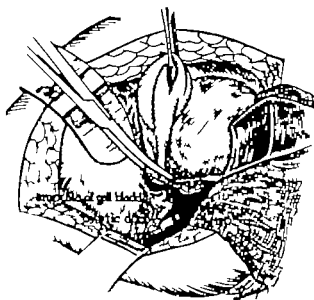


Fig. 6 Distal end of hepatic duct closed, proximal end open. Gall bladder sectioned through ampulla; distal edge not crushed.

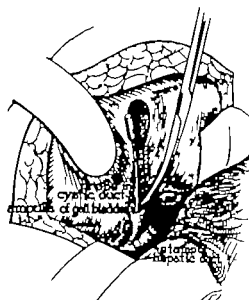


Fig. 7 Probing cystic duct in order to determine patency should be carried out before removal of the gall bladder.

The problem of bridging the gap between the cut ends of the common hepatic duct was managed by using the cystic duct and the ampulla of the gall bladder to provide a mucous membrane lined tube and a tube already accustomed to handling biliary drainage which permitted little chance for later stricture development.

A forceps was applied across the ampulla of the gall bladder and it was cut across proximal to this (Fig 6). The edge not crushed by the forceps was used for the anastomosis. A probe was then passed through the ampulla down the cystic duct and the common duct into the duodenum doubly to assure the patency of the entire tract (Fig 7). This flanged out ampulla (which was assurance against later stricture formation) was then sutured to the open end of the common hepatic duct *everting* rather than *inverting* the edges (Fig 8a), a further step in preventing stricture formation with chronic or atraumatic needles. A small catheter size 12 French, was placed so that its bell end opened into the proximal end of the common hepatic duct, and it was brought out through a tiny incision in the ampullary portion (Fig 8a). The remainder of the gall bladder was then removed and bed sutured over (Fig 8b).

Three Penrose drains were placed and brought out through the main incision. The catheter was brought through the main incision also but about an inch away from these drains.

The tumor filled the entire section of duct except for a very small space through which a small probe could be passed. The growth of the tumor was producing a very marked intra luminal pressure as it bulged outward.

The tumor was examined by Dr. A. H. Bosley, whose report is as follows:

An irregular mass from the hepatic duct measuring 2.5 by 2 cms. The color is brownish and the tissue is moderately firm with softer areas in the center. A lymph gland which measures 7 by 4 by 5 mm is fairly regular in shape and is rather soft. Microscopically sections were made from both extremities. Some of the sections show rather large gland acini lined by single layers of cuboidal cells filled with mucinous material (Figs. 9 and 10). Other sections show atypical gland acini that are lined by hyperplastic cells that are irregular in size and shape with mitotic figures that are atypical. The arrangement is quite frequently papillomatous (Figs. 11 and 12). The wall is not demarcated other than a connective tissue band between the glandular tissue. Sections from the lymph node show no evidence of metastasis. Diagnosis: papillary adenocarcinoma, grade II.

The gall bladder aside from its marked distention, was normal. He made a good recovery and the

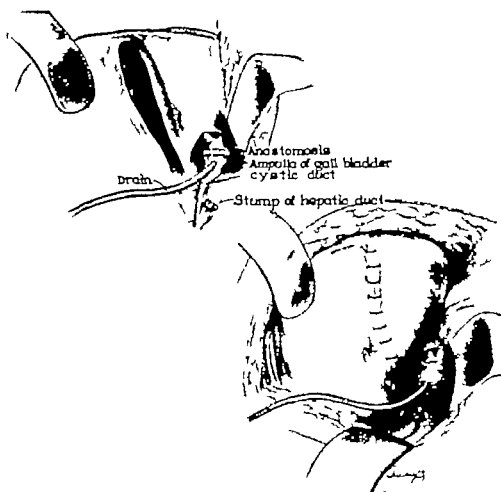


Fig. 8. a, left, Anastomosis of ampulla to proximal end of common hepatic duct. Note eversion of edges, catheter drain. b Completed operation.

only complication was a failure of the skin edges to unite. The deeper layers all held; he had no hernia but a secondary closure of the skin edges was necessary. Highest postoperative temperature was 99.8

passed on into the duodenum (Fig. 13). At this time his urine still contained bile and the stools were negative for bile. Report of the x-ray examination for March 5, 1946 was:

"Beautiful filling of all the hepatic ducts. Common duct is open and material flows freely into duodenum."

On March 16 another injection was done demonstrating the same situation. X-ray report for March 16, 1946 (Fig. 14) was:

"Very excellent injection of the biliary tree. The material flows into the duodenum."

He continued to improve; the external biliary drainage became much less 36 hours after the catheter was removed on March 18 and on March 22 he was allowed up in a wheelchair. His stools were beginning to have a more normal color; his appetite was very good and he felt himself gaining strength every day. By March 25 there was almost no drainage and he was allowed to go home.

This case has unusual features:

1. With marked loss of weight and strength, he still had a good blood count.

2. His appetite was never bad even from the beginning.

Date	Icterus index	Stools (bile) Albumen globulin	Urine (bile)
2-2-46	100		+
2-15-46	Operation		
2-16-46	80	o	+
2-18-46	80		+
2-20-46		o	
2-22-46	70		
	Total protein	6.8	
	Albumen	5.3	
	Globulin	5	
	Albumen-globulin ratio	3:1	
2-26-46	66		
3-18-46	Catheter removed		
3-20-46		+	
3-21-46	25	+	
3-25-46	22		o

On March 5 the biliary system was injected through the catheter and besides outlining the intra-hepatic system also demonstrated that the media



Fig. 9. Low power



Fig. 10. High power

3 We wonder if any connection exists between the numerous skin cancers removed 5 years before. Once before one of us (J P B) saw an elderly man develop primary carcinoma of the liver 10 years after having had a basal cell carcinoma of the face removed with radium.

We believe that the obstruction was complete but that at times a little bile was forced

through the narrow tract by pressure from the liver otherwise the bile in the gall bladder would have been "white bile" instead of the black.

If no bile at all had reached the intestine it would have had marked anorexia, but this was not the case.

We are unable to explain the enormously distended gall bladder. According to Cow



Fig. 11. Papillomatous arrangement, typical gland acini. Low power



Fig. 12. Papillomatous arrangement. High power



Fig. 13 left. Injection of biliary system. Note passage of media into duodenum.

Fig. 14. Note injection of cystic and common bile ducts. Media passes into duodenum.

Voisier's law: extrinsic pressure on the ducts (and usually pressure exerted at a point distal to the junction of cystic and hepatic ducts) produces a distended gall bladder. Here the pressure was intrinsic and was at a point well proximal to the junction of cystic and hepatic duct. It was evident that bile was getting by in tiny amounts and being stored up in the gall bladder but the gall bladder was not contracting and emptying itself through the sphincter of Oddi very well. Perhaps the abnormal pressure in the hepatic duct in some way interfered with the reciprocal autonomic regulation of the gall bladder sphincter of Oddi mechanism.

The cystic duct here was quite small but a 3 millimeter dilator could be passed through it and we depended on the inherent ability of the duct as a mucous membrane lined tube to dilate sufficiently to carry the total biliary stream. The correctness of this assumption was demonstrated clinically when at removal of the catheter the external drainage promptly ceased, the urine cleared and the stools regained their normal color. This characteristic ability of a mucous membrane lined channel to dilate and thus carry a heavier load than nature originally intended should always be remembered in dealing with similar problems.

The use of the ampulla of the gall bladder is noteworthy. Every end-to-end anastomosis, especially when the ends are inverted as in intestinal work, has a certain amount of narrowing due to slight septum formation by the inverted portion plus a later contraction of the circular line of union. Therefore we used a section of the gall bladder with at least twice the cross section diameter of the stump of the duct to which it would be joined. The edges were everted and thus no septum or spur whatever was formed. So far as we know this procedure has not been previously reported.

On July 20, 1946 a follow up revealed our patient in good condition, his wound well healed, no jaundice and a good appetite and he had gained 18 pounds since leaving the hospital March 25, 1946.

In reviewing this case attention is called to an alternate method that might be used in a similar case. The method presented depends upon a patent cystic duct. Most cystic ducts are patent, yet the possibility of a closed duct must be remembered. Where a diagnosis of hepatic duct tumor has been made at operation and the gall bladder present and healthy the following method of attack is suggested.

Aspirate the gall bladder preferably near or at the fundus.



Probe the cystic duct either through the aspiration opening in the gall bladder or through a small opening in the ampullary region and if patent the method already presented may be used if desired, but if for any reason it is not applicable the following method may be employed

Resect the hepatic duct tumor but make every effort not to damage either the cystic or hepatic artery

Do not close the distal end of severed hepatic duct

Beginning at the fundus, dissect the gall bladder away from its bed protecting the cystic artery at the base of the flap

Anastomose the fundus of gall bladder to proximal end of hepatic duct

Implant distal end of hepatic duct into side of gall bladder which will probably be a little

above the ampullary region. If the gall bladder should be half as large as in the case presented no trouble will be experienced.

Put catheter or soft T tube in gall bladder

#### SUMMARY

A case of papillary adenocarcinoma of the common hepatic duct, with successful resection has been presented. A method of stitching the ampulla of the gall bladder and cystic duct as a substitute for the common hepatic duct has been demonstrated

#### REFERENCES

- LICHTMAN S. S. Diseases of Liver Gallbladder and Bile Ducts. Pp. 852-854. Philadelphia. Lea & Febiger, 1912
- MARSHALL, JAMES M. Surg. Gyn. Obst., 1912, 34 4-12
3. ROLLESTON H. D. and McNICK, J. W. Diseases of Liver Gallbladder and Bile Ducts. London: The Baillière Tindall Co. Ltd., 1919.





Fig. 1 (a) Diagrammatic representation of method of sectioning graft from the ilium with electric saw. (b) Diagrammatic representation of method of sectioning graft from the ilium with electric saw.

sliver graft. The length of the graft is determined by the length of the usual 6 inch piece of bone removed. The length of the graft is determined by the length of the usual 6 inch piece of bone removed. The length of the graft is determined by the length of the usual 6 inch piece of bone removed.

The experience that iliac bone is more rapidly incorporated into the host bone than cortical bone when used as graft material as reported in the author's initial communication has been sustained. This fact has not only been interpreted on the basis of the roentgenographic features of graft incorporation but from the gross and microscopical features of graft specimens removed at the time of reoperation in 6 patients. These observations have served to sustain the concept that cancellous bone by the nature of its architecture encourages more rapid invasion and replacement by new bone than does cortical bone. This has held true not only in the instance of small chip and sliver grafts which have been used to fill in bone cavities and to reinforce cortical grafts but in our cases where the cancellous grafts have been massive. The technique of exposure of the iliac wing by liberal stripping subperiosteally of soft tissues

from both the external and internal aspect has permitted the removal of massive grafts which are easily shaped with the electric saw to bridge ununited fractures and to fill bony defects (Fig. 1 a and b). This is further facilitated by the control of bleeding with the electric cautery. By the use of the electric knife and by the removal of the graft with the longitudinal attachment of the Lock saw.

In discussing graft material the author is fully aware that no bone graft specimen is wholly cancellous or cortical bone. The massive iliac graft while it is mainly cancellous in structure has an inner and outer table of cortical bone which in effect lend to the stability of this type of graft while a cortical graft from the femur or tibia may have a layer of cancellous bone on its deep surface and a variable amount at its end depending on how much of the metaphysis of the donor area has been removed.

Those who have used cortical grafts especially to bridge gaps, know that a critical

period exists after the third month at which time the center of the graft may begin to resorb and may disappear or be the site of a fracture. In this type of graft this phase of resorption is easily detected on roentgenograms the cortical graft appears denser and whiter than the adjacent host bone. The same phenomenon may occur with massive iliac grafts although this is harder to detect on roentgenograms where the cancellous graft fails to stand out in contrast to the surrounding bone. In 3 cases 1 with a nonunion of both bones of the midforearm another of the surgical neck of the humerus and the third involving the upper third of the femur dissolution of the central portion of the massive iliac graft appeared between the third and fourth postoperative month with recurrence of nonunion while in a fourth case a nonunion of the forearm recurred after the use of an iliac graft with a plate which had bridged the fracture inadequately the graft resorbing in its center in like manner. In other words although cancellous bone is more rapidly incorporated into host bone when used as graft material, its central portion where the process of creeping substitution and the replacement of new bone by mature bone is last manifest represents a site of structural weakness which requires prolonged and rigid support and protection. This is especially true where the graft is bridging a gap and is surrounded in this region solely by soft tissues. Rigid fixation cannot be obtained by plaster of Paris alone no matter how accurately applied, and it is best secured by the use of a metal plate. Such additional plate fixation is absolutely necessary in the grafting of single long bones as the femur and humerus, and particularly in their upper and middle thirds where the stress of the lever action of the extremity is most vicious and in the forearm and leg when both long bones are ununited. In the forearm and leg where one of the long bones is intact, the splintage afforded by the intact component will suffice with the usual method of fixation of the graft and a plate need not be utilized. Recurrence of nonunion has occurred in this group of patients, excluding those failures incidental to postoperative infection as a result of failure to recognize two essential mechanical

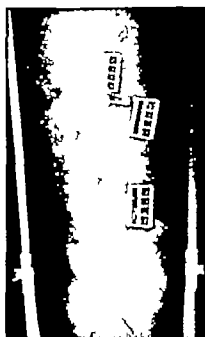


Fig. 1 Patient sustained a compound fracture of the right femur in a motorcycle accident. Reconstruction of a nonunion with gap-defect was performed by means of a massive cortical graft from the left tibia, which was affixed as an onlay to the proximal femoral fragment with three stainless steel screws after its distal end had been driven into and well impacted within the substance of the short atrophic distal fragment. The use of a metallic plate was mechanically impossible in this subject. The anteroposterior roentgenographic view made 3 weeks postoperatively and just prior to his transfer to another military hospital, is illustrated. The limb was protected in balanced suspension with skeletal traction through the upper end of the tibia at the time that this examination was made.

principles early in this study i.e. the need for metallic plate fixation in certain instances as defined above and the need for rigid fixation by plates of adequate length.

On the other hand iliac bone when it includes one and especially both tables, has sufficient stability for use alone and without plate fixation as in the treatment of ununited fractures of a single forearm bone or of the tibia in the presence of an intact fibula, and when it is fashioned from the iliac crest and includes three cortical surfaces—the crest and both tables—it is as rigid as a segment of cortical bone of similar dimensions.

Cortical bone must be used in selected cases.

a. Where the graft is necessary to bridge a considerable gap as in the femur and must measure in excess of 5 inches it is obligatory that cortical bone be used. The osteogenic properties of such massive cortical grafts will

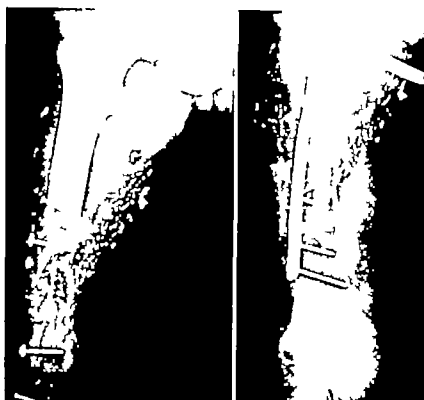


Fig. 3, a and b. Patient sustained severe compound comminuted fracture of the right femur as the result of enemy shell fire. An onlay iliac graft, fixed with stainless steel screws, was employed to bridge the 3 inch (7.5 cm.) defect and the internal was packed with shivers of iliac bone. The wound healed *per primam* but despite adequate protection of the extremity in balanced suspension and skeletal traction, the center of the graft proceeded to resorb with recurrence of nonunion 6 months postoperatively. A second graft obtained from the left tibia was applied and rigid fixation secured by the application of a stainless steel plate. a, left, is an anteroposterior roentgenogram of the femur just prior to the second grafting and, b, right, is an anteroposterior view made 6 weeks following this operation. The limb was protected in balanced suspension with skeletal traction through the upper end of the tibia at the time this report was completed.

be enhanced by the additional use of shivers of cancellous bone removed from the ilium. This has been the experience in 3 patients with ununited fractures of the femur and with massive defects. In one of these dual tibial grafts were applied and transfixed to each other and to the atrophic ends of the femoral fragments and further fixation was obtained by a long metal plate. In the second case the massive cortical graft removed from the tibia was transfixed to the proximal fragment with three screws and its distal end was driven into the spongy substance of the short distal fragment for a distance of about 2 inches (Fig. 2). In the third case a massive iliac graft resorbed in its central portion with recurrence of nonunion (Fig. 3a). At operation the defect was bridged and rigidly im-

mobilized with a metallic plate and a massive cortical graft was applied (Fig. 3b).

In a fourth instance where a gap of 5 inches existed in the upper end of the humerus with loss of the humeral head and entire glenoid, the shaft of one fibula was used between the remains of the scapula and the humeral shaft, being driven into the humeral fragment distally and transfixed at its proximal end to the extremity with one screw. In this case resorption occurred in the center of the graft with a pathologic fracture even though the area appeared adequately protected in plaster of Paris. At the time of regrafting the viable fibular fragments were found to be firmly incorporated into the host bone and the pathologic fracture was bridged by a tibial graft held with two screws above and two below the

fracture site. Union of the pathologic fracture has occurred and the tibial graft is becoming incorporated into the substance of the original fibular graft (Fig 4).

b. Cortical bone must be used where a rigid piece of bone which is perfectly straight is required as graft material. For instance, in 1 patient two cortical grafts were introduced across an ununited fracture of the neck of the femur with viable head one above and the other below an accurately placed Smith Peterson nail. Since the grafts were applied through the greater trochanter channels having been drilled accurately under roentgenographic control it was essential to use an absolutely straight graft of rigid nature which would tolerate introduction with a mallet, and cortical bone was felt to be most suitable. The writers have had the same experience with the use of cortical grafts in the Brittain type of hip fusion although this type of case is not included in this report.

2. *The specific place for plate fixation in combination with iliac grafts fixation by multiple screws in oblique fractures.* The specific purpose of a metallic plate is to give rigid fixation to the fracture and to protect the graft throughout its period of incorporation. When the iliac graft is applied across the fracture site or defect and is transfixed with screws through graft and both cortices of the host bone and at right angles to the plate and its screws added fixation is insured.

The duration of the period of external fixation varies with each case. Much depends upon the degree of stability of the fracture as determined preoperatively, the method of internal fixation employed at the time of operation, and the size and nature of the defect for the greater the defect the longer the period required for complete revitalization of the graft and the greater the danger of its resorption or fracture. The degree and length of protection will also depend upon the site of the defect. The demands for protection are greatest for a weight bearing bone (femur or tibia) and for a single bone as the femur or humerus particularly in their middle and upper thirds or



Fig 4. Enormous defect in the rigid humerus following a compound comminuted fracture incurred in battle with loss of the proximal half of the humerus and the entire shoulder joint. At the first operation a fibula graft was inserted between the acromioclavicular joint and the distal humeral fragment, but the center of this graft, despite protection of the extremity in plaster of Paris, resorbed in its center with the appearance of a pathologic fracture 6 months postoperatively. The illustration shows the roentgenographic appearance 3 months following the second operation at which time the fibular fragments were reduced and immobilized by an oblique tibial graft. The fibula now appears to be well united and the tibial graft is undergoing incorporation into the adjacent bone. The extremity was protected in a plaster-of-Paris shoulder spica at the time this report was completed.

for double bone involvement in the forearm and leg. An intact radius-ulna, or fibula offers considerable protection to a fracture of the adjacent bone.

In the instance of ununited fractures of the femur plate-graft fixation has been rigid enough to warrant the elimination of postoperative plaster-of-Paris fixation and the extremity has been protected by skeletal traction in balanced suspension. Such patients have been up in an ischial weight bearing brace 4 months postoperatively with full weight bearing by the 6th month and brace support has been discarded between the 9th and 12th month postoperatively (Fig 5 a and b, Fig 6 a and b). Patients with ununited fractures of the tibia treated by the graft plate technique have often borne weight in a walking cast between the 3rd and 4th postoperative month and this has been followed by brace protection for 6 months or if there has

This may be varied in the instance of extremely porotic bone where the graft is applied cross the fracture at directly opposite the plate, permitting a more secure bony purchase for the screws fixing the plate.

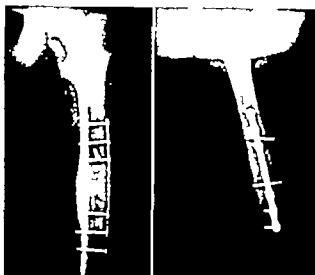


Fig. 5 a and b. Simple fracture of the left femur which was treated by open reduction and plate fixation 6 weeks after injury by a falling log. Delayed union with an interval gap between the fragment ends and with little callus formation was evident 6 months later. An iliac bone graft was applied and the metallic plate left *in situ*. a and b, Anteroposterior and lateral roentgenograms of the femur made one year postoperatively. The medullary canal is reforming, there is thorough incorporation of the bone graft and union is solid. Note how the superficial portion of the massive graft has resorbed, as evidenced by some protrusion of the screws and it is for this reason that the operative technique has been modified to include counter-sinking of the main graft. Brace support was eliminated in this case 9 months postoperatively.

been much bony defect, for 9 months. Fractures of the upper extremity have been mobilized at the end of 3 months being protected in an abduction cast or brace when the fracture involved the upper third of the humerus or by a bivalved hanging cast for fractures distal to this region.

It is the experience of the writers that the use of a plate in addition to the bone graft is absolutely essential in the surgery of ununited fractures of solitary long bones such as the femur and humerus particularly in their upper thirds where the lever action of the extremity is most vicious. Nonunions have recurred in one case in the surgical neck of the humerus and in another in the upper third of the femur following bone grafts with simple screw fixation even though the humerus case appeared adequately protected in a plaster-of-Paris shoulder spica and the femur was still supported in traction-suspension. Even in the instance of massive defects where the union is afforded by a narrow osseous bridge and where

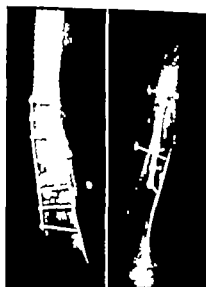


Fig. 6, a and b. Compound comminuted fracture of the right femur incurred in battle with resultant sepsis which was treated by the iliac graft metallic plate open 7 1/2 months after the initial injury and 6 months after cessation of all drainage. a and b, Anteroposterior and lateral roentgenograms made one year postoperatively. The graft is completely incorporated into the host bone, there is solid union of the fracture, and the medullary canal is reforming. Brace discarded in this case 9 months postoperatively.

this lesion exists in the upper third of the humerus or femur the authors advocate that a metallic plate be employed in addition to the replacement graft (Fig. 7 a, b and c). In the forearm where both bones are uninjured, plating of the ulna in addition to grafts of both radius and ulna is recommended, while in the leg when both tibia and fibula are uninjured the plate-graft technique is recommended for the tibia. As noted before, in the forearm if the radius or ulna is intact and in the leg if the fibula is intact, sufficient stability is afforded and a plate need not be used (Figs. 8, 9).

The greatest problem has been to apply the plate in such a manner as to secure maximum rigidity and for this reason since the shape of the fracture gap and the fragment ends vary widely the site and manner of application of the plate must be varied to conform to the mechanical requirements in each case. It is essential to have a plate that is long enough and to have at least two and preferably three screws fixed firmly above and below the fracture level. In the presence of long bone defects a plate longer than that usually employed for



Fig. 7 a, b, and c. This subject incurred a compound comminuted fracture in the upper third of the left femur in battle. Seven months later he presented a large defect at the fracture site with a narrow bony bridge across this defect. Strengthening of the strut by an iliac graft and filling of the defect with shivers of iliac bone was performed; the graft being held securely by two screws above and two screws below, as shown in a, left. Four months later, although the extremity was still protected in balanced suspension and without any history of an injury, a check roentgenogram b, center, demonstrated increased lateral bowing of the femoral fragments. At recuperation, motion at the fracture site and at the proximal end of the graft was demonstrable. A metallic plate was applied laterally after correction of some of the lateral bowing and the iliac graft was applied to bridge the defect more securely c, right. Anteroposterior roentgenogram made 2 weeks following the plate graft operation. The limb was supported in balanced suspension with pin traction through the distal end of the femur at the time this report was completed.

that particular long bone will have to be used. For this reason the longest standard type metal plate utilized for the internal fixation of fractures of the femur is inadequate in the treatment of considerable gaps in that long bone. The authors have had to improvise and fashion plates as long as 9 inches in length in order to bridge certain femoral defects and yet insure adequate proximal and distal screw fixation, and this material has been usually derived from the long arm of the longest Moore type plate. If the technique herein reported is acceptable it becomes apparent that plates up to at least 10 inches (25 cm.) in length must be manufactured of stainless steel or vitallium, and the authors have called attention to this need. In a nonunion of the subtrochanteric region of the femur the Blount or Moore plate has served effectively for application of the graft plate technique in this region.

Another method of internal fixation has been employed which is restricted to the

oblique type of ununited fracture and which has permitted the elimination of a plate in such cases at the time of application of the bone graft. The fracture is transfixed after freshening its surfaces and insuring accurate contact by two or three screws, and then the graft is applied at right angles in a prepared bed across the fracture and is held by two screws above and two below this site. This technique has been employed in the tibia and ulna, and in the instance of the tibia the graft has been applied wherever possible on the fibular side and in the ulna on its radial side.

3. *Modifications and variations in the technique of the combined graft plate method and of bone grafting without plate fixation.* While the authors recommend the use of plates and screws as an essential feature of their grafting technique, they are fully aware of the undesirable features of metallic internal fixation. There is no question that once postoperative infection has occurred (and the potentiality





Fig. 8. Compound comminuted fracture of the left radius, incurred in battle, with resultant nonunion and a gap defect of 3 inches. At operation 6 months following the cessation of all drainage, an iliac graft, shaped to fit the oblique ends of the radial fragments, was interposed and affixed by screws proximally and distally. The ulna was intact but its distal end was resected to permit more accurate repositioning of the fragments of the radius and to correct the radial deviation of the hand and wrist.

The illustrations of the anteroposterior and lateral roentgenograms made 3 months postoperatively show good incorporation of the iliac graft into the host bone. Note that while the density of the graft and radial fragments is the same, the ground glass-like appearance of iliac bone has not been lost at this time and the reformation of a medullary canal is not yet manifest roentgenographically.

for this complication always exists in this type of battle injury even with the best preparation and technique) the presence of foreign bodies will serve to encourage and perpetuate such an infection.

The technique of the plate-graft procedure has been described at length in the authors' original communication. They have found it of considerable advantage to utilize the electric knife and cautery in exposing the fracture and preparing the field for the graft and they have used this technique in exposing and removing grafts from the ilium. Both fields are kept dry by the use of continuous suction.

Although the soft tissues which have been dissected from both tables of the ilium are resutured with care following removal of graft material and despite hemostasis by the electric coagulator and the use of bone wax to control bone bleeding, ecchymosis and, in some cases, hematoma formation may occur. The latter has been controlled without any ill effect by early aspiration. The writers who have attempted a second removal of bone from the same ilium in 2 cases and encountered

considerable difficulty due to scarring and soft tissue adherence at the site of the bone defect, caution against this procedure and advise the use of the opposite ilium instead. These findings may account for the lack of residual disability following the resection of even massive portions from one or both ilia. There has been no instance of herniation through the iliac wound. The ilium at the site of resection will tend to regenerate although defects are seen to persist in late postoperative roentgenograms.

Femur cases are brought to the operating room in their traction-suspension and are operated upon with the weight applied continuously to the pin through the distal end of the femur or the proximal end of the tibia. In the instance of other long bones a plaster-of-Paris support is applied several days before surgery and is bivalved to permit immediate application postoperatively, and this external limb is usually changed 3 weeks postoperatively. The positioning of the patient at the time of surgery will depend entirely on the site of approach selected for the involved bone and depending on this position either the right or left ilium is used. For this reason both iliac crests are prepared preoperatively.

When necessary the patient is prepared with whole blood transfusions preoperatively and in all cases blood is administered during the operation. Usually 1,000 cubic centimeters is administered to femur and humerus cases and 500 cubic centimeters in operations on other long bones which permit the use of a tourniquet. The procedure can be greatly hastened by the use of two teams. In the last 5 months of this study the senior author found it necessary to prepare the field for the graft and to remove the graft himself. Despite this, the procedure has not become complicated and operation upon some of the most difficult femur cases has not exceeded  $2\frac{1}{2}$  hours. With a two-team technique the operation on the femur has been completed well within a 2 hour period.

Penicillin has been employed systematically in all cases, in doses of 20,000 units every 4 hours and more recently in doses of 40,000 units every 4 hours. Administration is begun at 6 p.m. on the evening before surgery and

continued for a minimum of 5 days and in cases requiring extensive surgery for 10 days postoperatively.

As originally described in the instance of the femur this long bone is exposed and a six screw plate is applied on the side of greatest stress which is usually lateral as manifested by the tendency for lateral bowing in most instances. It is essential that a plate of adequate length be employed with a minimum of two screws above and two screws below the fracture level which screws must include both cortices of the host bone. The authors have employed washers fashioned from metallic plates where it has been necessary to remove the hard outer table in reshaping the iliac graft and to assure a more adequate purchase of the screws. All metallic bodies have been constructed of stainless steel. Prior to the application of the graft a trough is constructed and the medullary cavities of both fracture fragments are opened. This is done anteriorly or laterally depending on which side the plate has been applied. This cavity is filled with long strips of iliac bone and the massive iliac graft is then applied across this area and is fixed with one or two screws above and below the fracture level. It has been found advantageous to recess and to countersink this massive graft for this assures more adequate contact with the host bone and what is very important in cases in which there has been considerable scarring facilitates closure of the overlying tissues without tension. Prior to the application of the graft the ends of the fragments may be drilled. Long shavers of iliac bone are placed across the exposed surfaces of the fracture. Except where it is necessary to remove tissue for exposure and graft application the scar between the fragment ends is not resected and the fragment ends are not unduly exposed.

It was the authors' experience very early in the surgery of ununited battle fractures that the presence of marked scarring created difficulty not only in exposure but also in closure. Any attempt to close these wounds under tension may result in breaking down of soft tissues or create a dead space which encourages hematoma formation and the danger of secondary infection. It was also obvious that



Fig. 9 Compound comminuted fracture of the tibia, incurred in battle, with residual nonunion and a gap-defect of 3 inches (7.5 cms.). Operation was performed 6 months following the cessation of all drainage and after preliminary scar excision and the gap was bridged by a massive, full thickness iliac graft. The fibula was intact and a metallic plate was not applied. The illustration shows the roentgenographic appearance of the iliac graft 5 months post-operatively. Clinically the leg was quite stable. At the time that this report was completed the extremity was protected in an achial weight bearing brace with a molded leather cuff for the leg.

if an effort was made to expose the fragments freely and to attempt to correct overriding or bowing deformities closure became difficult or impossible. For this reason except in a few instances where the fragment ends have been widely separated the usual procedure has been to disturb the position of the fragments very little or not at all and to expose them just sufficiently to permit application of the plate and countersunk graft provided of course that the general alignment of the axes of the fragments has been satisfactory.

Where the graft is employed without plate fixation it is adequately shaped and is fixed with two screws above and two below the fracture level. The manner of fixation of the graft will vary depending on the mechanical requirements in each case and this must be anticipated from the roentgenograms pre-operatively and determined accurately at the operating table. It is preferred to apply grafts on the most vascular side that is away from scar and on the side most heavily muscled

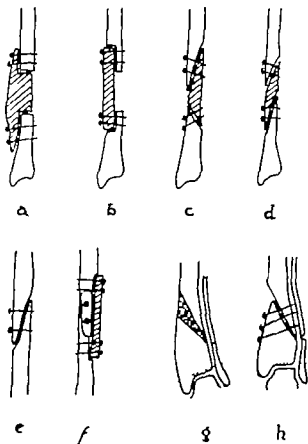


Fig. 10. Line drawings illustrating methods of shaping grafts for nonunion with defects in single forearm bones or in the tibia. a, Flange graft. b, Graft step-cut and recessed at each end. c, d, Trapezoid and parallelogram-shaped grafts to fit oblique ends of fracture fragments.

e and f, Fixation of the long oblique type of ununited fracture by multiple transfixion screws, with application of the bone graft at right angles to the direction of these screws.

g and h, Valgus deformity of the ankle and foot following malunion at the distal end of the tibia. Resection of wedge, shaped so as to create, in effect, an oblique type of fracture which is fixed with several screws. The concept of this type of osteotomy is based on the success following multiple-screw fixation in the treatment of the acute type of long oblique fracture when open reduction is indicated, as well as in the treatment of similarly shaped ununited fractures as illustrated in e and f.

In the instance of a nonunion at the distal end of the radius, it has usually been found advisable for adequate purchase of the graft to bridge both nonunion and the wrist joint simultaneously and thereby to effect both healing of the ununited fracture and wrist fusion. In one instance of ununited fracture of the radius and another in the femur the distal fragments were so severely porotic that a good purchase of the graft could not have been secured with screws and the grafts were driven

into and thoroughly impacted within the distal fragments.

The flange graft devised by the authors for the filling of defects particularly of forearm bones, is shaped from the crest of the ilium in such a way that its body accurately fits in and fills defects up to 5 centimeters in length while its ends are shaped into flanges of about 2.5 centimeters in length for lateral application to the fracture fragments with screws above and below the gap-defect. Another type of iliac graft employed to fill large defects includes one table (for forearm bones) or two tables (for the tibia) and is applied by step-cutting its ends and mortising these into recessions at the ends of the fracture fragments where they are fixed with screws. A trapezoid shaped graft or a parallelogram-shaped graft is best suited to fill a defect where the fragment ends are oblique (Fig. 10, a, b, c and d).

Rigid fixation has been satisfactorily obtained in long oblique fractures by the use of 2 or 3 transfixion screws across the oblique fracture after baring the ends and reshaping them for accurate contact and the graft is applied at right angles to these screws (Fig. 10, e and f). This technique has been employed in 5 cases, 3 times in the ulna and twice in the tibia with excellent union in all instances. In association with this experience a method of osteotomy has been developed for the treatment of malunited fractures of long bones wherein a wedge of bone is excised in such a manner that not only is the existing deformity corrected but also a long oblique type of fracture is created which is held securely by two or three transfixion screws (Fig. 10, g and h). This procedure has been successfully performed on 6 patients, 3 in the tibia, 2 in the radius and 1 in the ulna.

The usual approaches, that is, lateral and posterolateral for the femur, anterolateral for the humerus, posterior for the forearm (performed best with the arm across the chest) and anteromedial or anterior for the tibia, have had to be varied in some of these cases. It is presupposed that every effort will be made to replace inadequate skin through plastic surgery prior to the bone graft. This is essential especially if the approach must be made through or close to such an area, and also to

insure adequate nutrition of the fracture and the graft. The unfortunate fact however is that soft tissue scarring is often so severe that even such replacement of skin and subcutaneous tissue does not eliminate the massive scarring of the deeper tissues which may extend down to the bone itself. In such cases it has been advantageous to approach the long bone through more normal tissue and thus to completely avoid the severely scarred area. For example an anterolateral approach to the tibia has permitted good exposure of the lateral aspect of the tibia and application of the graft on that side while in one instance in the upper third of the leg it has permitted the additional medial shifting of the fibula and its transfixion to the tibia. In two tibial cases presenting severe anterior scarring despite previous pedicle skin grafts a posterolateral approach was employed and the grafts were applied to the posterior surface of the tibia. However exposure was found to be very limited and in one case the graft could be transfixed with only one screw above and one below the fracture level while in the other case the graft was placed in the prepared site across the fracture without screw fixation. It is therefore an approach that is not recommended as routine procedure but which may serve to advantage in this type of case.

4 *Incidence and factors involved in failure of the graft operation—an evaluation of results up to March 15, 1946.* A total of 91 bone graft operations have been performed on 85 patients. Of these 34 have been by the combined plate-graft technique and include 31 operated on with plate and cancellous bone graft, 2 with plate and cortical graft (both in femurs with massive defects and nonunion) and 1 case with an ununited fracture of the neck of the femur in which the cortical grafts were combined with fixation by a Smith Petersen nail. The site of operation was as follows: shaft of the femur in 22, neck of the femur in 1, radius and ulna in 5, humerus in 3, and tibia and fibula in 3. In 57 operations grafts were used alone with simple screw fixation and of these 54 had iliac grafts, 1 femur case with massive defect had combined cancellous and cortical grafts and 1 case with a gap-defect in the humerus had two cortical graft operations.

The site of operation in this group of cases was as follows: tibia in 16, radius in 1, ulna in 12, femur in 7, humerus in 5, spine of the scapula in 1, and clavicle in 1.

Massive defects of bone complicated the ununited fractures and exaggerated the complexity of their reconstruction in 29 cases. The bones were involved as follows: femur in 10, radius in 8, tibia in 4, ulna in 4, and humerus in 3. On the other hand bone grafts were employed in the treatment of massive defects which were bridged by a narrow bony strut in only 8 cases: 5 in the femur, 1 in the humerus, 1 in the tibia and 1 in the radius. Adequate time should be allowed to permit hypertrophy of the existing strut and the authors have been amazed how often patients listed as potential candidates for bone replacements have demonstrated after observation for several months sufficient bone reformation so as not to require surgical interference. Experience with reference to the incidence of postoperative infection following reconstructive bone surgery in battle casualties which will be discussed later further justifies this conservative attitude. Large defects in the upper end of the femur and humerus where the effect of the lever action of the extremity may prove very vicious warrant consideration for surgery earlier than those defects of long bones distal to these levels. One must be guided by the size of the original bony strut bridging the defect, the progress of its hypertrophy during the ensuing months, and whether or not the defect is protected by an intact adjacent bone as in the forearm and leg.

An analysis of the plate-graft group indicates that definite union occurred in 20 cases observed for 4 months postoperatively or longer and definite nonunion recurred in 2. One nonunion recurred as the result of faulty technique and has since been reoperated upon while the other followed a postoperative infection. Satisfactory union was progressing in 8 cases observed over 10 weeks postoperatively in whom the extremities were still protected in braces or casts while in 4 cases all femurs it was too early to evaluate the probable end results at the time that this analysis was completed. In 3 of these the postopera-

TABLE I.—RESULTS OF 91 BONE GRAFT OPERATIONS IN 85 PATIENTS

Performed between September 1, 1944 and March 1, 1946 and evaluated up to March 5, 1946

	No of operations	Type of graft	Bones involved	Union following initial graft	Union following reoperation	Total union	Failures due to infection	Injury to artery
Plate-graft technique	34	Iliac 3	Femur 22	28		20		1
		Cortical 3	neck					
			Radius and ulna 5					
			Humerus					
			Tibia and fibula 3					
Graft with screw fixation	57	Iliac 34	Tibia 6	43	5	30		
		Iliac and cortical	Radius 5					
			Ulna					
		Cortical	Femur (union in 5) 7					
			Humerus 5					
			Spine of scapula					
			Clavicle					

tive course has been most satisfactory while in one case the presence of a very mild postoperative infection left the fate of the graft in doubt (Table I).

In the patients treated by grafting without plate fixation 28 fractures were definitely united 4 months or more postoperatively while in 6 patients there was definite recurrence of nonunion. Four of the recurrences were the result of errors in technique and were subsequently reoperated upon and two recurrences followed postoperative infections. A fracture of the bony strut in another patient following a bone replacement operation for massive femoral defect necessitated a second bone graft. Union had progressed satisfactorily in 17 cases observed for more than 10 weeks postoperatively while it was too early to determine the course in 5 cases observed for less than 10 weeks at the time of this final analysis. In only one of these because of a mild postoperative infection was there any doubt as to the fate of the bone graft (Table I).

In the 8 cases of massive defects with union replacement surgery was by massive iliac grafts alone. In one of these a defect in the upper third of the femur a fracture occurred through the narrow bony strut, although the

patient was still in suspension. He was reoperated upon by the combined plate-graft technique, and this instance served to impress the authors with the wisdom of utilizing plate fixation in addition to bone replacement in the treatment of massive defects, even in the presence of some union in the upper end of the femur and humerus.

The authors can speak with certainty of an incidence of 9 failures of initial bone grafts by their technique, while in 2 other cases, both of whom had mild postoperative infections and had been observed less than 10 weeks, the fate of the graft could not be accurately determined at the time that this study was completed. Of the 9 definite failures, 3 were incidental to postoperative infections which required the removal of plate and graft, while 6 were the result of faulty technique. Five of these 6 cases, who had had cancellous grafts, were reoperated upon and progressed or were progressing to satisfactory union. In 4 of these patients the recurrences were due to failure to use a plate along with the graft. One was a nonunion of both bones of the forearm, another a nonunion of the surgical neck of the humerus, and the third and fourth were defects in the upper half of the femur. In a fifth case with ununited fractures of both

bones of the forearm the plate-graft technique had been used but the plate had been too short and had not bridged the gap-defect satisfactorily. The one cortical graft failure was the case previously referred to with a massive defect in the upper end of the humerus and absence of the humeral head and glenoid in whom a fibular graft had been initially employed with gradual resorption at its center and in whom at reoperation a tibial graft was applied across the fibular fragments (Fig. 4). The authors suggest that a fibular graft so used should not have multiple drill holes placed in its central portion as recommended to enhance its revascularization for they feel that this may encourage resorption and fracture in this region. They also feel that this hazard may be lessened by the additional use of slivers of iliac bones, placed along the surface of the cortical graft.

The authors feel that the end results in the last 9 cases, performed during January and February 1946 could not be evaluated accurately at the time of this report. There have been therefore 9 failures following 82 initial bone graft operations in a series of 76 patients who have been observed a sufficient length of time varying from 10 weeks to 18 months and this represents an incidence of 10.8 per cent. Six of these 9 failures have been successfully reoperated upon—a total of 79 successful unions and 3 failures as evaluated up to March 15 1946 (Table I).

It has been experienced widely that the use of a plate for internal fixation of long bone fractures particularly of the transverse type will encourage delayed union and even non union since the plate tends to hold the fragments apart and appears to discourage callus formation on the side to which it is applied. Six cases in this series were simple fractures of the femur which had been treated early by open reduction and plate fixation and the occurrence of nonunion in these cases was unquestionably influenced by the use of these plates. The performance of iliac bone graft operations was greatly facilitated in these instances by the fact that the plate had already been applied and the bone fragments were well positioned and since the fractures had been simple dissection was performed with

ease along anatomical planes. Union occurred in all six cases, and was sufficiently firm in one instance, 5 months postoperatively to permit full weight bearing. The authors feel very strongly that the plate-graft technique will find eminent success in its use in ununited fractures in civil practice where many of the fractures have been simple and those that are compound present few of the complexities of battle fractures. They feel that the vicious features of plating as employed in the internal fixation of acute fractures do not apply in the combined plate-graft technique and that the only dangers involved are those incidental to the introduction of an inert metallic substance. The value of rigid fixation in the successful grafting of complicated ununited fractures of long bones as herein reported more than justifies the continued use of metallic plates and screws.

5 *Incidence and factors involved in the occurrence of postoperative infection following iliac grafts in the presence of infection.* The authors have elected to wait at least 6 months following the cessation of all drainage before attempting any reconstructive bone surgery. This period represents a longer waiting interval than that accepted by other orthopedic surgeons but the authors believe that the hazards of postoperative infection and of failure of bone grafting are exaggerated by such haste and the question in their minds at this time is whether a 6 months waiting period is sufficiently long.

In this series, postoperative infections occurred in 11 out of 91 operations or 12.1 per cent. The local infection was moderately severe in only 1 case requiring removal of the plate and graft 2 weeks postoperatively and it was mild or moderate in the remaining 10 cases. Surgical interference could be safely deferred in these 10 cases for 4 to 6 weeks or more postoperatively with control by penicillin and early drainage without hazard to the patient. Six of these 10 patients have been operated on and plates and screws removed in 3 (2 femurs 1 tibia) and the screws alone in the remainder (2 radii 1 ulna). Two others, both femurs, were well united but persisting drainage 4 months postoperatively in both indicated the need for subsequent removal of

plates and screws. In 2 others a femur and a tibia the postoperative period of 8 weeks was considered too short for proper evaluation of the ultimate fate of the graft and removal of the metallic bodies had been deferred.

In 6 of the mild or moderately infected cases 4 ununited fractures of the femur 1 of the radius and 1 of the tibia, union occurred with incorporation of the major portion of the graft. Failure of union occurred in 2 more both of whom originally demonstrated large gaps, but the graft became incorporated into one of the fracture fragments. In other words where the infection had been mild enough to warrant delay in surgical interference (in 10 of the 11 cases) the graft became incorporated with union in 6 and became incorporated but with recurrence of nonunion in 2 more. The fate of the graft was in doubt in the remaining 2 cases at the time that this study was completed.

Definite failure of union following iliac bone grafting occurred in 3 cases in this entire series as a result of infection *per se*. *Postoperative infection therefore although a most undesirable complication does not mean failure of an iliac bone graft if surgical interference can be sufficiently delayed.* The authors believe that this is more apt to occur with iliac bone as graft material because this type of graft is so rapidly invaded by new bone and incorporated into the host bone.

One cannot deny that once infection has occurred the metallic bodies employed for internal fixation although inert act by their presence to perpetuate the infection and this applies whether stainless steel plates and screws or just screws alone have been employed. The only patient in whom the infection subsided spontaneously had had an iliac bone graft to fill a large defect in the tibia and this graft had been firmly mortised into the defect without screw fixation.

Nevertheless although the presence of metallic fixation presents this untoward feature the advantage of plate fixation is striking even in this group of cases. Of the 6 cases wherein union occurred in the presence of infection 4 were ununited fractures of the femur and had had the combined plate-graft operation. The plates served to maintain rigid fix-

tion at the operative site and preserved the alignment of the bone fragments until union had occurred and the foreign bodies could be safely removed.

The authors believe that these postoperative infections are not the result of faulty technique and offer as proof the absence of infection of the donor wounds in any of their cases. The incidence of infection reported herein parallels that recorded in other military installations. These battle fractures have been severely compound, they have been associated often with considerable soft tissue damage and drainage has persisted for variable periods prior to complete healing. The background as well as the condition of the involved extremity at the time of surgery i.e. altered circulation, skin and soft tissue scarring and bony deformity influence and encourage the occurrence of postoperative complications. It must be emphasized that in all of the cases presenting postoperative infection in this series there had been previous infection and osteomyelitis (compound battle fracture with drainage) and that this complication did not occur in any previously uninfected case.

The authors call attention to a factor which has received little or no attention viz. the existence of living organisms at the site of original injury even in the absence of drainage from 6 months to one year. Cultures were made at the time of bone graft surgery in a group of 18 cases. These cases had not drained for at least 6 months and had adequate penicillin and sulfonamide therapy following the initial injury and at the time of bone grafting. Also the gross appearance of the field at the time of exposure was satisfactory i.e., there were no areas of necrosis, no dead fragments and no evidence of any inflammatory process. Positive cultures were reported in 9 cases or 50 per cent! Those patients with negative reports had an uneventful convalescence. Of the 9 patients with positive wound cultures one had been a simple fracture of the humerus with failure of union following open reduction and plating while the 8 remaining cases had been compound fractures, and all 9 cases demonstrated definite wound reaction postoperatively. Redness and induration of the wound occurred in 2 cases for 1 to 2 weeks postopera-

tively and then subsided (Staphylococcus albus 1 Staphylococcus aureus 1) seepage persisted for 2 weeks in 1 case and then subsided completely (Micrococcus spheroides) while mild drainage occurred in 5 the wounds requiring dependent drainage several days postoperatively (Staphylococcus albus 2 Streptococcus hemolyticus 1 Staphylococcus aureus 1) There was no reaction of the donor wound in any of these cases. While this series is far too small to render significant percentages it is important to realize that there are battle fractures requiring reconstructive surgery which under present standards have been considered adequately prepared for such surgery wherein living organisms have been cultured and that such cases have manifested uniformly definite local wound reactions and in some instances actual postoperative drainage.

The incidence of positive cultures might very well be higher in series where a shorter period than 6 months has been arbitrarily accepted as a sufficient waiting period. How may extension of the waiting period beyond 6 months lessen this hazard? Two of the cases yielded positive growths after waiting periods of 9 months and 1 year respectively! While there is no means at this time to determine the presence of living bacteria at the site of intended surgery either prior to or at the time of surgery a positive culture will at least serve to put the surgeon on guard. Penicillin and sulfa sensitivity tests may serve to guide him in the use of these or other agents. Because of the inability at this time to determine the presence of living bacteria prior to or during surgery or to protect against or to eliminate this factor effectively the authors have concluded that there will continue to be an irreducible minimum incidence of postoperative infection following bone graft or other reconstructive surgery of battle fractures.

#### CONCLUSIONS

1 The principle forte for the use of iliac bone has been the fact that it is cancellous and therefore accessible to rapid revascularization and that it is richly osteogenic. There is reason to believe that some of the iliac bone survives in contrast to a cortical graft, and the remainder becomes rapidly invaded by

new bone. Iliac bone grafts maintain a density on roentgenograms which is comparable to that of the host bone and the relationship does not change with time.

A point to be considered in the use of iliac bone is whether the cancellous ilium undergoes metaplasia to assume an architecture capable of sustaining the stresses and strains of weight bearing and muscle pull and what time element is involved. Roentgenograms appear to show evidence of such metaplasia beginning at about 12 weeks after implantation while roentgenograms at 6 months and longer show the grafts to be practically indistinguishable from the adjacent cortical bone.

Resorption of iliac grafts has occurred as late as 4 or 5 months postoperatively due possibly to incomplete metaplasia and structural weakness of the graft and the result of stress and strain upon an inadequately protected graft. This also occurs with cortical grafts and is one of the dominant reasons for the use of internal metallic fixation in conjunction with grafting procedures.

2 There are certain instances where cortical bone must be employed for example where grafts must be excessively long and in cases in which an absolutely straight, rigid segment of bone is required.

3 To assure absolutely rigid protection during the phase of graft incorporation especially where large defects are being bridged it is recommended that the plate graft technique be employed in the surgery of nonunion and massive defects of single long bones as the femur and humerus and in the presence of nonunion of both bones of the forearm and leg. Where one of the bones of the forearm is intact and in the leg in the presence of an intact fibula the graft alone held with two or more screws above and below the level of the fracture offers adequate fixation.

4. The technique of plate-graft application and of fixation of the graft when used alone without a plate must be varied to meet the mechanical requirements in each case. Incisions may have to be varied depending on the degree and site of soft tissue scarring. The oblique type of fracture lends itself very well to simple transfixion with the use of multiple screws.



5 Failure of the bone graft operation with recurrence of nonunion excluding those cases associated with postoperative infections, has been due to such errors in technique as failure to use a plate when specifically indicated and failure to use a plate of adequate length

6 Postoperative infection does not mean failure of iliac graft incorporation especially if the infection is mild and well controlled and removal of the metallic fixation can be deferred

In an effort to account for this complication the authors place much significance upon the

fact that in a certain number of battle fractures active growths of bacteria have been cultured from the site of original wounding six months to one year following the cessation of all drainage. Since there is no way at this time, to determine accurately the presence of living bacteria at the site of injury prior to or at the time of surgery or to eliminate this factor effectively the authors have concluded that there will continue to be an irreducible minimum incidence of postoperative infection following bone graft or other reconstructive bone surgery of battle fractures.

# COAGULATION THROMBI IN SEGMENTS OF ARTERY AND VEIN IN DOGS AND THE GENESIS OF THROMBOEMBOLISM

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SINCE the early experiments of William Hewson it is known that blood remains liquid for a long period of time between ligatures in a vein segment. This phenomenon was further studied by Baumgarten. He found that when the double ligature is applied under antiseptic precautions and the wound heals aseptically the included blood column remains liquid. On the other hand such experiments without antiseptic precautions resulted in coagulation, a fact which has been confirmed by Senfleben in Cohnheim's laboratory.

Our problem was to investigate whether tissue juice from vein of homologous and heterologous origin would coagulate the stagnant blood within a formed vessel segment *in vitro*. This study was of special interest because it has been claimed that the endothelial lining prevents coagulation. We studied further the effect of human placental thromboplastin (10) on the formation of coagulation thrombi. Our observation also yielded information about the adhesiveness and syneresis of a blood coagulum formed within arterial and venous vessel chambers *in vitro*. The experiments were performed in healthy young mongrel dogs.

Because of the basic nature of these investigations pertaining to the phenomenon of thrombus formation and more recent studies on the phenomenon of platelet agglutination a discussion of thrombosis and of thromboembolism becomes necessary.

## EXPERIMENTS

**Procedure** The carotid artery is dissected free for approximately 8 centimeters and occluded with rubber shod clamps first proximally then distally. A 25 gauge needle is intro-

duced at the proximal end, care being taken not to injure the artery more than necessary. Blood is withdrawn from the occluded vessel segment into a syringe and the volume noted. One-tenth cubic centimeter of tissue juice or thromboplastin is introduced into the vessel segment. The needle is removed, the proximal clamp is released to allow the segment to fill with blood and the vessel is clamped over the orifice made by the needle. After an incubation period of from 1 to 9 minutes the vessel is excised immediately and placed on filter paper. Both clamps are removed and the vessel is cut along its long axis. The formation of the coagulum is noted carefully. As a control the coagulant agent is replaced by 0.1 cubic centimeter of saline and the above procedure followed.

**Results** Figure 1 shows in full size photograph a resected vein segment containing the coagulation thrombus. The photograph illustrates that there is no adhesiveness of the thrombus to the vessel wall. Upon removing the clamps the thrombus emerged freely without mechanical or manual manipulation. A small amount of serosanguineous liquid was present, apparently exhibiting syneresis.

Figure 2, an artery segment (full size), has been opened along its long axis to illustrate syneresis of the thrombus. This phenomenon is especially evident if one compares the length of the vessel with the length of the thrombus. On both ends of the segment one also can observe marked areas which are due to staining of the filter paper with serosanguineous liquid.

Table I shows results in 6 vein segments, 5 of which resulted in thrombus formation with an incubation time of 5 minutes, whereas 1 with an incubation time of 3 minutes did not exhibit coagulation. Table II presents the effects of vein juice from dogs and chickens on the formation of coagulation thrombi. In 7

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TABLE I—IN VIVO ACTION OF DOG VEIN JUICE ON COAGULATION OF BLOOD IN VEIN SEGMENTS OF DOGS

Dog Number	Jugular vein			Segment length mm.	Blood volume cc.	Vein juice	Incubation time min.	Coagulation	5 minutes	Where no clot at
	R	R	be L=Left							
96	R			15	9		3			
	L			15			3	++	+	
87	L			60	7		3	++	+	
	R				6		3	++	+	
827	L			61	6		3	++	+	
	R			1	6		3	++	+	

o = negative  
+ = positive  
++ = complete

segments employing vein juice from dogs 4 coagulated completely after 1 5 and 3 minutes whereas partial coagulation was formed in 2 segments following 2 minutes and in 1 following 3 minutes incubation time. Partial coagulation is designated by a coagulum which is mixed with coagulable whole blood. This is readily differentiated from serosanguineous liquid as obtained by syneresis by (a) its color (b) the fact that it coagulates on standing (c) its consistency in that it does not exhibit complete blood gelation but rather fibrin threads with or without gel formation.

Vein juice from chickens was employed in 6 segments resulting in partial coagulation after 1 and 2 minutes and complete coagulation after 4 and 5 minutes.

From Tables I and II it also can be seen that there are relatively large volumes of the test material as compared to the blood volume used in the arteries. This relationship, however, does not necessarily influence the coagulation time as may be seen in Table II. In dogs 902 and 828 both blood volumes were large and both test materials amounted to 1 cubic centimeter of the blood volume yet partial

TABLE II—VEIN JUICE OF DOGS AND CHICKENS INDUCING COAGULATION THROUGH IN SEGMENTS OF CAROTID AND FEMORAL ARTERIES

Dog						Vein juice from		Incubation time min.	Coagulation	5 minutes	Where are blood cells
Number	Sex M=Male F=Female	Weight lbs.	Artery C=Carotid F=Femoral R=Right L=Left	Segment Length mm.	Blood volume cc.	Dog	Chicken c.				
88	M	41	LC	70				3	++	+	
90	M	3	LC	7					(+)		
921	F	30	LF	3					(+)		
861	F	11	LC	66	3			3	(+)		
926	M	3	LF	50	3			3	++	+	
897	F	11	LC	6	6			3	++	+	
878	F	20	LC	6	3			3	++	+	
8	M	37	RF	67	4				(+)		
8	M	36	RF	36					(+)		
820	F	11	LC	7	0				(+)		
92	M	11	LF	11				4	++	+	
827	F	10	LC	7				3	++	+	
96	M	41	LC	70				3	++	+	

+ = positive  
(+) = partial  
o = negative  
++ = complete

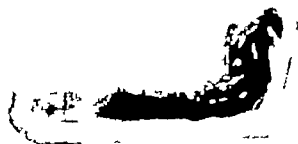


Fig. 1 Coagulation thrombus in vein segment.

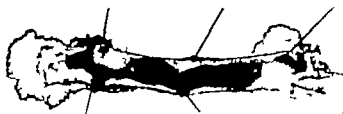


Fig. 2 Coagulation thrombus in artery segment.

tial coagulation was observed after 2 minutes in dog 902 and complete coagulation was found after 15 minutes in dog 828. Similarly in dog 922 with a blood volume of 0.2 cubic centimeter and 0.1 cubic centimeter of test material coagulation was observed after 4 minutes. On the other hand with a blood volume of 0.9 cubic centimeter and 0.1 cubic centimeter test material partial coagulation was found after 2 minutes in dog 840.

In comparing Tables I and II no conclusion can be made whether or not coagulation is enhanced in arterial or in venous segments. Only in 1 instance in a vein segment of dog 916 was the incubation time found to be less than 5 minutes.

Table III lists the controls physiologic saline being used in 6 artery and 4 vein segments. No coagulation occurred in the controls after 5 to 9 minutes incubation time.

The effect of Copley's preparation of purified thromboplastin from human placenta (10) upon coagulation thrombi is summarized in Table IV. Eight carotid arteries, 5 femoral arteries, and 16 jugular veins were employed. Coagulation occurred in all instances except in 1 jugular vein segment with an incubation time of 1 minute. Another such segment of uniform length blood volume and amount of thromboplastin exhibited coagulation following the same incubation time. All coagulation thrombi exhibited syneresis and no adhesiveness to the vessel wall. It should be noted that in all cases the coagulation was complete.

Of interest is the comparison between length of the vessel segment and its blood volume. Vessel segments of 45 to 72 millimeters in length were used.

In all our observations on coagulation thrombi syneresis was always found even

though the incubation time of the test material with whole blood was as short as 1 minute. From this one may infer that syneresis occurs rather immediately following coagulation with in a vessel segment. Adhesiveness to the vessel wall was absent in all artery and vein segments in which coagulation thrombi had formed (Tables I, II, and IV).

Table V shows the results of several manipulations on the blood vessel such as clamping it along the entire segment applying a double silk ligature insertion of a needle into the lumen pinching with forceps along the entire segment and crushing over silk with a hemostat. In 9 artery segments clamping with a hemostat after an incubation time of 5 to 8 minutes did not result in coagulation. In dog 924 the jugular vein was isolated for approximately 5 centimeters and ligated at its distal and proximal ends. This segment containing the column of blood was incubated for 18

TABLE III — INFLUENCE OF PHYSIOLOGIC SALINE UPON STAGNANT BLOOD IN ARTERY AND VEIN SEGMENTS OF DOGS

Dog number	Blood vessel R=Right A=Artery L=Left V=Vein	Segment		9% salt solution cc.	Incubation time min-utes	Coagulation
		Length mm	Blood volume			
8	R. carotid	60	5		5	
93	R. femoral	58	3		5	
88	R. femoral a.	70	5		5	
926	L. Carotid	6	1		7	
84	L. femoral a.	60	5		8	
929	L. femoral	6	4		9	
85	R. jugular	60			5	
85	L. jugular	60			5	
873	R. femora	58	.6		5	
871	L. femora	60	7	0.3	5	

= negative

TABLE IV — THE EFFECT OF PURIFIED THROMBOPLASTIN FROM HUMAN PLACENTA ON THE COAGULATION OF BLOOD IN VIVO IN ARTERY AND VEIN SEGMENTS OF DOGS

Artery and vein segments				Thrombo- plastin	Incubation time min.	Coagulation	Syneresis	Adhe- sion to wall
(Vessel)	Total number	Length mm.	Blood losses					
Carotid artery		65	4			++	+	
		70			5	++	+	
	3	6	7-0			++	+	
	3	43-79	6-		5	++	+	
Femoral artery		52-65	3-0			++	+	
		70	8		5	++	+	
		59				++	+	
Jugular vein		60				++	+	
		90-6	0-			++	+	
		57-6	4			++	+	
		60				++	+	
						++	+	

+ = complete

- = negative

+ = positive

hours, during which time its coagulable blood did not coagulate. In 2 vein segments a needle was inserted with a stylet in place and allowed to incubate in the stagnant blood column for 5 minutes. After this period of time the blood was not coagulated. In 2 vein segments, the blood was milked out of the segment manually and the vein crushed with a hemostat along the entire segment. The proximal clamp was then released to permit the vessel chamber to fill with blood. After an incubation time of 10 minutes no coagulation occurred.

Upon longitudinal section of the vein segment definite areas of injury to the intima were observed macroscopically. The same effect was also obtained in 6 out of 8 vein segments which were crushed over silk according to the procedure of Murray (20). The incubation times were 10 minutes in 3 cases, 3, 30 and 36 hours in each one case with no coagulant effect. However in 2 cases in which incubation times were 24 and 48 hours coagulation occurred and syneresis and nonadherence of the coagulation thrombi were found.

#### DISCUSSION

##### 1. Physical properties of coagulation thrombi

Our observations are of fundamental significance since they give evidence that a blood

coagulum which is produced intra-arterially or intravenously without infection is a coagulation thrombus which is not adherent to the vessel wall and moreover exhibits syneresis (clot retraction). These latter phenomena nonadherence and syneresis of a noninfected coagulation thrombus, together with clot firmness are the basis for the thromboembolic disease. It stands to reason that a clot that does not fill a vessel segment completely because of syneresis and which is not otherwise adherent to the vessel wall is likely to become an embolus. Recently the differentiation between phlebothrombosis and thrombophlebitis has been stressed by several surgeons, especially by Ochsner and DeBakey. In phlebothrombosis or the so-called quiet venous thrombosis of Homans a soft nonobstructing clot exists which increases the danger of embolism. In thrombophlebitis, on the other hand, the clot has been found usually firmly adherent to the vein wall and is therefore unlikely to become detached and result in embolism. This contention as far as the noninfected vessel wall is concerned, can be supported by our findings. We have not made any observations on the adherence and syneresis in infected vessel segments. Moreover we found this phenomenon was present not only in vein segments but also in arteries.

TABLE V—THE EFFECT OF CLAMPING, DOUBLE LIGATURE AND INJURY UPON BLOOD COAGULATION IN ARTERIAL AND VENOUS VESSEL CHAMBERS IN DOGS

Dog Number	C=Carotid A F=Femoral A J=Jugular V R=Right, L=Left	Length of segment mm.	Treatment	Incubation time	Coagulation
56	LFA	65	Clamping	5 min.	
828	LFA	70	Clamping	5 min.	
830	LFA	6	Clamping	5 min.	
84	LCA	60	Clamping	5 min.	
93	LCA	65	Clamping	5 min.	
8	LCA	64	Clamping	6 min.	
926	RCA	63	Clamping	7 min.	
939	RFA	55	Clamping	7 min.	
87	RFA	40	Clamping	8 min.	
924	RJV	5	Double silk ligature	8 hrs	
856	RJV	66	Needle inserted	5 min	
856	LJV	66	Needle inserted	5 min.	
9	RJV	60	Placed with forceps	min	
93	LJV	60	Placed with forceps	min	
875	RJV	58	Crushed over silk	30 hrs	
875	LJV	50	Crushed over silk	min.	
871	LJV	43	Crushed over silk	mi	
46-3	RJV	41	Crushed over silk	mi	
46-	LJV	75	Crushed over silk	24 hrs	++
875	RJV	8	Crushed over silk	48 hrs.	++
46-4	RJV	75	Crushed over silk	3 hrs	
46-8	LJV	6	Crushed over silk	36 hrs	

-negative

+=positive

++=fibrin and nonadherent

The firmness of coagulation thrombi has not been studied. However there can be wide variations in firmness of coagula of human blood as has been shown by Lalich and Copley (18) with a special viscometer. No correlation has been found between firmness and retraction of a blood coagulum according to Copley (9).

Attempts have been made by Vigyazo to produce experimentally clotting in segments of varicose veins in man. The resulting thrombus was a red or coagulation thrombus which was not adherent to the vein wall. Some clot adherence was only found after several days following the production of the thrombus. This latter observation was already made in 1856 by Virchow. He found that blood coagula are free during the first time following their production. Only later with the onset

of chemical and morphological changes stickiness occurs between them and the surrounding tissue. Virchow observed this in apoplectic extravasates of all organs in the clots of aneurysms and in the occluding plugs of veins.

2. *Injury to the vessel wall and thrombus formation.* Baumgarten observed that the complete stasis of the blood in a vessel segment does not necessarily lead to thrombus formation. He found that no coagulation occurred even if the intima is damaged because of the ligation. His experiments were carried out in arteries and veins of dogs, rabbits and guinea pigs under aseptic conditions. In our experiments we found thrombi only in 2 out of 8 cases of severe injury (crushing over silk) to the vessel wall. No thrombi developed in 5 other instances with less injury to the vessel

wall Our investigations suggest that the incubation period following injury may affect the formation of a coagulation thrombus.

The results show that crushing over silk in stagnant blood columns does not always produce coagulation thrombi. With circulating blood it has been shown by Murray and associates (19) that white thrombi occur at the site of the injured vessel wall. However in earlier investigations Welch claimed that it is possible to produce experimentally severe injury of the internal coats of blood vessels without any resulting thrombosis.

One may argue whether or not the lesion of the endothelial cells or a dysfunction of the cells as it was assumed by Cohnheim in 1882 would result in thrombosis. Bizzozero observed that in causing slight damage to the inner surface of an arterial wall in small mammals a so-called white thrombus was formed which consisted almost entirely of blood platelets. Later in 1886 Eberth and Schimmelbusch found that in damaged blood vessels first a white thrombus occurs which is mainly a platelet thrombus which may contain white blood cells. Upon this primary formation of a thrombus a second so-called red thrombus forms which is coagulated whole blood. Best, Cowan and MacLean found that when a shunt, composed of glass or cellophane tubing is inserted between an artery and a vein in anesthetized dogs, cats, monkeys and rabbits large white thrombi rapidly form and in many cases completely obstruct the flow of blood. These thrombi usually grow downstream rather than upstream from the original focus. Subsequently to the white thrombus a red thrombus forms. These observations made in artificial vessel segments concur with the classical observations.

In the injured vessel in which the flow of blood is not completely and primarily blocked platelets will adhere to the injured vessel wall and form platelet or white thrombi. This process may be enhanced by the infusion of tissue juice through the lesion in the vessel wall since Copley and Houlihan (12, 13) have shown that tissue juice does agglutinate platelets although purified thromboplastin does not. An admixture of tissue juice is apparently not necessary to form white thrombi ac-

cording to the experiments of Best, Cowan and MacLean in artificial glass and cellophane shunts. However in injured blood vessel tissue juice may well enhance the formation of white or mixed thrombi. This process may be further augmented in infected or edematous vessels because of the infusion of larger amounts of tissue juice.

More recently Chambers and Zwerbach made the observation that the interendothelial cement is sticky and offers considerable surface on the inner lining of the endothelium to which formed particles adhere. Whether or not defects in this lining or deficiencies of the substance comprising the interendothelial material would influence the formation of coagulation thrombi and agglutination thrombi will have to be decided in future experimentation. It is possible that the cement substance may itself contain a platelet agglutinant factor.

3. *The nature of intra-vascular blood clotting.* Blood clotting can no longer be considered primarily as the coagulation of whole blood, because of the recent observations on the mechanism of platelet agglutination (12, 13). Is the following schema developed by Copley (11) the phenomenon of blood clotting is presented in all its possible occurrences.

Blood clotting according to the point of view presented in the schema is a general term for either plasma coagulation, cell agglutination and clotting in which both phenomena are mixed. As plasma coagulation is understood that the precipitation of fibrin is synonymous with blood coagulation. This process may ultimately terminate in gelation of the blood plasma or the fibrin respectively. In the schema gelation is shown to occur with or without preceding fibrin formation.

It is not the scope of this presentation to discuss the mechanisms of fibrin formation and gelation. The phenomenon of cell agglutination is subdivided into agglutination of platelets, red and white cells. The agglutination of white cells which is known to occur appears to be insignificant because of the small number of white cells in normal blood. White cells may be agglutinated with platelets *in vivo* forming the so-called white thrombi. In *in vitro* forming the so-called white thrombi. Is red cell agglutination immunologic reactions are prevalent however red cells may aggluti-

# BLOOD CLOTTING

- I Plasma coagulation
  - A Fibrin precipitation
  - B Gelation
    - 1 With preceding fibrin formation
    - 2 Without preceding fibrin formation
- II Mixed (I and III)
- II Cell agglutination
  - A Platelet agglutination
    - 1 Without preceding fibrin formation
      - a Without subsequent fibrin formation
      - b With subsequent fibrin formation
    - 2 Immunologic?
  - B White cell agglutination
    - 1 With platelet agglutination red cell agglutination
    - 2 Without platelet agglutination red cell agglutination
  - C Red cell agglutination
    - 1 Immunologic
    - 2 With preceding fibrin formation

ate with preceding fibrin formation as it is shown in polycythemia vera. Platelet agglutination occurs without preceding fibrin formation and appears with or without subsequent fibrin formation. Whether or not immunologic reactions take place in the agglutination of platelets will have to be decided in future investigations. From this schema it is furthermore proposed to define thrombosis or thrombus formation as intravascular blood clotting during life.

This schema helps us to understand the differentiation between coagulation thrombosis as produced in our investigations and the agglutination thrombosis or mixed thrombosis is produced by Best, Murray and associates and earlier in the classical observations by a number of workers. The injured vessel segment does not readily produce coagulation thrombosis, because apparently in a noninfected blood vessel, not sufficient tissue juice containing thromboplastin would infuse into the segment as to initiate by its content of

thromboplastin blood coagulation. In infected and edematous vessel segments coagulation thrombosis may possibly occur in a stagnant vessel chamber because sufficient tissue juice containing enough thromboplastin could enter the chamber and produce coagulation. It should be emphasized that tissue juice is not identical with thromboplastin although the latter substance is one of the constituents of tissue juice.

It may be inferred that the generally accepted differentiation between infected and noninfected thrombosis does not suffice. For a more advanced approach of various problems pertaining to thrombosis including effective therapy one should keep in mind the presented differentiation given in the schema. This presentation does not claim to include all possible influences and factors on thrombus formation; however, it is meant to be a guide for a better understanding of the problem of thrombosis. The general contention that thrombus formation in itself constitutes solely a coagulation phenomenon is theoretically no longer tenable.

4 *The genesis of thromboembolism*. According to Bauer emboli occur within 24 to 48 hours after thrombus formation in veins. During this time the wall of the vein is as yet not involved in any way and the thrombus is anchored only. This observation corroborates our findings that coagulation thrombi are not adherent to the vessel wall and are at the same time synergetic, both of which are of potential danger in the genesis of embolism.

The findings of Best, Cowan and MacLean that white thrombi which are noninfected may break off easily appear to be of significance. Coagulation thrombi and agglutination thrombi may well become adherent to injured walls of infected blood vessels. The firmness of these thrombi under both infected and noninfected conditions will have to be investigated.

It should be emphasized that slowing of the blood stream, damage to the vascular endothelium and changes in the blood must be regarded as causes of thrombosis. This view has been accepted by Aschoff in his latest publications on this subject (1, 2). Of interest are the observations of Copley, Kirschman and Whitney (14) who studied the anomalous flow proper





11. Idem. Ann New York Academy Sciences, 1947 In press.
12. COPLEY A. L. and HOULIHAN R. Federation Proc 1945 4 173.
13. Idem. To be published.
14. COPLEY A. L. KRICHA, L. C. and WHITNEY M. E. J Gen. Physiol. 1948 26 49.
15. EBERTH, C. J., and SCHIMMELRUSCH C. Virchows Arch. 1886, 103 30 105 331 456
16. HEWSON W. Experiments on the Blood London W Bowyer and J Nichols, 1771
17. HOMANS J. Med Clin N America 1942 26 1457
18. LAUCH, J. J. and COPLEY A. L. Proc Soc Exp Biol N Y 1942 51 232
19. MURRAY D. W. G. JACQUES, L. B. PERRETT T. S. and BEST C. H. Surgery 1937 2 163
20. MURRAY G. Arch Surg 1940, 40 307
21. OCHSNER, A. and DEBAKEY M. N England J M 1941 225 207
22. SCHTIEBEN Virchows Arch. 1879 77 421
23. VIGYAO, J. Zbl Chir 1928, 55 70
24. VIRCHOW R. Gesammelte Abhandlungen zur wissenschaftlichen Medizin. P 75 Frankfurt a M. Meidinger Sohn & Co 1856
25. WELCH, W. H. Tr Path. Soc. Phila., 1887 13 281



deficits described the general and neurological examinations gave normal findings. There was total motor paralysis of both lower extremities except for the ability to move the left large toe slightly. The patellar and Achilles tendon reflexes were hyperactive. There was patellar and ankle clonus and the Babinski sign on both sides. All forms of sensation were lost up to the level of twelfth dorsal and partial loss of pain temperature and touch sensibilities for three segments higher. Routine examinations of the blood and urine gave normal results and the blood Kahn test was negative. Roentgenograms of the lungs revealed no evidence of tuberculosis. Films of the dorsal spine showed a marked scoliosis to the right with maximum angulation at the sixth dorsal (Fig. 1). There was no evidence of other pathology in the spine or ribs.

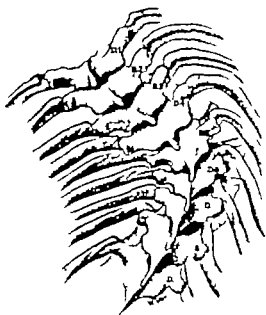


Fig. 1 A drawing made from a roentgenogram of the dorsal spine in the case of G. S. to illustrate the degree of scoliosis. The maximum angulation is at the sixth dorsal.

In view of the seriousness of the neurological findings it was felt that an exploration of the spinal cord was advisable. On December 9, 1943, the laminae arches from the second dorsal to the seventh dorsal inclusive were removed under avertin anesthesia. No evidence of extradural cyst or neoplasm was disclosed. An incision was made in the dura and a soft rubber catheter was easily passed upward to the seventh cervical and downward to the twelfth dorsal. The cord except for a marked rotation and angulation appeared normal. There was no evidence of bone pathology within the limits of the exploration. It was concluded that the angulation of the cord had been exaggerated rather acutely and that this was the factor responsible for loss of function. It being obvious that the laminectomy had not relieved the deformity, the idea of transplanting the cord seemed logical. To accomplish this, portions of the pedicles and transverse processes of the vertebrae and heads of the ribs at the fourth dorsal to the seventh dorsal inclusive were rongeured away on the concave side. Four pairs of nerve roots were ligated and severed extradurally from the third to the sixth dorsal inclusive. As soon as the roots were severed, the cord with very little aid assumed its new position so as to relieve the acute angulation (Fig. 2). The wound was closed in the usual manner without further procedure.

The postoperative course was uneventful except for a superficial infection in the wound which healed readily. Within 3 days the patient began to recover sensation and motor function in the lower ex-

trémities. On January 22, 1944, a plaster jacket was applied from shoulders to groins, and on March 17, 1944, he was discharged with almost complete recovery of sensation, motor function and bowel and bladder control. He returned home by train and fully ambulatory.

A follow-up letter from the Public Welfare of New Mexico on March 9, 1946 (3 years following discharge from the hospital) stated that several check-up examinations revealed a continued state of well-being. A recent check by Dr. R. F. Forbis, Hot Springs, New Mexico, revealed no losses in the neurological status and the scoliosis appears to have become quiescent. (In May 1944, a Taylor brace was substituted for the plaster jacket.) The boy is ambulatory without crutches and has been trained in boot making by the State Vocational Rehabilitation Service.

Cord signs associated with scoliosis of this type are rare. The impairment of cord function in this patient was undoubtedly due to a more rapid development of acute angulation than usual. The cause of the scoliosis is undetermined and no other pathology of the spine or cord could be demonstrated. The rapid recovery of function after the acute angulation of the cord was relieved and the patient's course during the past 2 years indicate that there is no other pathology in or about the cord. Laminectomy alone would have afforded no relief, but the results of the cord transplantation show the possibilities of extended

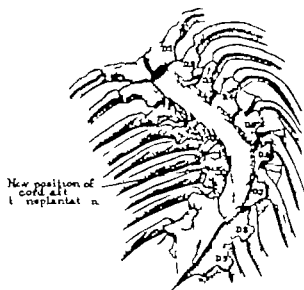


Fig. A diagram illustrating the manner in which the cord was transplanted in the case of G. S. After ligating and cutting the nerve roots extradurally from the third to the sixth dorsals inclusive, the cord was moved into its new position and the acute angulation relieved. The patient presented the neurological deficits of almost complete transverse lesion of the cord before operation. Full recovery was resumed following the operation and has been maintained to the time of writing (2 years).

surgery and pave the way toward a more rational solution of the problem.

#### THE PROBLEM OF THE TUBERCULOUS SPINE WITH CORD SIGNS

As already pointed out, significant cord impairment is not commonly associated with tuberculous kyphosis but occasionally the syndrome does occur. I had the privilege of studying and operating upon 3 such patients in the clinic of Dr. Arthur Steindler and the conclusions and convictions that were evolved from the study are briefly as follows: (1) In all 3 cases a considerable mass of tuberculous granulation tissue was disclosed intraspinal and extradural. The mass of tissue compressed the cord and was the causal factor for the onset of paralysis. In 2 of the patients the kyphosis was of only moderate grade while in the third it was severe. All 3 patients had had tuberculosis of the spine for a long time but the development of cord signs was relatively acute. The granulation tissue (containing some pus) was situated at the kyphotic angle, the locus of maximum intensity of the pathol-

ogy of the spine. (2) The development of a tuberculous abscess or tuberculous granulation tissue intraspinal may occur at any time during the patient's course, dependent upon the quiescence or activity of the tubercle. (3) The progress of cord impairment is ordinarily be relatively rapid, measured in days or weeks. (4) Laminectomy is indicated in such cases and should not be postponed unreasonably long. The granulation tissue and pus should be removed or adequately decompressed. Obviously the dura should be opened. It is perhaps best not to drain the wound but if a rubber drain is left in place, it should be removed in 24 hours. (5) The diagnosis is not the cause of cord impairment. One can be reasonably certain that an expanding mass is developing intraspinal which should be removed. As a matter of fact, these pathological events are well known and there should be no puzzling equivocalness arriving at the diagnosis and logical treatment. It is a fact nevertheless that when confronted with a patient who has a severe kyphosis of long standing and thought to be quiescent and who begins to develop signs of cord paralysis, there may be considerable decision relative to the indications for surgery. The problem here is not unlike that of osteomyelitis of the spine associated with a paraspinal abscess in respect to diagnosis and treatment. Paralysis develops in the course of days and unless the cord compression is relieved by laminectomy before paralysis is complete, the prognosis for return of function is notoriously poor. Spinal punctures are contraindicated in both the pyogenic and tuberculous infections.

#### TUBERCULOSIS KYPHOSIS WITH COMPLETE LESION OF LONG STANDING (ANTHONY'S TRANSPLANTATION OF THE CORD)

A. R., a white male, aged 41 years, was admitted to the Presbyterian Hospital, Denver, Colorado, April 16, 1944. He complained of severe pain in the distribution of the eighth, ninth, and tenth nerves. He developed a tuberculous kyphosis in childhood and almost lost the use of his legs at the age of 14. He managed to get about with crutches until the age of 38 when he developed the signs of a complete transverse lesion at D 10.

Examination revealed complete sensory and motor paralysis up to the level of tenth dorsal vertebra.

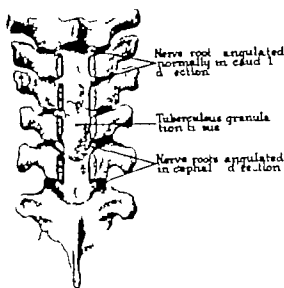


Fig. 3 A drawing to illustrate the intraspinal findings in case of A. R. After removing the laminar arches of the eighth to the eleventh dorsals inclusive a large tumor like mass of fibrofatty tissue presented extradurally at the apex of the kyphotic angle. It had compressed the cord to about one-sixth its normal size. Note how the kyphosis and collapse of vertebral bodies cause a reversal of the normal angle which nerve roots make with the cord.

voluntary bowel and bladder control. There was a marked gibbus at ninth and tenth dorsal. A roentgenogram of the spine showed an extreme kyphosis with angulation at ninth and tenth dorsal and considerable destruction of these vertebrae. The findings were those of an old Pott's disease with no evidence of recent activity.

I had intended to attempt an alcohol injection of the involved nerves to relieve a traumatic neuritis, but this was abandoned because of the severe deformity and distortion of anatomical landmarks. A laminectomy was decided upon for the purpose of putting the appropriate nerve roots intraspinally.

On May 1, 1944 the laminar arches from the eighth to the eleventh dorsal inclusive were removed. A thick mass of tough scar tissue presented at the ninth and tenth dorsal segments. It was situated posterior to the dura and compressed the cord to about one-sixth its normal size. The mass consisted of fibrofatty tissue and in my opinion was obviously the end result of tuberculous granulation tissue established in early life (Fig. 3). The nerve roots from the seventh to the eleventh dorsal inclusive and on both sides were ligated and cut extradurally to alleviate pain. By gentle retraction of the cord to one side and then the other the posterior aspects of the vertebral bodies and intervertebral discs were chiseled

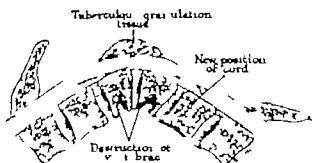


Fig. 4 A drawing to illustrate the manner in which the cord was transplanted anteriorly and the acute angulation relieved. The new position of the cord indicated by dotted lines is somewhat exaggerated in the drawing. The maximum shift in position anteriorly was one-quarter inch.

away in such a manner as to relax the acute angulation of the cord (Fig. 4). Recovery of function was not anticipated because of the long standing paralysis but the feasibility and ease of anterior transplantation of the cord was demonstrated. There was no evidence of active pathology and the wound was closed in the usual manner.

The patient was considerably relieved of girdle pain but to the time of writing 22 months since the operation there has been no evidence of return of cord function.

There is no question concerning the cause of the transverse myelitis in this case and had a laminectomy been performed early in life when the cord signs made their first appearance this patient might well be ambulatory. This is the significant lesson to be drawn from the case. There appeared to be two episodes in the patient's history. At about the age of 14 he became partially paralyzed but managed to get about with the aid of crutches. At the age of 38 the paralysis became complete. Judging from the histology of the scar tissue I do not believe there was a recrudescence of active tuberculous pathology. The intraspinal mass of tissue was established early in life and was of considerable size. It is quite likely that some small aggravation of the kyphosis at the age of 38 was sufficient in conjunction with the tumor like mass to complete the transverse lesion of the cord.

#### EVALUATION OF RESULTS

In respect to the possibility of anterior transplantation of the cord I feel the follow

ing remarks are pertinent (1) I do not feel that the procedure has an application of special importance in the treatment of tuberculous kyphosis with cord signs. The causal factor in these cases has already been elaborated. Moreover in the treatment of active tuberculous infection more harm than good might easily be done in attempting such a procedure. (2) The application of anterior transplantation of the cord may be of value however in other types of cases for example in the case of rapidly developing acute kyphosis following trauma. (3) In performing a number of laminectomies in cases of compression fracture of the spine associated with a transverse cord lesion I have been impressed with some consistent findings. It is often difficult to correlate the benign appearance of the cord at the level of the fracture with its total and permanent loss of function. Macroscopically and to palpation at any rate there often appears to be no anatomical disruption or softening of the cord. There is almost always however an acute hump knuckle or angulation in the cord due to a posterior protrusion of the fractured vertebral body. A simple laminectomy does not correct this deformity. I have strongly entertained the belief that the acute pressure of the bony protuberance that indents the anterior aspect of the cord impairs or obstructs the anterior spinal artery. It may be possible that the resulting vascular insufficiency contributes materially to the transverse myelitis and impairment of cord function. In any case if an emergency laminectomy is performed in the case of acute spinal fracture with transverse myelitis, I feel the significant objective consists in removing the bony or cartilaginous protrusion into the spinal canal. While this is quite possible technically it should be done with great care. Careless re-

traction of an acutely damaged cord obviates all chance of recovery. If one pair of neighboring nerve roots are first cut extradurally retraction of the cord and chiseling of the protruding vertebra is greatly simplified. However one does not disturb ever so little the blood supply to a damaged cord segment by severing the vessels that accompany nerve roots. These facts must be left for future evaluation and must be determined for the individual case. If such treatment of the acute spinal fracture may not be strictly relevant to the cord transplantation it is discussed here, the technical procedure is much the same for the latter.

#### SUMMARY AND CONCLUSIONS

The feasibility and indications for lumbar and anterior transplantation of the spinal cord are discussed. A case of severe kyphosis with acute angulation and physiological transverse lesion of the cord is presented. The cause of the scoliosis was undetermined. Lateral transplantation of the cord with relief of the acute angulation resulted in complete resumption of cord function.

The onset of serious cord impairment associated with tuberculous kyphosis should be considered due to an intraspinal tuberculous process or growth of granulation tissue. Laminectomy and decompression of the cord are definitely indicated. A case of tuberculous kyphosis with transverse myelitis of longstanding is presented. A tumor like mass of scar tissue was disclosed intraspinally at the apex of the kyphotic angle. This mass was the responsible factor for the complete transverse lesion of the cord and was the result of tuberculous granulation established early in life.

# RECONSTRUCTIVE SURGERY OF THE CHEST WALL

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ALTHOUGH thoracic surgery is one of the newest fields of surgical development the results achieved during the past two decades have been remarkable. Significant contributions to this field of surgery have been made by Lilienthal, Sauerbruch, Nissen, Churchill, Cutler, Graham, Alexander, Beck, Blalock, Rienhoff and Blades. The advances made in reconstructive surgery of the chest wall, however, have not paralleled the advances made in intrathoracic surgery. Plastic or reconstructive surgery should by no means be limited to those parts of the body that are exposed. From the standpoint of plastic surgery, there is no essential difference between the repair of defects of the chest wall or the extirpation of a recurrent carcinoma of the chest wall following a radical mastectomy and the covering of an injured eyelid, the closure of a salivary fistula, the removal of a carcinoma or scar of the face, or the re-establishment of motion in a hand distorted as the result of burns. The textbooks on general surgery, however, devote little if any space to reparative surgery of the chest wall, although some operative procedures for the repair of defects in this region may be found in specialized articles (13-16).

There are many conditions of the chest which may not respond well to ordinary procedures but which can be greatly benefited by the application of the more intensive and specialized techniques developed from experience in plastic surgery. The purpose of the present paper is the enumeration and brief description of certain of these conditions and a more detailed account of the procedures employed in the treatment of 3 specific conditions, namely, recurrent carcinoma of the breast, persistent bronchial fistulas, and hypertrophy of the breast.

## SURGICAL TREATMENT OF RECURRENT CARCINOMA OF THE BREAST

Few operations have been designed for the eradication of neoplastic processes recurring after the removal of tumors of the breast and chest wall either by surgery or by irradiation. The use of irradiation therapy to supplement surgical excision has prolonged the life of some patients with recurrent cancer of the breast but many do not receive the benefit of irradiation when the disease has recurred and only rarely is the surgeon willing to make a second attempt to eradicate the disease. The statements (3) that 'recurrent or metastatic deposits of mammary cancer which make their appearance following radical mastectomy are manifestations of an incurable disease' and that 'the disease cannot be eradicated in this stage by any of the therapeutic measures available at present are fortunately no longer true. Any operation which improves the effectiveness of surgery or irradiation or which prolongs life must be considered of value.

The distinction between recurrent and metastatic cancer is seemingly an arbitrary one. The *recurrent* lesions are those which appear in areas which are easily accessible to operation. The *metastatic* ones appear in more distant organs. Geschickter has found that recurrence is seen in the skin and subcutaneous tissues of the chest wall, in the lymph nodes of the axilla or supraclavicular region on the affected side and in the opposite breast in this order of frequency. Nodules in the skin of the chest wall, in the parasternal region are the most common type of skin recurrence following radical mastectomy. Other similar manifestations include recurrence in the scar, isolated nodules in the skin, multiple nodules of carcinoma *en cuirasse* and the carcinoma *tous dermatitis* referred to as inflammatory or erysipeloid cancer.

Major factors influencing the probability of recurrence and determining the technique for

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eradication of the recurrent growth are the type of incision and procedure employed in the initial operation for mastectomy. Numerous modifications of the original Halsted (7) operation have been made by different operators (5 10 14 17 18) independently or inspired by Halsted's work (Fig. 1). Time and experience, however, have led the majority of surgeons to a fuller appreciation of Halsted's (6 8) basic methods and principles. In using the elliptical incision which parallels the anterior axillary fold, the operator may follow either the Halsted or the Handley techniques. That of Halsted, which frequently necessitates grafting, requires the removal of a wide margin of skin around the growth. The Handley technique involves removal of less skin, but more extensive undermining of the flaps in order to secure primary closure. Stewart employs transverse elliptical incisions, which may permit the removal of large amounts of skin and primary closure without grafting (Fig. 1).

Whatever the type of radical mastectomy preferred by the surgeon, an attempt is made at operation to remove in one mass all of the structures which are liable to immediate invasion by the tumor. Because of the assumption that spread of the disease from its original focus proceeds by continuous permeation in all directions, an extremely wide excision *en bloc* of the structures surrounding the primary tumor is advisable. Separation of the tissues by any means within the operative field must be scrupulously avoided, for such separation may result in the invasion of structures by tumor being left behind. Halsted's original basis for the operation was empirical and antedated Handley's theory of lymphatic permeation by cancer cells. However, Halsted's experience with the localization of recurrences and metastatic foci following less extensive types of mastectomy is ample reason to attempt the widest possible excision.

It is true that in some cases the extension of the cancer occurs by way of the blood stream and that tumor emboli may result in distant metastases even though the microscopic examination of the specimen following radical mastectomy fails to show involvement of the axillary lymph nodes and neighboring structures. Nevertheless, the operation is

performed by Halsted (7) and Meyer remains the standard procedure for radical mastectomy since it is based on sound surgical and pathological principles and is applicable to the majority of cases in which clinical evidence fails to indicate that the disease has already passed beyond the scope of operability. The proximity of the cancer to vital structures and its extent at the time of operation greatly influence the success of treatment.

Geschickter states that the 5 year survival rate in surgery in operable cancer approximates 70 per cent for cases without axillary involvement and 25 per cent in cases with axillary involvement. The two groups are about equal in size. The combined curability averages 47 per cent. Adair found that the 5 year survival rate for radical mastectomy in the operable group was 45 per cent and only 18 per cent in a similar group treated by irradiation alone.

The criteria for inoperability should not influence the surgeon to exclude operation for palliative reasons, in cases in which irradiation is inadequate or contraindicated, nor should it be assumed that all of these patients are definitely incurable, as was the assumption in the cases here presented (Figs. 2 6).

CASE 1. A 44 year old white woman was admitted to the Duke Hospital May 10, 1945. Ten years previously a mass had developed in the left breast which was excised at another hospital. It promptly recurred and a radical mastectomy was performed by a second surgeon. During the ensuing year, she received intermittent irradiation therapy following which she remained asymptomatic for 5 years, when the lesion recurred in the chest wall. A biopsy taken and histologic sections disclosed a "recurrent medullary carcinoma." The lesion was considered "inoperable" and palliative irradiation was instituted. The patient was given a total of 2100 roentgen units to the primary recurrence with the use of 800 kilovolts, 30 centimeters distance, 0.25 cu. ft. Three months later this same area was given 1200 roentgen units with 800 kilovolts, 30 centimeters distance, 0.5 copper filter with the lesion well shielded. The patient returned 11 months later with numerous areas of recurrence in the skin of the chest wall each of which was treated separately by superficial therapy. She was also given 1200 roentgen units to a sterilization dose. The lesions which they recurred 1 year later she had additional irradiation, when she was referred to the hospital for operation. She recurred with secondary lesions of the chest wall.

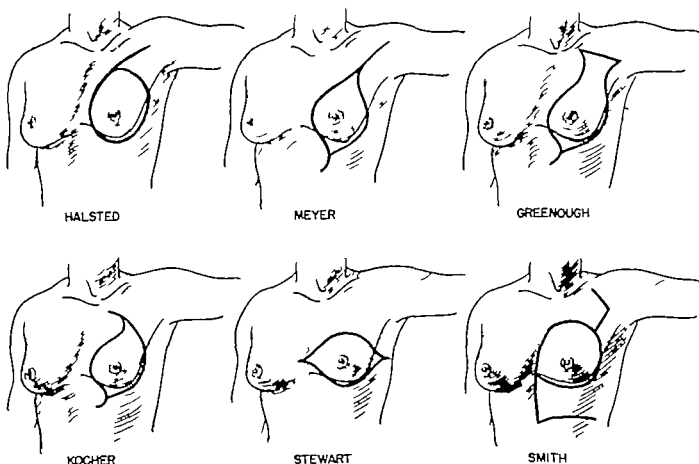


Fig. 1. The major factors which influence the probability of local recurrence are the type of incision and procedure employed in the original operation for mastectomy. Numerous modifications of the original Halsted incision have

been made by different operators (5, 10, 14, 17, 18). Whatever the type of incision employed, an attempt should be made to remove *en bloc* all of the structures which are liable to immediate invasion by the tumor.

(Fig. 2a). An exposed rib could be seen at the base of the ulcer. The surrounding skin was thin and telangiectatic. Pain was constant and intractable.

**Operation.** Excision of recurrent carcinoma of the chest wall: application of split thickness skin grafts to pericardium. On May 12, 1945, with the patient anesthetized with sodium pentothal and nitrous oxide, a closed system being used, the entire chest, abdomen, and one thigh were prepared as a sterile field. The proposed area of excision was widely outlined by a toothpick moistened with 5 per cent alcoholic solution of brilliant green. The medial incision extended along the right lateral border of the sternum. The superior limb followed the clavicle high into the axilla (Fig. 3). The inferior incision began along the right costal margin and traversed the left costal margin. The lateral incision followed the medial margin of the latissimus dorsi. The recurrent carcinoma and the soft tissues of the entire left chest wall were removed *en bloc* beginning at the periphery. The tumor had invaded the underlying ribs and parts of the sternum together with the third, fourth, fifth, sixth, and seventh ribs were resected and the pericardium was exposed (Fig. 3). There were no visible implants in the pleura.

The very large operative defect was reduced somewhat in size by approximating the four corners (Fig.

5). It was impossible to cover the defect with a direct transfer flap or to utilize the right breast, which was quite small. There was no alternative other than to tack the pericardium to the intercostal muscles and sternum (Fig. 4) by interrupted sutures of white silk. Although the heart was seemingly lifted forward by this tacking procedure, there was no visible interference with its function. Two large heavy split thickness skin grafts cut from the thigh were sutured to cover the operative defect which measured 8 inches wide (17.6 cm.) and 9 inches long (19.8 cm.) (Fig. 5). The suture ends were not cut so that they could be tied over a bolus of cotton waste to obtain pressure on the graft directly over the pericardium. The operative area was dressed 10 days later at which time there was an almost complete take of the graft except for a 1 centimeter area over a protruding portion of a resected rib which did not completely heal for several weeks. The patient at present (Fig. 2b, c, d) is entirely well and performs her household duties without symptoms. She does not wear a protective support. The electrocardiogram is normal and no murmurs are heard over the heart. There is no evidence of local recurrence or distant metastases.

The graft has remained soft and semitransparent. Cardiac contractions and pulsations are clearly visible. Forced expiration with increased intrapulmo-

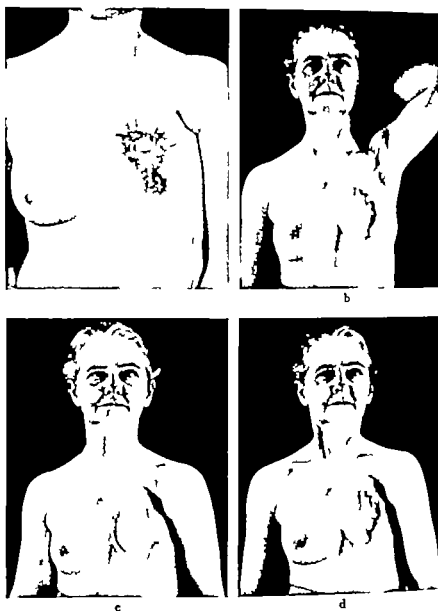


Fig. 2. Case 1. a, A large recurrent carcinoma of the chest wall following radical mastectomy and irradiation therapy. Her condition was thought to be inoperable. She could not tolerate additional irradiation. b, Lesion widely excised together with underlying ribs and sternum and split skin grafts applied directly to pericardium and chest wall. c, Position of graft at forced expiration. d, Graft-covered pericardium is drawn inward at beginning of inspiration. Photographs b, c, d were taken 10 months following operation.

nary pressure causes the graft covered pericardium to bulge beyond the surrounding chest wall (Fig. 2c). When the patient decreases her intrapulmonary pressure the graft covered pericardium is drawn inward below the level of the chest wall (Fig. 2d). Violent waves are seen when the patient coughs.

So far as we are aware this is the first time that a skin graft has been applied directly to the pericardium.

**CASE 2.** A 45 year old colored woman was admitted to the Duke Hospital January 6, 1951. Five months previously she noted a mass in the left breast which continued to increase progressively in size. She had lost about 20 pounds in weight and 3 scanty menstrual periods followed the birth of her last child 2 years previously.

Physical examination showed a hard, slightly tender, freely movable mass measuring 3 by 5 centimeters located in the upper inner quadrant of the



Fig. 3

Fig. 3. The recurrent carcinoma was widely excised. The tumor had invaded the underlying ribs, and parts of the sternum together with the third, fourth, fifth, sixth, and seventh ribs were resected and the pericardium and left pleural cavity exposed.

Fig. 4. The pericardium was tacked to the intercostal muscles and fascia covering the sternum, by using interrupted sutures of white silk so as to form a surface on



Fig. 4

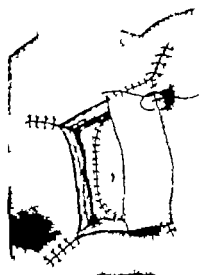


Fig. 5

which a graft could be placed. Although the heart was lifted forward by this tenting procedure, there was no visible interference with its function.

Fig. 5. The large operative defect of the chest wall was somewhat reduced in size by approximating the corners. Two heavy split thickness skin grafts cut from the thigh were used to cover the defect which measured 8 inches in width and 9 inches in length.

left breast. Although several axillary lymph nodes were palpable they were not interpreted as metastases. She had hypertensive cardiovascular disease. The blood pressure was 200 systolic and 140 diastolic. A roentgenogram showed the heart to be moderately enlarged. The aorta was tortuous. There was a harsh blowing systolic murmur heard over the entire precordium. Serologic tests for syphilis were strongly positive.

A radical mastectomy was performed by use of a wide en bloc excision. Since the skin flaps could be approximated a skin graft was not used. Pathologic sections disclosed an adenocarcinoma of the breast without axillary metastases. During the convalescence she received 2000 roentgen units of irradiation through two ports.

She remained well for almost 1 year. Upon returning for a checkup examination on January 4, 1946 she was found to have a hard fixed neoplastic mass in the skin and sternum overlying the junctions of the second and third ribs on the left side (Figs. 6a, b). A roentgenogram of the chest showed the heart to be tremendously enlarged in its transverse diameter. No destruction of the sternum or ribs was discernible.

**Operation.** On January 6, 1946 with the patient anesthetized with ether a closed system being used an incision was made to encircle widely the recurrent carcinoma. The medial parts of the second and third ribs, together with the left lateral margin of the sternum and manubrium were resected. The pleura was opened. The great vessels at the base of the

heart appeared normal. No pleural implants could be felt.

The remaining breast was thin and pendulous (Fig. 6a) and could be readily mobilized upward. A direct transfer single pedicle flap was measured and outlined with brilliant green (Fig. 7). It was then incised, transposed and sutured to cover the operative defect, two rows of interrupted sutures of silk being used. The area from which the flap was taken was closed in a similar manner by drawing the breast upward (Fig. 8). Pathologic sections disclosed a recurrent adenocarcinoma of the sternum and ribs. All incisions healed *per primam* and the patient was discharged on the tenth postoperative day (Fig. 6c).

#### PRIMARY TUMORS ARISING IN THE CHEST WALL

Many of the common benign tumors have been found to arise in the chest wall. The most important however are those which arise from the bones. Simple osteomas have been described but in many instances cartilage is present and therefore these tumors should be classified as enchondromas. Some are malignant and this is particularly true of the cartilaginous tumors which arise in the costal cartilages or the scapula. They may become tremendous in size even when they are benign and may produce pressure against

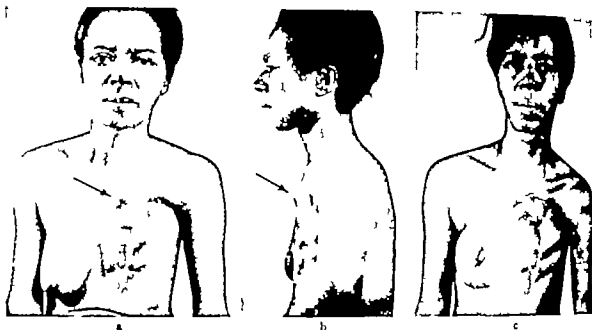


Fig. 6. Case . . . a, b, Recurrent carcinoma of the skin, sternum, manubrium, and ribs following radical mastectomy performed . . . year previously. c, Recurrence . . . as excised

and defect covered immediately with direct transfer single pedicle flap from the opposite chest. All Pathology taken on 11th postoperative day.

other structures. On other occasions, marked deformities develop. Extirpation of these tumors should never be undertaken lightly, for one may have to remove a large portion of the chest wall (Fig. 9). The most common malignant tumor arising in the chest wall is a *sarcoma*, practically all varieties of which have been observed in this location by Hedblom. In a series of 213 cases of tumors of the bone

chest wall Hedblom found 131 to be *sarcoma*. *Carcinomas* of the chest wall, *exclusive* of those which arise in the mammary gland, in the skin, or in the axilla, are never primary (4).

#### OBLITERATION OF EMPYEMA CAVITIES CLOSURE OF BRONCHIAL FISTULAE

*Empyema*. The primary object in the treatment of acute empyema is first to save the life

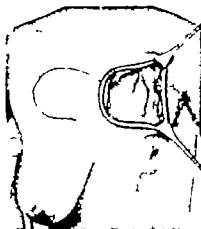


Fig. 7. The recurrent carcinoma . . . as removed by resecting parts of the manubrium sterni, second and third ribs. The great vessels at the base of the heart were exposed. A flap from the right breast . . . as outlined with brilliant green.



Fig. 8. A direct transfer single pedicle flap from the neck upper chest wall was transposed and sutured in position to cover the operative defect, two rows of interrupted silk sutures being used. By drawing the right breast upward, the donor area could be closed.



Fig. 9. A 36 year old white man with a sarcoma of the posterior chest wall which had grown from a walnut-sized tumor to its present dimensions in 2 years. a, b) Repeated hemorrhages from the tumor hastened his admission to the



hospital. X-ray films showed no destruction of the spine or ribs. The tumor was widely excised and the defect covered with two heavy split skin grafts. c. Photograph on sixth postoperative day: sutures not yet removed.

of the patient and second to prevent chronicity. A frequent cause of chronic empyema is failure to provide adequate drainage. Other contributing factors are the presence of foreign bodies or cavities which cannot be obliterated because of fibrosis of the lung and fixation of the mediastinum or the rigidity of the overlying chest wall preventing approximation with the lung or conversely by the rigidity of the lung. Many of the operations designed for the correction and treatment of chronic empyema are based on the principle of freeing the rigid walls of the cavity to permit approximation of the tissues and healing by the formation of scar tissue. The Estlander operation involves removal of the overlying ribs—a procedure not always adequate since the underlying parietal pleura may be so greatly thickened that collapse of the chest wall will not occur unless the pleura is also removed. The Schede operation is designed for removal of the thickened parietal pleura. The principle of the Delorme operation is the removal of the rigid surface of the visceral pleura from the lung in order to permit it to expand enough to contribute to obliteration of the cavity.

**Bronchial fistulas** frequently follow operations for empyema or lung abscess as residual communications between the bronchus and the skin. While serious hemorrhages may occur from the mouth of the fistula the chief complaint of the patient is the inconvenience caused by wearing a dressing. Of greater importance is the serious danger of immersion of

the fistula in water which may result in drowning by the entrance of water directly into the lungs through the external opening.

There is a tendency for all especially the smaller bronchial fistulas to heal as the result of circular contraction of the peribronchial tissue and of the scar tissue around the mouth of the fistula shown experimentally by Bettman, James Tannenbaum and Slobe. Consequently a period of several months should elapse before operative closure is undertaken. However if a large bronchial opening becomes adherent to the skin it is less likely to close spontaneously than if it were deeply situated and in some instances the fistula persists. Graham and Blades have found that repeated cauterizations of the bronchial fistula are usually ineffective. Some fistulas may be closed with several rows of sutures after the lung has been freed from its attachments to the chest wall—a procedure which will permit the contraction of scar tissue to aid in the closure.

In many instances more extensive reconstructive procedures occasionally involving partial resection of the lung are necessary for the permanent closure of the fistulas. When the decision has been made to close a fistula surgically the operation should be preceded by attempts to determine the size, extent and contour of the fistula and the presence or absence of a foreign body. Since the transposition of a skin or skin and muscle flap is a simple procedure it would seem that this is the method of choice especially when the bron-

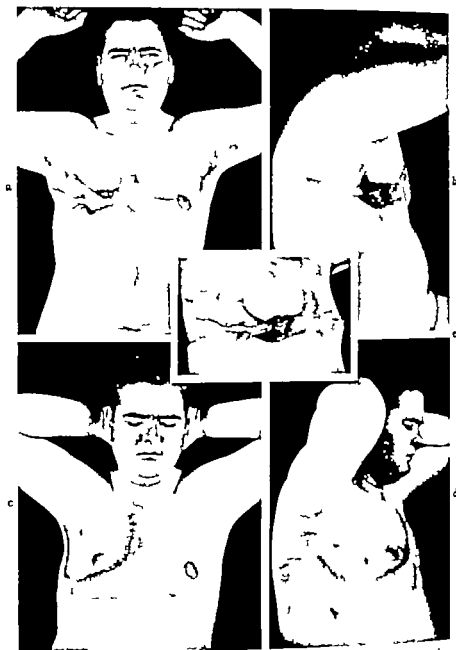


Fig. Case 3. a, b, c Deformity of the chest wall resulting from two operative procedures to drain an empyema and lung abscess, and from four subsequent operations performed to close the persistent bronchial fistula. A communication with a bronchus can best be seen in b. b A pectoral muscle flap was transposed to fill the defect. Condition prior to discharge, c, d, taken on the eleventh postoperative day.

chial fistula leads into a pulmonary cavity of considerable size. The success encountered by this means in the elimination of long standing bronchial fistulas resistant to lesser procedures is illustrated in the following case:

**CASE 3.** A 24 year old white man was admitted to the hospital January 15 1945. He had had pneu-

monia in 1936 1937 1938 and, on his first admission on February 25, 1941, he had the signs, symptoms and findings of a large empyema on the right. The anterior portions of the fifth and sixth ribs were resected to establish open drainage and, subsequently parts of the fourth and seventh ribs were removed to drain a large lung abscess. During the following months, the patient developed multiple bronchial fistulas which persisted even though the



Fig. 11. Insert shows the horseshoe shaped incisions used to excise the scars resulting from the previous operations. The large skin and subcutaneous tissue flap was mobilized superiorly to the clavicle. The pectoralis major was incised beginning about 3 centimeters above the superior border of the pulmonary cavity and continued upward as shown by dotted line, along the right lateral border of the sternum and the clavicular attachment was freed superiorly.

Additional operations were performed in 3 years in an attempt to close them. Hemorrhage from the mouth of the cavity hastened the present admission. The right chest wall was markedly deformed due to previous operations, the chronic empyema, and the bronchial fistulas (Fig. 10a, b, c). He had to wear a dressing constantly. He could not take a tub bath or go swimming for fear of drowning, and when

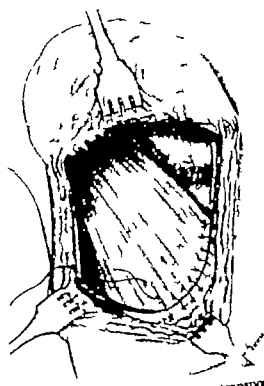


Fig. 13. The pectoral muscle flap was transposed laterally and inferiorly in order to obtain the necessary length to cover completely and reinforce the first line of sutures. The flap was then anchored in its new position to the originally incised inferior muscle margin. The heavy skin and subcutaneous tissue flap was then sutured to the inferior incised margin with interrupted sutures of silk.

smoking it was embarrassing to him and disconcerting to others to see the smoke curl from beneath his clothing.

On January 19, 1945 the following operation was carried out under pentothal nitrous oxide-ether anesthesia. The scars resulting from the previous operations were removed by using horseshoe shaped elliptical incisions as shown in the insert (Fig. 11)



Fig. 12. The muscle was incised about 3 centimeters above and below the margins of the pulmonary cavity. a. The muscle flaps were mobilized toward each other and sutured with interrupted silk, b.



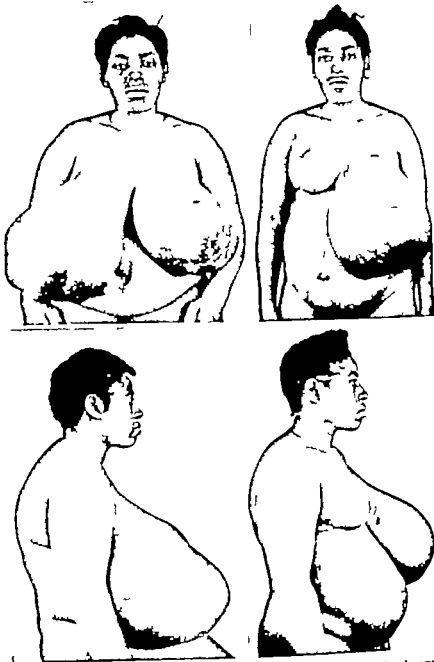


Fig. 14. Gravid hypertrophy of the breasts occurring in a year old colored woman. Although there was some increase in size associated with the progression of pregnancy it was not until she had reached the seventh month that her breasts began to increase rapidly in size, and within 3 to 4 weeks had assumed tremendous proportions. The breasts did not regress during the postpartum period. The patient, as almost completely incapacitated, any movement was laborious and awkward. A right mastoplastic was performed. The specimen weighed 3 pounds (14.5 kilos). Since it was not advisable to transpose the nipple nor to use it as a free graft, an artificial nipple and areola were constructed.

A large heavy pectoral skin and subcutaneous tissue flap was elevated superiorly and the inferior border was undermined and mobilized (Fig. 13a). The pectoralis major was incised about 3 centimeters above

and 3 centimeters below the borders of the pleurothoracic cavity (Fig. 13a). These flaps were mobilized and then turned inward and sutured with interrupted sutures of silk partially to obliterate the

cavity (Fig 13b). A pectoral muscle flap was then elevated by incising the muscle along the lateral margin of the sternum medially and the clavicular attachment was freed superiorly (Fig 11). The entire muscle flap was mobilized and rotated laterally and inferiorly to obtain the necessary length to cover completely and reinforce the first line of sutures. The flap was then anchored in its new position to the originally incised inferior muscle margin (Fig 13). Interrupted sutures of silk were used. The heavy skin flap was treated in a similar manner. No drains were inserted. Primary healing occurred and the patient was discharged 12 days after the operation. He has remained entirely well.

#### RECONSTRUCTIVE SURGERY OF HYPERTROPHIED PENDULOUS BREASTS

Benign and malignant breast tumors have at least one feature in common: they are formed by abnormal and purposeless multiplication of cells previously derived from normal cells. Benign tumors resemble closely the tissue from which they originate. The cells are arranged in a relatively orderly fashion and although the tumor may attain great size it rarely jeopardizes the life of the host except by interference with vital functions by pressure. In contrast, malignant neoplasms consist of abnormal cells which may tend to approach the undifferentiated embryonic type. They are not orderly in growth but invade and destroy adjacent tissues or metastasize to distant parts of the body and finally lead to the death of the patient.

Massive hypertrophied breasts are in most instances comparable to benign tumors and should be considered and treated as such. The increased size may be due to enormous deposits of fat or to marked proliferation, hyperplasia, and hypertrophy of the breast tissue proper (Fig 14). Massive breasts not only incapacitate the bearer but are conspicuous and unsightly. The breasts cause self-consciousness in the bearer, are a source of pain and discomfort, and may cause scoliosis, kyphosis, or lordosis. The excessive perspiration is unpleasant, and the patients avoid society, become depressed and morose, and an ensuing psychosis may develop.

Surgical removal or correction of hypertrophied breasts is just as real and as fully justifiable especially in young women as the indication for many ordinary or well recognized surgical procedures such as the correc-

tion of gynecomastia in the male or the reduction in size of an elephantoid extremity due to lymphatic obstruction. Rather than simply to amputate such breasts, it is much better to remove them in a manner that leaves a pleasing instead of an ugly appearance at their site if this can be accomplished without increase in the risk. Reconstruction of enlarged breasts is indicated when the hypertrophy leads to a disfiguring or disabling deformity and when there is a reasonable probability that the operation will restore the affected parts approximately to normal without undue danger to the patient. The operation is designed to restore physical as well as psychological balance and properly executed it will accomplish these objectives.

In the technique for the correction of massive breasts by partial removal, there are many variations in procedures and many details helpful in obtaining the desired final result. Some of these have been described by Thorek, Maliniac, Lamont, Pickrell, and others. In some instances satisfactory results in the treatment of massive hypertrophy of the breasts can be attained only by subtotal excision of the enlarged organs and construction of an artificial nipple (Fig 14).

*Virginal and gravid hypertrophy.* While the majority of cases of virginal hypertrophy have their onset during adolescence, a similar condition may also occur during pregnancy. Virginal hypertrophy must be distinguished from adipose breasts. Enlargement of the breasts due to deposition of fat may occur in cases of pituitary disturbance where there is an increase of fat about the hips and in the mammary glands but the excessive growth seen in virginal hypertrophy does not occur.

"Because the end-organ rather than the hormonal functions is at fault in virginal and gravid hypertrophy, endocrine therapy is unsuccessful." (3) Surgery therefore is the only alternative.

#### CONCLUSION

There are many conditions of the chest wall which can be greatly benefited by the application of specialized plastic surgical techniques. While the foregoing presentation is selective, we have briefly described the procedures em-

ployed in the treatment of four specific conditions, namely (1) recurrent carcinoma of the breast (2) sarcoma of the chest wall, (3) persistent bronchial fistula, and (4) hypertrophy of the breast

A case is presented in which a skin graft was used successfully to cover the pericardium following excision of a recurrent carcinoma of the chest wall.

#### REFERENCES

1. ADAIR, F. E. *West. J. Surg.* 1940, 48, 645.
2. BETTMAN, R. B. JAMES, W. A. TANNERBAUM, K., STONE, E. *Surg. Gyn. Obst.*, 928, 46, 602.
3. GERSHICHTER, C. *Diseases of the Breast*. Philadelphia: J. B. Lippincott Co., 1943.
4. GRAHAM, E. A., and BLADES, B. In *Textbook of General Surgery* by Cole and Elman. Chap. 39, 4th ed. New York: D. Appleton-Century Co. 1944.
5. GREENWOOD, R. B. *Ann. Surg.* 1915, 62, 11.
6. HALSTED, W. S. *Johns Hopkins Hosp. Rep.* 1915, 3, 355.
7. Idem. *Ann. Surg.* 1917, 64, 497.
8. Idem. *J. Am. M. Ass.* 9, 1, 60, 1119.
9. HEDGECOCK, C. A. *Arch. Surg.* 91, 1, 51.
10. KOCHER, T. *Textbook of Operative Surgery*, 1st ed. Revised Translation from the fourth German ed., by H. J. Stiles, London: A. and C. Black, 1909.
11. LAMONT, E. S. *Surgery* 915, 17, 379.
12. MALINTAC, J. W. *Arch. Surg.* 915, 31, 57.
13. MAURER, E. and BLADES, B. *J. Thorac. Surg.* 15, 77.
14. MEYER, W. 1894, 45, 746.
15. PICKRELL, K. L. Metzger, J., Holloway, J. *Pathology of the breast*. *Surg. Clin. N. America*, 1917, 12, 149.
6. PRINGLE, W. H. *J. Thoracic Surg.* 1915, 14, 49.
7. RODMAN, W. L. *Diseases of the Breast with Special Reference to Cancer*. Philadelphia: P. Blakiston Son & Co., 1908.
8. STEWART, F. T. *Ann. Surg.* 915, 62, 359.
10. THORPE, M. Springfield, Ill.: Charles C. Thomas, 1942.

# PROTECTIVE ACTION OF SULFANILAMIDE ON EXPERIMENTAL CHLOROFORM HEPATITIS

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**D**IFFERENT substances exist which exert or display a protective action against experimental chloroform intoxication. Methionine and cysteine decrease the degree of hepatic injury and the mortality rate produced by chloroform in hypoproteinemic dogs (10). Xanthine and sodium ricinoleate increase the resistance of rats against the toxic action of carbon tetrachloride and chloroform (7). The same investigators found that sulfanilamide given orally to rats protects them against the chronic carbon tetrachloride intoxication as measured by the degree of liver cirrhosis and the mor-

tality rate. The protective action is shown by the mild liver necrosis always observed in the sulfanilamide fed rats as compared with the controls. The protection seems to be due to the sulfonamide group. P- amino benzoic acid does not interfere with the protective action exerted by sulfanilamide.

Forbes and Evans (5) studied the action of sulfanilamide against the liver injury produced by chloroform inhalation in rats. They classified results according to the degree of liver central necrosis revealed on the histologic examination.

After an extensive study we found that chloroform anesthesia of 1 hour's duration in dogs produces a hepatic lesion (hyaline central necrosis) which is followed after 3 weeks, by a

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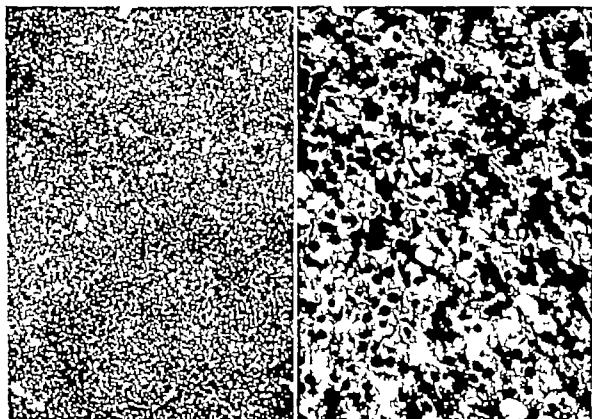


Fig. 1 Dog 511 (control) a, left, Biopsy of liver. Low power view 48 hours after anesthesia. Central hyaline necrosis. b, High power showing nuclear disintegration, cytolysis and some mitotic figures.

TABLE I

	Days	Dog No. 317 8.4 kgm.	Dog No. 327 8 kgm.	Dog No. 330 8 kgm.	Dog No. 3 8.8 kgm.	Dog No. 476 8.4 kgm.	Dog No. 328 6.5 kgm.	Dog No. 436 8 kgm.	Dog No. 52 6.5 kgm.	Dog No. 5 7 kgm.	SS No. 15
		Proth. %	Sulfam. %	Proth. %	Sulfam. %	Proth. %	Sulfam. %	Proth. %	Sulfam. %	Proth. %	Sulfam. %
Dogs treated with sulfanilamide	3 ( )	94.1	—	92	—	92	—	92	—	—	—
	5	—	9.4	—	6.30	—	7.30	—	10.05	7.67	—
	6 (xx)	88	8.3	92.6	0.53	75	3.04	97	3.59	84	12.86
	7	49	—	96	0.6	83	3.8	85	3.5	87	3.8
	9	40	—	93	3.36	84	2.6	87	3.7	86	3.8
Control dogs (not treated with sulfanilamide)	3 (x)	—	—	—	—	—	—	—	—	—	—
	5	—	—	—	—	—	—	—	—	—	—
	6 (xx)	92.2	—	82	—	73	—	83	—	77	—
	7	3.6	—	—	—	3.6	—	3.5	—	3.3	—
	9	9.4 ( )	—	—	—	—	—	4.3 ( )	—	—	—
Protective Index		+	+	+	+	+	+	+	+	+	+

(x) Beginning of the fasting period

(xx) Anesthesia

( ) Dogs Nos. 57 and 3 sacrificed for histological study

( ) Dog No. 323 — Died 30 hours after anesthesia

Dog No. 325 — Died during anesthesia

Dog No. 499 — 1 week after anesthesia. Died 48 hours after anesthesia

Dog No. 411 — Died 30 hours after anesthesia

Dog No. 629 — Died 4 hours after anesthesia

(+) Dog No. 6 — Sulfanilamide given 1 hour prior to anesthesia

complete histological recovery of the parenchyma, although regeneration by rapid multiplication of the remaining hepatic cells replaces the greater part of the functional deficit of the organ within 6 days (3, 4). In these instances hypoprothrombinemia is an early index of the hepatic damage produced by chloroform. The lowest values are obtained 24 to 48 hours following anesthesia. By the fifth day (or at most the sixth) the prothrombinemia has reverted to its normal value. Its variations closely indicate the course of injury as well as the reactive capacity of the liver (12).

In the present work we have studied the protective action of sulfanilamide on liver injury produced by chloroform anesthesia in dogs as well as the degree of hepatic insufficiency and protection by sulfanilamide as measured by the variations in prothrombinemia as compared with controls.

#### METHODS

Two groups of normal dogs which had been fasted for 3 days (water at will) were used

One group received orally 150 milligrams of sulfanilamide per kilogram of body weight daily during 5 days prior to the anesthesia. The other group served as a control. Each pair of dogs (sulfanilamide and control) was subjected at the same time to chloroform anesthesia of 1 hour's duration. A Bock apparatus was used in order to minimize the variations imputable to the anesthesia itself. The blood concentration of sulfanilamide was determined periodically during the period of treatment and after the anesthesia by using the method of Banfi and Loochanch (2). The variations of prothrombinemia were followed in the same samples of blood drawn during the experimental period. The method of Tabor and Banfi was used for the last purpose (11).

#### RESULTS

In Table I are shown the results obtained in 8 control dogs subjected to a chloroform anesthesia. 5 died within 24 to 48 hours after the anesthesia. All dogs previously fed with sulfanilamide survived. The decrease in prothrombinemia was less pronounced in the

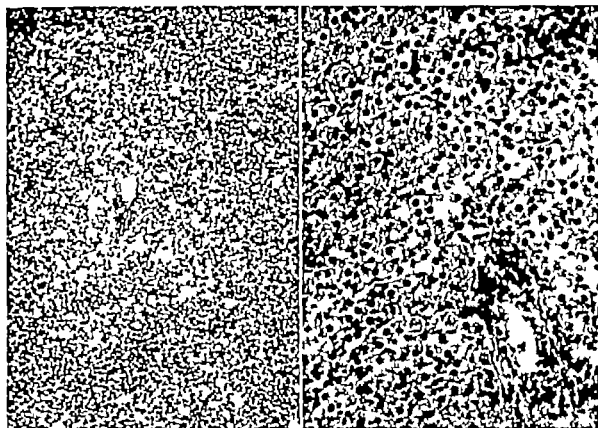


Fig. 3. Dog 517 (sulfanilamide). a, left, Biopsy of liver. Low power view 48 hours after anesthesia. Very mild injury. b, High power showing no nuclear derangement and almost normal architecture.

binemia produced by chloroform was less in the sulfanilamide group than in the controls.

The degree of protection is expressed by the difference between the lowest concentrations of prothrombin reached after the anesthesia in the sulfanilamide fed dog and in the control. The protective index thus obtained gives a fairly approximate figure of the protection conferred. In every instance the favorable influence exerted by sulfanilamide is shown. The protective index varies from +6.4 to +79.5, averaging +35. This average was calculated by excluding the results obtained in the pair of dogs 611 and 614 because in this instance sulfanilamide was administered 1 hour prior to the anesthesia. If sulfanilamide is given 1 hour prior or during the anesthesia, the drug does not exert any protective action.

The effect exerted by sulfanilamide is shown during the first 24 hour period after the anesthesia. During this period the control dogs regularly vomit and are depressed. These symptoms were not observed in the sulfanilamide group. The photomicrographs show

pieces of liver tissue obtained 48 hours after the anesthesia. The degree of hepatic necrosis was less in the sulfanilamide treated group if compared with the control.

#### COMMENT

The results obtained clearly show that sulfanilamide exerts a protective action against liver injury produced by chloroform in dogs. The degree of liver injury, its course, the reactive capacity and the protection conferred can be accurately measured following the variations in prothrombinemia. When sulfanilamide is administered at the same time or 1 hour prior to the anesthesia, the protective action is not observed, which suggests that the action displayed by the sulfanilamide is not a direct one through the liver parenchyma. McIver (9) has shown that thyroxin increases the susceptibility of rats to chloroform intoxication. Earlier works on chloroform liver injury in dogs also pointed out the increased susceptibility to chloroform of the animals previously fed with thyroxin. Several investigators (1-8) showed that sulfanilamide de-

presses the basal metabolic rate in rats by producing an increase in size of the thyroid gland and decrease of colloid. From these studies Forbes presumes that the action of sulfanilamide in protecting the liver against the chloroform injury is due to the decreased susceptibility obtained through a thyroid depressing effect of sulfanilamide. If the same hypothesis is to be used to explain the results obtained in dogs, it must be submitted to experimental investigation.

Many clinical cases of liver necrosis due to sulfanilamide were reported in the literature. However, some authors recommend the use of the drug in biliary infection. To the present time no experimental animal is suitable for producing a liver injury with sulfa drugs. We were not able to produce a liver injury with any dose of sulfanilamide in dogs. This leads us to presume that human susceptibility to sulfa drugs stands by itself. Therefore the mechanism by which the protective action of sulfanilamide is exerted against chloroform liver injury in dogs would explain many of the contradictory findings found in the literature concerning the toxic action of sulfanilamide on human liver. Further investigations are required.

#### CONCLUSIONS

1. Sulfanilamide given daily to dogs prior to a chloroform anesthesia of 1 hour's duration

decreases the degree of liver injury regularly produced by chloroform. In this experimental condition hypoprothrombinemia and histological changes are less severe than in the control animals.

2. The degree of protection obtained with sulfanilamide can be accurately expressed by the protective index which results from the difference between the lowest figures of prothrombinemia obtained in the sulfanilamide-fed dog and the control.

3. Sulfanilamide given to dogs during the time of the anesthesia does not protect against liver injury produced by chloroform.

#### REFERENCES

- ASTWOOD, E. B., SULLIVAN, J. J., BISSELL, A. and TYSLOWITZ, R. *Endocrinology* 943, 31210.
- BAXT, R. F., and LONCHARICH, J. A. *An. farm. bioclin.*, B. Air 1945, 16, 29.
3. BAY, R., TANTURI, C. A., and BAXT, R. F. *Sem. med. B. Air* 943, 50, 357.
4. Idem. *Bol. Inst. clin. quir. B. Air* 943, 9, 395.
5. FORBES, J. C., and EVANS, E. L. *War Med* 1943, 4-4, 8.
6. FORBES, J. C., LEACH, B. E., and WILLIAMS, G. Z. *Proc. Soc. Exp. Biol., N.Y.* 94, 51, 47.
7. LEACH, B. E., and FORBES, J. C. *Proc. Soc. Exp. Biol., N.Y.* 94, 48, 36.
8. MACKENZIE, C. G., and MACKENZIE, J. B. *Endocrinology* 1943, 3, 85.
9. McIVER, M. A., and WINTER, E. A. *J. Clin. Invest.* 942, 9.
10. MILLER, L. L., ROSS, J. F., and WHIFFLE, G. H. *Am. J. M. Sc.* 940, 300, 739.
- TANTURI, C. A., and BAXT, R. F. *An. farm. bioclin.*, B. Air 1949, 83, *J. Lab. Clin. M.*, 940-July.
2. TANTURI, C. A., CANET, JOAN F., BAY, RICARDO, and B. VII. ROBERTO F. *Surg. Gyn. Obst.*, 940, 83, 7.

# GASTRIC CARCINOMA

## A Comparative Review of the Origin, Diagnosis and End-Results in 583 Patients

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**A**FTER the third decade, neoplasm is second only to cardiovascular disease as a cause of death. Since about one-fifth of this mortality is due to carcinoma of the stomach, the subject is of prime importance and worthy of constant repeated analytical study.

In a review covering 444 patients with carcinoma of the stomach discharged from the Fourth Medical and Surgical Division of Bellevue between 1919 and 1938 the dismal outlook was pointed out (2). The purpose of this review is to investigate whether the past 7 years has altered the status of the patient with gastric carcinoma. From 1939 through 1945 of 171 patients discharged with the diagnosis of carcinoma of the stomach, 32 were eliminated because of insufficient diagnostic proof.

The diagnosis in the remaining 139 cases was verified by pathological specimen and unquestionable x-ray evidence. Of these (Fig. 1) 76 (64.3%) were considered inoperable following admission. The reasons for inoperability were: 14 were moribund, 22 had extreme cachexia or senility, 28 showed extensive lesions with metastases, and 12 refused operation. Forty-three per cent of these patients died while on the wards<sup>1</sup>.

The remaining 51 cases (36.7%) were considered operable. An effort was made to do an exploratory operation in every case in which any hope for improvement by surgical intervention was thought possible. Exploratory laparotomy in 22 cases (43.5%) proved that no further operative measure could be undertaken. On 10 patients a palliative procedure was performed as temporary relief for obstructive lesions.

In only 19 patients was gastric resection feasible. Whenever possible wide resection was performed even though evidence of malignant extension, such as enlarged lymph nodes (which were probably neoplastic) was present. This group had a mortality of 26 per cent. Resection was possible in 13.7% of the total number of cases and in approximately 38 per cent of the operable cases. Only 7 patients (5%) were discharged from the hospital as possible cures.

The symptoms in our present series were approximately the same as those found in our previous series of patients. Pain, weight loss, vomiting and weakness remain the predominant reasons for seeking medical attention and hospitalization. In an effort to determine further we have attempted to divide the time of the onset of the various symptoms (Table I) into "early" and "late." Pain and loss of weight head the list of complaints, while cachexia and a palpable mass are the common late findings. The value of this compilation is questionable inasmuch as the signs and symptoms which are characteristic of one patient are late for another. It is probable that it will be necessary to find additional means and methods other than these symptoms if we are ever to diagnose gastric carcinoma early.

This conclusion is further borne out by a study of the relationship between the time of onset of the signs and symptoms, the operability of the patient, and the resectability of our patients (Table II).

As was also shown in our previous series, the graphic representation (Fig. 2) of the age relationship between operability and the lapse of time after the patient's first complaint does not indicate the possibility of cure. Resectability can be prognosticated by what we now

<sup>1</sup>For purposes of this study it is considered a mortality if the patient does not leave the hospital, regardless of the cause of death or length of time following operation.



TABLE I.—SIGNS AND SYMPTOMS\*

Sign and symptoms	Early	Late	Total	Per centage
Pain (epigastric discomfort)	13		14	98
Loss of weight	20	27	47	84
Vomiting	21	30	51	6
Palpable mass	9	23	32	48
Weakness	24	29	53	45
Anorexia	5		6	3
Cachexia	4	14	18	27
Nausea (only)	3	2	5	20
Eructation			14	7
Fluorimetric	6		12	12
Melena		3	3	

\*Signs and symptoms due to metastases or extension of malignancy (perforation, ascites, etc.) have not been listed.

symptomatology. In the overwhelming majority of cases, our present criteria allow us to make a diagnosis only in the late cases and as we continue to depend on inadequate methods, it is only by purest accident that early cases come to operation. Since waiting for clinical signs and symptoms to appear has resulted in low rates of operability and resectability regardless of their duration further attempts to increase our diagnostic accuracy dependent on complaints of the patient are doomed to failure.

#### GASTRIC ANALYSIS

Gastric analysis was performed in 63 cases. Fifty-five (87%) showed marked hypoacidity or achlorhydria. 6 (8%) showed normal acidity and 2 (3%) showed hyperacidity. In view of the frequency of hypoacidity in normal people over 50 years of age the findings in this test are not diagnostic however a decrease or an absence of free hydrochloric acid must arouse strong suspicion and necessitates the positive exclusion of carcinoma. The possibility of cancer occurring in the presence of normal and increased acidity has been called to our attention. The high percentage of cases of hypoacidity or achlorhydria in both of our studies is perhaps indicative of the number of patients with advanced type of cancer admitted to Bellevue Hospital. In consideration of the simplicity of this procedure gastric analysis should be part of a routine examination of all those in the cancer age group.

#### X RAY EXAMINATION

X ray examination of the stomach with contrast media was carried out in 124 of the 139 cases. One hundred twelve showed roentgenologic evidence of gastric malignancy a diagnostic accuracy of more than 90 per cent. Of the 12 cases eventually diagnosed as carcinoma by autopsy or laparotomy 7 were reported as negative, 3 were diagnosed as ulcer of the stomach, 1 as an extragastric tumor and 1 as a benign tumor of the stomach.

During the 7 years covering our present study there has been a large increase (approximately 30%) in the number of patients subjected to x ray examination for gastric disease. An increasing percentage of cases are correctly diagnosed by fluoroscopic and x-ray examination. The roentgenologist has proved himself vastly superior to the clinician in diagnosis, and the asymptomatic patient will only come to operation subsequent to discovery of the condition by x ray examination (9).

A comparison of the percentage (Fig. 3) of operable cases and the possibility of cure during the past 7 years (Series A) with the previous 20 years (Series B) shows a decided similarity. With the exception of the increase in resectability (2% to 5%) there is no statistically important change. The rate of operability remains approximately the same (33.4% to 36.7%).

Without any attempt to excuse our poor results, it must be considered that the cases studied were of consecutive admissions, and many had been diagnosed elsewhere. Thirteen (28%) were considered unresectable by previous laparotomy or clinical examination, prior to admission to the hospital. If this number is subtracted from our total, it raises the percentage of operability from 36.7 to approximately 50 per cent and the percentage of resectability from 13.7 to 19 per cent. Even this increase in the percentage of operable and resectable cases, as compared with the results of our previous series (Series B) should not lead to the conclusion that the status of these patients has changed. The supposed improvement is more apparent than real. It cannot be considered as due to earlier diagnosis or therapeutic advance in view of the end results. In our opinion any increase in oper-

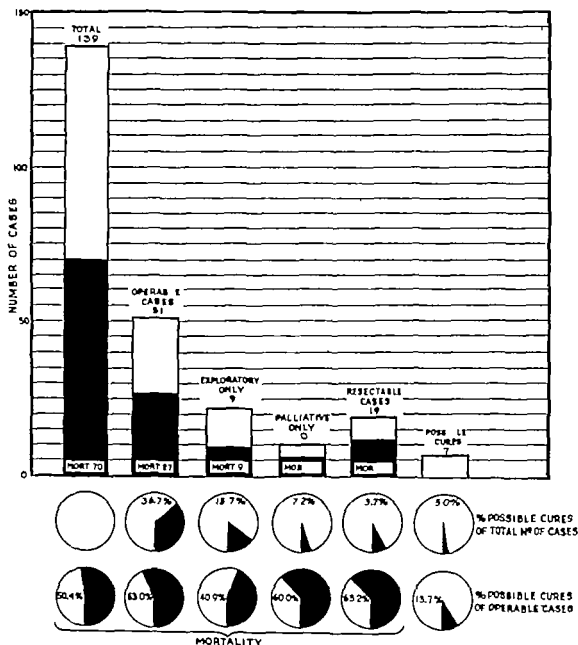


Fig. 1. The results in 139 consecutive cases diagnosed as carcinoma of the stomach from 1939 to 1945. Series B.

ability and decrease in mortality is due to improved techniques utilized in preoperative and postoperative care (i.e. intravenous plasma proteins, amino acids, vitamins, frequent transfusions, Wangenstein drainage, etc.) The institution of an anesthesia service at Bellevue Hospital, with trained anesthetists who visit the patients both preoperatively and postoperatively (frequently using positive pressure paravertebral block, cyclopropane and curare) has decreased the number of post-anesthetic and postoperative complications.

Although an increased number of patients recover from the operative procedure, this in-

crease is not reflected in the percentage of actual cures. This fact is emphasized by a study in the Fourth Division at Bellevue Hospital. 52 patients with a previous diagnosis of carcinoma of the stomach who were readmitted subsequently and observed during this period (1939 to 1945).

Of these 52 patients, 42 were previously operable; exploratory only was performed on 15, palliative procedures on 2, and gastric resections were done on 25. All of these patients either died during their readmission to Bellevue Hospital or they were transferred, by arrangement, to a home for incurables where they

TABLE II.—DURATION OF SYMPTOMS

Length of time	Inoperable	Operable	Resectable
Less than month	9	3	
to 3 months	13	9	4
3 to 6 months	5	13	
6 to 12 months	8	16	5
to 2 years	5		
to 3 years	5	5	4
3 to 5 years			
5 to 10 years			
Over 10 years			
Total	78	51	9

succumbed. None of the patients on whom resection was not done lived longer than 10 months, and the average length of life was 6¾ months. The subsequent course of the 25 patients resected (Table IV) and later readmitted indicates that even though an increase in the percentage of resectability has taken place the eventual outlook for what we now consider the most favorable cases is bad indeed. A life expectancy of less than 2 years following resection cannot be considered progress in the cure of gastric cancer.

#### PEPTIC ULCERS

There were 16 cases (11.5% of the total) in which the history made the possibility of malignant degeneration of a benign peptic ulcer a factor for consideration. As in the previous series, in which 17.1 per cent of the patients presented this possibility (as well as in other studies 2, 3, 8, 16, 17, 18) these cases have been carefully investigated. Seven were diagnosed as duodenal ulcers, and as such can either indicate errors in diagnosis or the con-

TABLE IV.—END-RESULTS IN 25 PATIENTS WITH GASTRIC RESECTION FOR CANCER

Readmitted between 1930 to 1945	
Length of time between operative procedure and final readmission.	
Less than 3 months	3
Less than 1 year	9
Less than 2 years	
More than 2 years	3
Total No. of months	583
Average	23½ mo.

\*One case was readmitted with period of 18 months between operation for gastric malignancy and death. Without this case the average length of time is reduced to 21½ months.

TABLE III.—GASTRIC ANALYSIS\*

	No. cases
Total	63
Hypocidity or achylia	33
Normal acidity	8
Hyperacidity	3

Method: A Levine tube No. 8 was passed through the nose into the stomach, and fasting specimens of about 30 cc. collected and labeled each 15 cc. of histamine was injected subcutaneously. A test specimen of about 10 cc. was then taken and labeled No. 1, and after that at 15 minute intervals additional specimens, the total of seven analyzed and labeled No. 2, No. 3, and No. 4, respectively.

comitant existence of a duodenal ulcer and a gastric malignancy near the pylorus. Each of the 9 cases which were diagnosed as gastric ulcer has been reviewed and received exhaustive study. Since the previous report from our gastroenterological clinic (18) concerning the possibility of malignant degeneration of peptic ulcers, we have followed 165 cases of gastric ulcers over periods from 1 to 19 years, and have failed to find a single case in which the transformation from a benign ulcer to a gastric neoplasm could be proved. Extensive investigations have either shown the separate and individual inception of the lesions, or demonstrated the error in the diagnosis of a benign peptic ulcer for what was later proved to have been a malignant lesion from its onset. In several cases of carcinoma of the stomach which we have reviewed, clinical history or x-ray study caused suspicion that they had their origins in peptic ulceration.

CASE 1. A 60 year old white male in whom a diagnosis of peptic ulcer had been made 17 years before had had a gastric resection at that time. The patient was admitted to this hospital in February 1937 because of a recurrence of ulcer symptoms. A gastroscopic examination revealed two ulcerative lesions near the ostia. He was discharged following improvement under medical care. In June, 1938 he returned because of persistent epigastric pain. An exploratory operation was performed demonstrating adhesions were released and the stomach was found free of disease by gross examination. Gastroscopic examination in December 1938 revealed no signs of ulceration, but the development of atrophic gastritis. He was readmitted in 1943 and laparotomy revealed an inoperable malignant lesion of the stomach.

CASE 2. A 47 year old white male, who had had a resection for gastric ulcer in April, 1930, returned because of malfunction of the stomach in March, 1940. A further gastric resection to eliminate the malfunctioning stomach was performed. Three months later he returned to the hospital because of a recurrence of gastric dysfunction. Exploration revealed extensive stony hard lesions on the stomach, liver peritoneum, and omentum. The pathologist reported car-

# ABRAHAMSON HINTON GASTRIC CARCINOMA

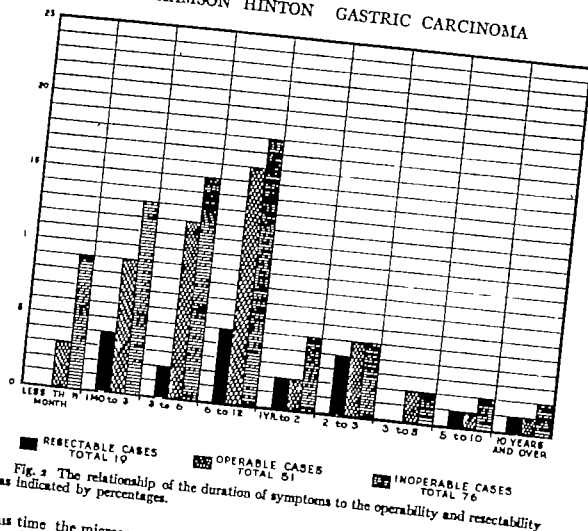


Fig. 3 The relationship of the duration of symptoms to the operability and resectability as indicated by percentages.

noma. At this time the microscopic sections taken from the stomach at the two previous operative procedures performed in 1937 and 1940 were re-examined by Dr. Douglas Symers, then Director of Pathology in New York City hospitals. He reported that adenocarcinoma was present in all the specimens previously removed and reported as peptic ulcers.

In both of these cases simple clinical deduction might lead to the belief that malignant degeneration of previously benign lesions had taken place. In one case we have gastroscopic evidence that the ulcerations had healed and atrophic gastritis was present 4 years prior to the patient's admission for a malignant condition. In the second case a careful pathological review of the microscopic sections from the two previous operations showed that the supposedly benign peptic ulcer had always been malignant.

In 1937 a series of 109 cases of gastric ulcers and 118 cases of gastric cancers were reviewed in search of evidence for the change from benign ulcer to neoplasm (18). Together with this series since 1919 we have followed 583 patients with carcinoma of the stomach who

have been admitted to our wards and 1,475 cases of peptic ulcer (of which 165 were gastric ulcers) which have been followed in our gastroenterological clinic over a 1 to 19 year period. In none of these cases was it possible to prove that malignancy had its inception in benign ulceration nor have any of the known ulcers developed malignancy.

Clinical and pathological experience in surgery warns against didactic statements concerning carcinogenesis. Isolated cases in our series might leave reasonable doubt concerning the inception of the malignant condition.

**CASE 3.** A 43 year old white male with a typical history of peptic ulcer over a 10 year period developed an additional severe pain radiating through the back. X ray films were interpreted as showing a large penetrating ulcer of the lesser curvature of the pars media. On resection of the stomach the lesion was suspected of malignancy on gross examination and the pathological examination showed adenocarcinoma of the stomach.

From this patient's history we can conjecture that this man had a peptic ulcer of the stomach over a long period of time suppos-

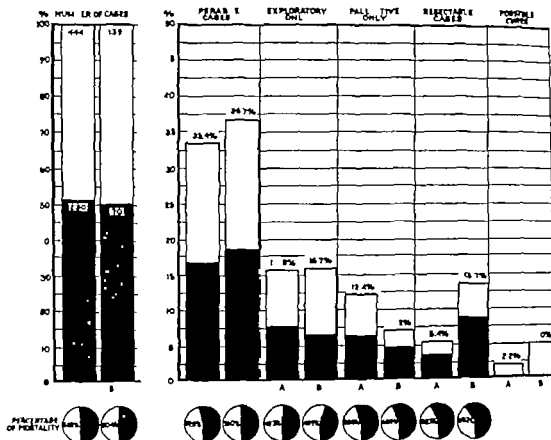


Fig. 3. The comparative results in the treatment of carcinoma of the stomach between 1910 and 1938 (Series A) with those of 1939 and 1945 (Series B)

edly verified by x ray findings, and later a malignant condition at operation. As to whether this man had both a carcinoma and a peptic ulcer at the same time, or whether he developed a gastritis which underwent neoplastic degeneration or whether the carcinoma originated at or near the peptic ulcer we do not know. Several eminent authors (4, 7, 14, 21, 27, 29) on this subject consider that the change from peptic ulcer to malignant lesion occurs frequently. Although it is possible that a neoplasm may arise at the site of the peptic ulcer in our experience this transformation is not only unusual but extremely uncommon. Whether a gastric carcinoma is early or late, small or large, it may undergo peptic ulceration eroding away all signs of malignancy (12) and at this time will give the signs and symptoms of this condition. By x ray examination it may even be mistaken for benign peptic ulcer and the malignancy may not be apparent until later. In spite of the fact that

we perform gastric resections on many patients, including those with intractable gastric ulceration as well as in any case in which there is doubt concerning the diagnosis of carcinoma we do not believe that the potentiality of malignancy originating in a benign peptic ulcer is an indication for operation.

#### GASTROSCOPY

Gastroscopic examination was attempted in 28 cases. In 22 the diagnosis of carcinoma of the stomach was correctly made. One case was termed negative and 1 case diagnosed as gastric ulcer. 4 attempts to perform gastroscopic examination were considered incomplete or unsuccessful and no report rendered.

The flexible gastroscope allows visualization of the gastric mucosa and is an additional means of verifying the diagnosis of gastric cancer. The interpretation of the results of gastroscopic examination (like the results of

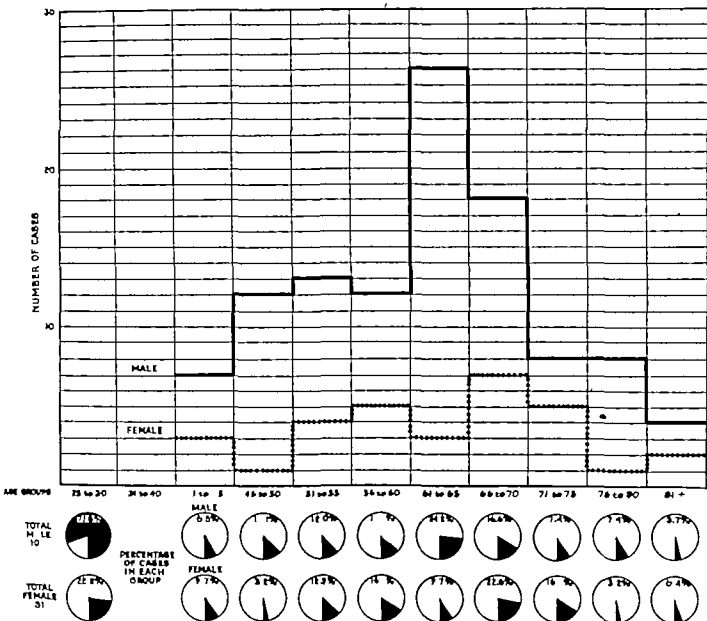


Fig. 4. The age and sex incidence.

any other diagnostic procedure) must be tempered with the knowledge that there is an element of error in the procedure, and also that the accuracy of the observations are dependent on the position of the lesion and the experience of the gastroscopist. However since any information concerning the condition of the gastric mucosa is of diagnostic importance gastroscopic examination should be utilized in all lesions of a questionable or controversial nature following x ray and laboratory studies.

The extensive use of this instrument by experienced observers has verified the findings of Faber and Konjetzky concerning the actuality of involutionary or retrogressive gastritis.

Chronic gastritis frequently accompanies gastric ulcers. To clarify a term, gastritis does not necessarily mean an inflammatory lesion but includes functional and pathological derangements of the glandular elements which make up the involutionary changes. As shown by Judd, definite changes in the mucosa indicative of severe chronic gastritis of long standing are present in association with gastric carcinoma. The origin of gastric cancer on a mucosa which is the seat of this pathological change has been described so frequently (5, 11, 12, 15, 22, 25, 26) during the past 20 years that we believe that this change must be considered an important factor in the vast majority of cases.

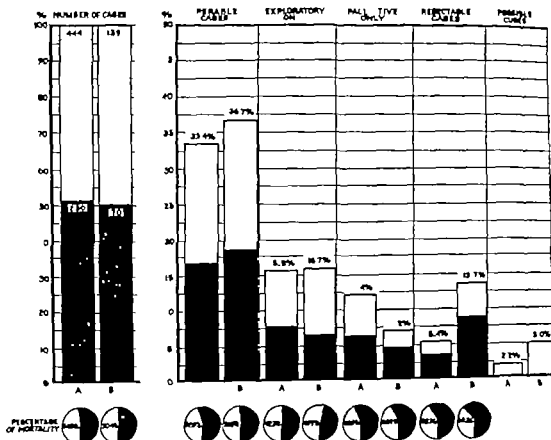


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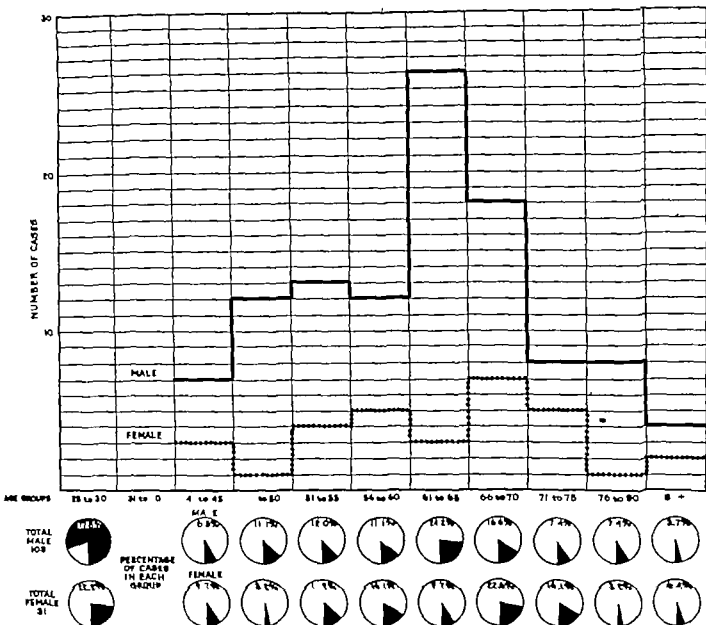


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Rigler has recently reported on the frequent occurrence (more than 8%) of carcinoma on the atrophic gastric mucosa of patients suffering from pernicious anemia. The age and sex incidence of chronic retrogressive gastritis coincides with the age and sex of the patients in both series of gastric carcinoma which we have reported (1-3). From our observations it would seem that the instigation of gastric carcinoma is much more closely related to the chronic pathological involutionary changes, which take place in the gastric mucosa than it is to benign peptic ulceration.

In reports on the endocrine nature of the gastric mucosa (1-3) we have called attention to massing of cases in the 40 to 70 year old group and the occurrence of cancer in 3.4 males for each female. Our findings in this review are practically identical with our previous studies (Fig. 4). Although we realize that carcinoma of the stomach occasionally appears in younger people, the great majority of these cases occurs after 40 and the problem of gastric carcinoma lies within this large group.

The preponderance of males and the high incidence in later life in all studies emphasize the endocrine factor in the etiology of gastric neoplasms. During that period in life when gastric carcinoma most frequently occurs there are marked changes of the content and nature of the sex hormones. Experimental work has shown (1-3) that activity of the gastric mucosa is influenced by hormones, including changes in the androgen-estrogen ratio. Although it is our belief based on the experimental results and clinical observations of ourselves and others (reviewed in previous publications 1-3) that the relationship between the hormone control of the gastric mucosa and gastric disease is an important carcinogenic factor, we fully realize that it will take further extensive experimental study to prove the various etiological agents responsible for the change from normal or pathological gastric mucosa to neoplasm.

#### DISCUSSION

From our findings it is evident that the outlook for the patient with gastric carcinoma continues to be dismal. Any gains that have been made are the result of improved pre-

operative and postoperative care. Parenteral administration of fluids to control biochemical changes, advances in anesthesia, and the advent of sulfonamides and penicillin have raised the rates of operability and resectability and lowered the operative mortality but have not appreciably affected the course of the disease. Comparative studies of the results from more specialized surgical clinics have shown that operability, resectability and the length of postoperative cure are greatly influenced by the selection of cases (14). But the prognosis of the patients in a large general hospital (which represents a cross-cut of the general population) remains distressingly unfavorable. The lack of time relationship between the onset of symptoms (as we now understand it) and the percentage of resectability reveals that our furthest progress has been our determined effort to diagnose late cases. The problem resolves itself to evolving a means of bringing patients with carcinoma of the stomach to operation early in their pathological course (6, 9, 12) rather than early in their clinical course. At present we operate on a curable carcinoma of the stomach by accident, or because of an extremely fortuitous early diagnosis.

Since our attempts to discover early gastric carcinoma are obviously failures, our efforts should be directed toward the improvement of our methods of diagnosis. At the present time our only method of revealing asymptomatic curable gastric cancer is by fluoroscopic and x-ray studies. The institution of these studies on a mass scale, by methods similar to those used in mass examinations for tuberculosis, offers a great opportunity to uncover asymptomatic malignant disease. The use of such a procedure has been advocated by several since 1935 (6, 18).

Comparative mass fluoroscopic and x-ray studies on approximately 400 American soldiers and 400 German prisoners with gastrointestinal complaints showed that 1 per cent of the German prisoners had carcinoma of the stomach while none was found in a similar group of American soldiers (30).<sup>1</sup> Although

<sup>1</sup>It is interesting to note that the reverse age group of the German prisoners was 34 while among the American soldiers it was 8.

the study of Dailey and Miller on 500 normal people did not reveal any gastric carcinoma we believe that it must be carried out in groups larger than 1000 to be statistically valuable, and that routine annual fluoroscopic and x ray studies of the stomach especially in the carcinoma age group, should be instituted.

A recent authoritative mass fluoroscopic and x ray study (28) on a consecutive group of 2,413 patients without gastrointestinal complaints revealed that 3 had asymptomatic gastric cancer. This procedure conducted on a larger scale would undoubtedly disclose and bring to operation a higher percentage of resectable and curable patients than any other means at our disposal. The outline of a plan by which mass fluoroscopic and x ray studies of the stomach could be routinely carried out on an increasing number in the carcinoma age group is proposed.

1 Education of the public (a) on the asymptomatic character of carcinoma of the stomach (b) on the necessity for routine fluoroscopic and x ray examination of the stomach

2 Fluoroscopic and x ray studies of the stomach performed (a) as part of an annual physical examination in military services (b) as part of an annual physical examination in veterans organizations (c) as part of an annual physical examination in large industries (d) as part of an annual physical examination on members of labor unions (e) as part of a physical examination prior to the issuance of health and life insurance policies (f) as a routine procedure on all patients over 40 years of age entering hospitals

3 Availability to private physicians of facilities for fluoroscopic and x ray studies of the stomach for those on every economic level so that all patients over 40 years of age are given routine annual examinations.

4 Gastric analysis and gastroscopy as well as further repeated x ray studies in all questionable or controversial lesions found on fluoroscopic examination

In our present state of ignorance concerning carcinogenesis in general and the early diagnosis of gastric carcinoma in particular, the popularization of fluoroscopic and x ray

examinations of the stomach presents an important method of discovering an increasing number of curable cases among the general population

### CONCLUSIONS

1 Comparative studies of 583 cases of carcinoma of the stomach between 1918 and 1945 demonstrate the poor prognosis and emphasize lack of progress.

2 The absence of relationship between the onset of the symptomatology operability and possibility of cure reveals our failure in the diagnosis of early cases.

3 Investigation does not substantiate the possibility of the transformation of benign ulcer to gastric carcinoma as anything but a rare occurrence

4 It is suggested that the following four factors have a definite relationship (a) age and sex incidence (b) chronic 'gastritis' (c) endocrine effects on the gastric mucosa (d) the inception of gastric neoplasm

5 A plan is presented for the utilization of mass fluoroscopic and x ray studies of the stomach, as a means of discovering curable malignant conditions

### REFERENCES

- 1 ABRAHAMSON R. H., CHURCH, R. and HINTON J. W. *Am. J. Sc.*, 1942 304 809-823.
- 2 ABRAHAMSON R. H. and HINTON J. W. *Surg. Gyn. Obst.*, 1943 76 147-163
- 3 *Ibid.* 1940, 71 135-141
- 4 ADAMS, J. G. *The Principles of Pathology* Vol. 1 p 616 Philadelphia Lea & Febiger 1908.
- 5 BLACKFORD, J. M. *J. Am. M. Ass.*, 1931 77 1410-1412.
- 6 BLOOMFIELD A. L. *J. Am. M. Ass.* 1935 104 1197-1202
- 7 CHANG, H. C. *Am. J. Digest. Dis.* 1936, 3 10-12.
- 8 CHURCH, R. E. and HINTON J. W. *N. York State J. M.*, 1934, 34 1079-1084.
- 9 COLE, L. G. *Am. J. Surg.* 1936, 31 206-224.
- 10 DAILEY M. E., and MILLER, E. R. *Gastroenterology* 1945 5 1-4.
- 11 DAVIS T. D. and VANDERHOOF D. *Virginia M. Month.*, 1926-1927 33 446-448.
- 12 EWINO J. *Am. J. Surg.* 1936 31 204-205
- 13 FABER, K. *Lancet*, Lond., 1927 2 901-907
- 14 GRAHAM C. J. *Am. M. Ass.* 1908, 51 651-653.
- 15 HEWNING, N. *Die Entzündung des Magens*. Leipzig: J. A. Barth, 1934.
- 16 HINTON, J. W. *Am. J. Digest. Dis.* 3 59-62
- 17 *Idem.* *Bull. N. Y. Acad. M.* 1941 17 829-843.
- 18 HINTON J. W. and TRUBER, M. *Surg. Gyn. Obst.*, 1937 64 16-21
- 19 JUDO E. S. *The possible relation of residual lesions in the gastric mucosa to the development of carcinoma of the stomach*. Thesis, Grad. Schl. Univ. Minn., 1938.

20. KONTZEVOY, G. E. Die Entzündung des Magens.  
HERRIK, F. and LUBARSCH, D. Handbuch der speziellen pathologischen Anatomie und Histologie. Vol. 4, p. 768. Berlin Julius Springer 1928.
21. MACCARTY W. C. Surg. Gyn. Obst., 1910, 10 449-462.
22. McNEER, G., and BAROWSKY H. Am. J. Digest. Dis., 1930, 6 180-182.
23. RIOLER, L. Radiology, 1943.
24. SAYPOOL, G. M., and HIXTON J. W. Am. J. Surg., 1941 2 431-434.
25. SCHINDLER, R. Gastroscopy Chicago. University of Chicago Press, 1937.
26. SCHINDLER, R., ORTMAYER, M., and RICHGAW J. F. J. Am. M. Ass., 1937 106 455-467.
27. SMITHIES, F. Cancer of the Stomach. Philadelphia and London W. B. Saunders Co 1916.
28. ST. JOHN F. B., SWINSON, P. C., and HANBY H. D. Ann. Surg., 1944, 19 225.
29. WILSON, L. B. and MACCARTY W. C. Am. J. Science, 1909, 138 846-852.
30. WYLLIE, MAJ P. E. Mil. Surgeon, 1946, 68. 131-134.

# THE PHYSIOLOGIC EFFECTS OF CURARE AND ITS USE AS AN ADJUNCT TO ANESTHESIA

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**C**URARE is still a relatively unknown drug. It is known to cause complete paralysis of the skeletal muscles by inactivating acetylcholine and thus blocking nerve impulses to the voluntary muscles. This paralysis begins with the muscles innervated by the cervical nerves and continues successively through the muscles of the extremities, the abdominal muscles, the intercostals, and finally the diaphragm.

Claude Bernard in 1857 reported that curare is absorbed from subcutaneous, intramuscular and intravenous injection and by the pulmonary and rectal mucosa, but is not absorbed by the mucosa of the rest of the intestinal tract, the genitourinary tract, or through the skin. Alexander Partos in 1930 reported that curare is detoxified by the liver and can be recovered from the liver substance. He believed the curare not absorbed by the liver was excreted unchanged by the kidneys. This theory agrees with the more recent work of the pharmacologists (Squibb) who have found that 40 to 60 per cent is excreted in the urine.

## ANIMAL EXPERIMENTATION

In the last 5 years the use of curare to obtain muscular relaxation in abdominal surgery has become widespread. In order to determine whether curare could safely be used to produce the apnea necessary for controlled respiration in intrathoracic operations in conjunction with nitrous oxide anesthesia the physiological effects of the drug on dogs were studied. A series of 50 dogs was given enough curare to produce apnea for from 2 to 8 hours. The first 25 dogs were given atropine 0/0006 (gr 1/100) and the second 25 morphine sulfate 0/015 (gr 1/4) or 0/03 (gr 1/8) depending on the size of the dog and atropine 0/0006.

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(gr 1/100) No difference was noted in the amount of curare necessary to produce apnea or the duration of the apnea in the two series.

An initial intravenous injection of 40 milligrams of curare was given (enough to cause apnea in about 2 minutes). As soon as apnea and muscular relaxation occurred an endotracheal tube was inserted and connected to a breathing bag and cylinder of oxygen. Artificial respiration was carried on by gentle intermittent pressure on the bag. We consider this a more physiological method than the use of a mechanical respirator. An oxygen flow of 7 to 8 liters per minute was maintained to prevent the accumulation of carbon dioxide in the bag. Further doses of curare were injected intravenously whenever the dogs started to breathe.

The average dose of curare in the first series of 25 dogs was 56 milligrams. Of the series 6 dogs died 1 of deliberately produced hypoxia and respiratory acidosis 1 of an overdose of prostigmine (2 c.c. of 1/2000) 1 of accidental failure to intubate and consequent acute anoxia, and 3 of pulmonary atelectasis after return to the cage. We found that to prevent atelectasis it was necessary to continue artificial respiration until the intercostal muscles were contracting strongly.

The second series of 25 dogs received an average dose of 88 milligrams of curare. Two of these dogs died 1 of pneumonia during an epidemic in the animal house 4 days after the experiment and 1 of atelectasis after being returned to the cage. This last animal was deliberately sacrificed in order to impress the students with the importance of continuing artificial respiration until the intercostal muscles recover their power of contraction. In no case could death be attributed to the specific toxicity of curare.

We concluded from this series that curare of itself does not cause death in apneic doses. A

second important discovery was that artificial respiration must be continued until the intercostal muscles are contracting strongly. Discontinuing before this stage of recovery even though strong diaphragmatic contractions were present and the dogs were able to oxygenate themselves adequately resulted in death from atelectasis.

Other interesting facts came to our attention during these experiments. Although the dogs were curarized to the point of apnea if a finger were moved toward the eye without touching the lashes, hair or skin the eyelids would close. A loud noise would often cause a sudden start in a dog apparently completely paralyzed with curare. Therefore vision and hearing must still be present after curarization and their reflex arcs be intact. It was also noted that the platysma seemed much less affected by curare than the other muscles. Even though the dog was in apnea, a flea crawling on the abdominal wall would cause violent twitching of the platysma in that area. Twitching of the platysma was the first sign of recovery from curare. This was most evident in the animals which had not received morphine. These phenomena raise grave doubts in our minds that apneic doses of curare produce anesthesia or analgesia.

A rise in blood sugar was found after the injection of curare in a series of 6 dogs. The rise averaged 49.9 milligrams per cent. All these animals showed glycosuria but no acetonuria.

Electrocardiograms were taken before during and after the repeated administration of curare in a series of 4 dogs. After curare the QRS voltage decreased, the T waves became variable and according to the cardiologists the tracings resembled those seen in potassium poisoning.

Electroencephalograms were taken on a series of 5 dogs and showed identical changes in all. Control tracings were taken 1 hour after premedication with morphine and atropine. A tracing was made while the dog was in apnea following the administration of 40 milligrams of curare. When the dog had recovered from the curare sufficiently to breathe an anesthetic dose of sodium pentobarbital was injected intravenously and a third set of electroencephalograms was taken. Two days later

tracings were repeated first with morphine and atropine and then with the same dose of pentobarbital as before without curare. Compared with the control tracings, those taken following curare showed a very marked lowering of the potentials together with slight dysrhythmia. Light flashed in the eyes or loud noises caused no alteration in the picture unless the dog jumped and moved the leads. After pentobarbital more marked dysrhythmia occurred than with curare. It was concluded that large doses of curare may cause a cerebral dysrhythmia compatible with a slight narcotic effect.

It was found that the repeated administration of curare over long periods of time caused no change in the animal's reaction to the drug. Four dogs received from 6 to 10 administrations of curare each in 6 months time for periods ranging from 30 minutes to 4 hours. They showed neither increased tolerance nor sensitivity to the drug at the end of this time. After recovery they behaved in all respects like normal animals.

A cesarean section under local anesthesia was performed on a pregnant bitch while she was in apnea induced by 40 milligrams of curare and 6 pups were delivered. All the pups breathed spontaneously, moved and showed no signs of being curarized. One pup was freed from its membranes and held in the surgeon's hands, the cord pulsating, while another 20 milligrams of curare was injected intravenously into the mother still in apnea from her first dose. The pup continued to squirm and cry for 10 minutes, at which time the cord was cut. After the delivery and while the mother was still in apnea the administration of ergotrate produced normal contraction of the uterine muscle. The mother recovered with no ill effects from the curare. During a second cesarean section performed in a similar manner 4 milligrams of curare were injected into the umbilical vein of a lively breathing pup while it was still attached to the placenta, causing complete apnea in 15 seconds. The pup could not be intubated because of the minute size of the larynx and controlled respiration by squeezing the chest was carried on for about 1 hour. After 45 minutes a few diaphragmatic contractions were felt, but a little

TABLE I

Dog	Weight Kilo- grams	Treatment	Dose of curare grams	Period of incubation minutes	Supportive therapy	Spontaneous respiration	Duration of experiment	Condition at end	Postmortem findings	Probable cause of death
132	13	M/03 A/0006	4 (300 c.c.)	205	1300 c.c. 5% glucose 30 c.c. 50% glucose Ephedrine 1 ml. intravenously	After 42 hr	55 hr 30 min.	Dead	Negative	Upset of electrolyt. balance after long period of controlled respiration and local anesthesia therapy
22	10.2	M/03 A/0006	1 (50 c.c.)	55	450 c.c. 5% D/W 0 c.c. 50% D/W 800 NSS	None	6 hr 55 min.	Dead	Pulmonary edema	Too much fluid intra- venously
25	1.8	M/03 A/0006	4 (300 c.c.)	185	500 c.c. 5% D/W 10 c.c. 50% D/W 800 NSS	None	8 h 45 min.	Dead		Too much fluid intra- venously
26	11.0	M/03 A/0006	1 (50 c.c.)	70	100 anapen (by stomach tube) 70 c.c. H <sub>2</sub> O (tube)	After 1 h 45 min.	15 h 15 min.	Alive		Now alive and well. Delivered pups 3 months later
27	1.4	M/03 A/0006	4 (300 c.c.)	100	65 c.c. anapen (by stomach tube) 50 c.c. H <sub>2</sub> O (tube)	None	11 hr 5 min.	Dead	Massive collapse left lung	Not turned frequently enough. On left side for last 3 hours.

M...morphine sulfate  
A...atropine

later the heart stopped. Postmortem examination showed hemorrhages into the heart muscle. It is probable that our attempts at resuscitation were too rough.

We conclude from this experiment that in dogs curare does not pass the placental barriers or paralyze the uterine musculature.

In an attempt to determine the relation between the apneic dose and the lethal dose of curare 5 dogs were given massive quantities in a short period of time by means of slow intravenous drip. Controlled respiration with oxygen through an endotracheal tube was instituted and the dogs were maintained in this manner until they either recovered or died. The results are listed in Table I. One animal survived after the administration of 1 gram (25 times the apneic dose) of curare. One dog which received 4 grams of curare breathed spontaneously after 42 hours in apnea though it died after 55½ hours. The postmortem findings (including microscopic sections) were negative in all cases except those in which too much fluid was given or controlled respiration was improperly carried out. In contrast to Cole's conclusions in his article on the lethal dose of curare these findings lead us to believe that curare has no specific toxicity and that these deaths were due to failure to maintain normal metabolism. The only positive finding which might be attributed to curare is the anuria that occurred in the first animal which possibly was due to a fall in blood pressure.

#### CLINICAL USE OF CURARE

After we had satisfied ourselves that doses of curare which produce apnea are harmless provided the anesthetist cares for the patient properly, the administration of apneic doses of the drug to humans was begun. The technique as finally developed is as follows:

**Induction.** The patient is heavily medicated with a short acting barbiturate morphine and scopolamine, nitrous oxide and oxygen are administered with a face mask, and the anesthetist's ability to inflate the lungs is tested by pressure on the breathing bag. An apneic dose of curare usually 200 milligrams in adults is injected intravenously. Artificial respiration is instituted with the mask and bag when apnea develops. When the patient has reached a maximum state of relaxation, after approximately 5 minutes an orotracheal tube with an inflatable cuff is inserted and connected to a canister of soda lime and a breathing bag. Anesthesia is continued with the concentration of nitrous oxide and oxygen which has been previously found to keep the patient well anesthetized and well oxygenated. A Luer of curare is connected by means of a 3 way stopcock to a continuous intravenous drip inserted in a wrist vein in convenient reach of the anesthetist.

For use with children this technique has been varied somewhat, as described in detail elsewhere (6). Briefly the procedure consists of premedication with morphine and scopolamine.

TABLE II—TYPE OF OPERATION

	Curare-atropine-oxide		All other agents	
	Cases	Per cent	Cases	Per cent
Intrapleural	106	60.5	41	23.4
Intra-abdominal	64	36.6	187	78.5
Miscellaneous	6	3.4	7	4

mine, basal narcosis with tribromethonal (avertin) intubation with cyclopropane and maintenance of anesthesia with a high flow of nitrous oxide and oxygen in an open system. Apnea is produced and maintained with repeated doses of 30 to 40 milligrams of curare during the time the chest is open.

**Maintenance** Some adult patients will resume spontaneous respiration before the chest is entered. If the respirations are sufficiently deep to provide adequate inflation of the lungs, the patient is allowed to breathe spontaneously until the pleura is opened. After that curare is added in 20 to 40 milligram increments as necessary to produce and maintain respiratory arrest as long as the pleural cavity is open. In a completely curarized patient the usual signs of light anesthesia are masked by the muscular paralysis. Diaphragmatic contractions, slight muscular twitching movement of the facial muscles, or a rise in blood pressure indicate too light a plane of anesthesia and the need for an additional dose of morphine, preferably administered intramuscularly.

**Terminating the anesthetic** When the surgeon has effected an airtight closure of the pleura, or closure of the peritoneum in abdominal cases, pressure on the breathing bag is discontinued and the patient is allowed to build up carbon dioxide in his blood stream. If spontaneous respiration is not resumed by the time slight cyanosis occurs, controlled respiration is again instituted. This routine is repeated every few minutes until the patient breathes spontaneously. He is then allowed to breathe for himself but until the intercostal

TABLE III—COMPLICATIONS DURING SURGERY

	Curare-atropine-oxide		All other agents	
	Cases	Per cent	Cases	Per cent
Pulse rise of over 20	42	24.0	88	50.2
Blood pressure fall to below 80	24	3.7	63	36.0
Cardiac arrest during operation with recovery	3	1	2	1.1
In shock at end of operation	3	2.0	10	0.9
Died during operation	4	2.3	1	0.6

TABLE IV—POSTOPERATIVE COMPLICATIONS

	Curare-atropine-oxide		All other agents	
	Cases	Per cent	Cases	Per cent
Pulmonary	93	53.0	91	51
Circulatory	66	37.7	84	48.0
Miscellaneous	86	54.5	144	81.1

muscles are functioning adequately an occasional squeeze of the breathing bag is given in order to prevent the upper lobes from becoming atelectatic.

When the anesthetist is satisfied that intercostal activity has returned sufficiently and it is desired to terminate the anesthetic, the breathing bag is emptied and filled with air. The lungs are then manually inflated several times with air after which the breathing bag

TABLE V—INCIDENCE OF COMPLICATIONS

	Curare-atropine-oxide		All other agents	
	Cases	Per cent	Cases	Per cent
<b>Pulmonary</b>				
Cough	53	30.2	34	19.4
Obstruction	1	.5	8	4.5
Laryngitis	9	5	8	4.5
Atelectasis	7	9.7	19	10.6
Pneumonia	7	4	13	6.8
Empyema	0	0	9	5
Pulmonary embolus	2	1.1	3	2.8
Subcutaneous emphysema	4	2.3	3	1.7
<b>Circulatory</b>				
Tachycardia	57	32.5	43	24.6
Arrhythmia	6	3.4	8	4.5
Hemorrhage	0	0.0	3	1.7
Shock	3	1.7	22	12.5
Decompression	0	0	6	3.4
Coronary insufficiency	0	0	2	1.1
<b>Gastrointestinal</b>				
Emesis	43	24.6	48	27.4
Distention	20	14	26	16
Hematemesis	0	0	2	1.1
Hepatitis	0	0	1	0.5
Peritonitis	0	0	3	1.7
Bowel obstruction	0	0	7	4
<b>Nervous</b>				
Irrational	4	2.3	6	3.4
Headache	3	1.7	3	1.7
Peripheral neuritis	1	0.5	4	2.3
<b>Genitourinary</b>				
Retention	5	2.8	4	2.3
Hematuria	0	0	4	2.3
Pyelitis	0	0.0	1	0.5
Cystitis	3	2.8	4	2.3
Oliguria	0	0.5	4	2.3
Uremia	0	0	3	1.7
<b>Miscellaneous</b>				
Mediastinitis	1	0.5	0	0.0
Wound infection	3	1.7	2	1.1

TABLE VI

	Curare-nitrous oxide		All other agents	
	Cases	Per cent	Cases	Per cent
Average day of ambulation	3	37	7	7.02
Average day of discharge	14	38	19	41
Mortality in 175 cases	13	6.9	12	6.9

is disconnected from the endotracheal tube. Secretions are aspirated from the patient's tracheobronchial tree by means of a suction catheter inserted through the endotracheal tube. Secretions are similarly aspirated from the oropharynx and the endotracheal tube is removed. If the intercostal muscles have not recovered their power of contraction by the time the operation is ended, the anesthetic is stopped and the patient's lungs are inflated rhythmically with oxygen or a mixture of air and oxygen. The endotracheal tube should under no circumstances be removed or the patient returned to the ward until the anesthesiologist is satisfied that the intercostal muscles are contracting vigorously. If this rule is disregarded the patient will almost invariably develop atelectasis. Prostigmine has proved to be ineffective in our hands in hastening the return of intercostal muscle contraction.

The patient is usually awake and able to answer questions before leaving the operating table, even after operations 6 hours or more in duration. However, it must be remembered that residual muscular weakness persists for several hours and makes careful aftertreatment necessary. The patient should be placed in bed on the side operated upon and turned frequently. Coughing and deep breathing should be encouraged. Oropharyngeal oxygen should be given if indicated by the presence of dyspnea, rapid pulse, or cyanosis.

This technique has been followed through out the entire series of cases, whether or not the operation was intrapleural, in order to build as large a uniform series as possible for statistical purposes. It has proved extremely satisfactory in intrathoracic cases. Tables II to VII present a statistical comparison of the course during and after surgery of 175 patients anesthetized with nitrous oxide and given appropriate doses of curare and an equal number of patients anesthetized for similar surgical procedures with ether, cyclopropane and spinal analgesia.

TABLE VII

	Curare-nitrous oxide		All other agents	
Age				
Average	43	7 years	47	1 years
Oldest	76	years	76	years
Youngest	16	mo	6	days
Duration of operation				
Average	4	hrs. 50 min	4	hrs
Longest	10	hrs. 40 min.	9	hrs 35 min
Shortest		10 min	1	hour
Dose of curare in milligrams				
Average	253	98		
Greatest	790			
Least	20			

**Advantages.** The administration of curare with nitrous oxide anesthesia allows the use of the cautery inside the pleural cavity while the patient's respirations can be controlled by the anesthesiologist. It produces profound relaxation of the abdominal muscles. However, this can be obtained by other anesthetic agents if properly used. The patients receiving this type of anesthesia remain in a very good condition during surgery and have fewer postoperative complications than those receiving other types of anesthesia. On the average the patients who received curare and nitrous oxide were ambulated earlier and were discharged from the hospital earlier than those in the control group.

**Disadvantages.** After curare is once administered the signs of anesthesia are completely masked by the muscular paralysis. During abdominal operations there have occurred sudden unpredictable bouts of strong diaphragmatic contractions which are very disturbing to the surgeons. The contractions resemble hiccough but they may well be at times accompanied by vomiting due to too light anesthesia. Curare is masked by muscular paralysis. Curare is given intravenously, which necessitates extra equipment and personnel to set it up, and its administration may be difficult in patients with poor veins. This technique requires the use of an endotracheal tube in every patient. In order to be a safe procedure it must be used only by well trained anesthesiologists.

TABLE VIII — LIVER AND KIDNEY FUNCTION

	Average preoperative	Average postoperative
Intravenous hippuric acid— 50 cases	1.04	0.87
Phenobarbital-phthalokin— 44 cases	75.6%	73.9%



## CLINICAL RESEARCH

Considerable experimental work has been carried out on these patients who received large quantities of curare.

**Blood pressure** It was found that the rapid injection of an apneic dose of curare (200 mgm.) to an anesthetized patient was often followed by an immediate and transient fall in blood pressure. Unless the pressure was taken within the first 5 minutes after the injection this fall was missed since the pressure rose rapidly to the precurare level.

**Electrocardiograms** Electrocardiograms were taken on 30 patients during nitrous oxide anesthesia just before and about 10 minutes after the injection of 200 milligrams of curare. The cardiograms after curare showed no significant changes from those with nitrous oxide and oxygen alone. In 5 cases there was a slight lowering of the T waves after curare which the cardiologists considered of no significance. It was suggested that what slight variations occurred were probably due to a change in the position of the diaphragm after it was paralyzed by curare.

**Liver and kidney function** The liver function was tested before and after curare in 50 cases. In most cases there was a slight decrease in liver function postoperatively. The fact that these patients had many other things done to them, such as long major surgical procedures, beside the administration of curare makes the significance of this change questionable. There was no significant change in kidney function postoperatively (Table VIII).

**Blood sugar** Blood sugar determinations were made on 4 patients before and after the administration of curare. The blood sugar rise in these anesthetized patients was minimal averaging 13 milligrams per cent. This fact raises the question as to whether the much greater rise in the unanesthetized dogs may be a psychic phenomenon secondary to a rise in adrenalin.

**Consciousness** Although we do not consider it a particularly important point, we have been interested in whether or not the injection of apneic doses of curare causes loss of consciousness. One of our patients distinctly remembered being draped for an intrathoracic

operation while she was in apnea from curare. The towel clips in her skin caused no pain. This may be because she was receiving nitrous oxide and oxygen enough for analgesia, but apparently not enough to cause loss of consciousness. If the inhalation anesthesia is stopped during an operation on a patient who is apneic from curare he will squirm and move his facial muscles. We have heard on good authority of 2 patients who received apneic doses of curare: 1 for an operation and 1 simply for experimental purposes, who were conscious and remembered it afterward. In both cases the patients suffered intense mental discomfort from their complete helplessness and inability to communicate with those around them. It is for this reason that we have hesitated to administer apneic doses to a conscious person.

With small doses up to 100 milligrams which produce muscular relaxation without respiratory paralysis, there is no loss of consciousness or analgesia whatsoever. We have tested this in 3 unanesthetized patients to whom curare was administered for relief of muscle spasm.

Some anesthetists (7-8) are using large doses of curare without any anesthetic agent for anesthesia during major surgical operations. The patients seem to have no memory of the procedure. According to the reports, much larger quantities of curare are necessary to keep these patients relaxed than we have needed in patients anesthetized with nitrous oxide.

**Action on smooth muscle** The action of curare on smooth muscle is still relatively unknown. We have confirmed the report of Gross and Cullen of dilatation and atony of the intestine following the administration of a large dose of curare, and the fact that the administration of morphine will prevent this dilatation of the intestine.

**Placental transmission and action on uterine muscle** Although we hesitate to report an isolated case, the results in this instance parallel so exactly the findings in dogs that we feel they should be included.

A hysterotomy and sterilization with curare-nitrous oxide anesthesia were performed on a 19 year old epileptic girl 4½ months preg-

nant A single dose of 200 milligrams of curare was administered 5 minutes after the nitrous oxide anesthesia was begun. The baby was delivered 40 minutes after the administration of curare, and when the patient had been in apnea for 35 minutes. The baby was too small to make any respiratory efforts but all its normal reflexes (withdrawal, knee jerks etc.) were present and as active as could be expected in a normal fetus of that size. The mother's uterine muscle contracted perfectly normally. The duration of the operation was 1 hour 40 minutes, the duration of apnea 1 hour 5 minutes. The baby of course was not viable but the mother made a normal recovery.

*Action of prostigmine* After the administration of large amounts of curare over long periods of time prostigmine has proved in our hands to be completely without effect. However, after a single apneic dose of curare or after smaller doses given for muscular relaxation prostigmine seems to overcome the muscular weakness of curare quite well.

*Mortality* We believe that in no case in this series could the death of the patient be attributed to the action of curare. Two of the patients on whom thoracic operations were performed died because of inability to cough out their secretions. The surgeons suspect that continued muscular weakness from the curare was the reason. However both patients had extensive rib resections and we believe that their difficulty lay in lack of support of the chest wall rather than muscular weakness. The fact that one died 4 days and the other 10 days following surgery would seem to confirm our opinion in no case have we seen delayed or prolonged action of curare.

#### INDICATIONS FOR CURARE

*Intrathoracic operations* Curare is indicated in intrathoracic operations in which the surgeon desires to use the cautery. Here the combination of nitrous oxide anesthesia and apnea from curare provides excellent operating conditions with relaxed diaphragm and quiet mediastinum and no danger of explosion.

*Intra-abdominal operations* Curare is indicated in intra abdominal operations requiring prolonged complete muscular relaxation in pa-

tients whose condition contraindicates the use of a spinal or inhalation anesthetic in a deep enough plane to produce the degree of relaxation needed. The combination of first plane inhalation anesthesia and curare administered for relaxation certainly causes less change in pulse and blood pressure than spinal or deep inhalation anesthesia for long periods of time.

*Emergency* Curare is indicated in the emergency where relaxation is needed rapidly. This includes certain cases in which it becomes suddenly necessary to intubate a patient who is lightly anesthetized when a spinal unexpectedly wears off or when for some reason an operation which was expected to be extraperitoneal becomes intraperitoneal.

We believe that at present these are the only three indications for the use of curare in anesthesia. If it can be proved that curare does not affect the uterine muscle or pass the placental barriers in human beings, such operative deliveries as version and extraction and high forceps delivery will be added to the list. Curare should never be required for cesarean section since no muscular relaxation is necessary for this operation.

#### PREREQUISITES FOR PROPER ADMINISTRATION OF CURARE

We believe that curare is completely harmless when used by one who has sufficient understanding of its action and of human physiology to give adequate care to the patient under the influence of the drug. In the hands of technician anesthetists ignorant of its physiologic effects who use curare because of inability to produce muscular relaxation by inhalation anesthesia it is dangerous.

We believe that the anesthetist who is to administer curare, at least for intrathoracic cases should fulfill the following requirements.

First, he should have a thorough knowledge of respiratory physiology and all the changes that can take place during controlled respiration of the changes when a lung is nonfunctioning with or without its circulation intact and of how to protect normal lung tissue from contamination by secretions from diseased portions.

Second, he must be able to give good inhalation anesthesia. He must be able to relax pa-

tients with ether and cyclopropane and to give good nitrous oxide anesthesia without any hypoxia

Third, we feel that every person planning to use curare in anesthesia should learn its action without anesthesia by administering it to unanesthetized dogs. Only in this way can the differentiation between the signs of too light anesthesia and too little curare be learned

It is of the utmost importance that anesthetists using curare be thoroughly convinced that although the diaphragm has recovered its power of contraction and the patient may be able to oxygenate himself well he will die of atelectasis if controlled respiration is stopped before the intercostals have recovered. This is most forcibly impressed on an anesthetist by allowing him to curarize and maintain a few dogs alone. Sooner or later he will kill one in this manner. The postmortem findings are typical and striking. The lesson is never forgotten

The importance of postoperative care must also be stressed. Frequent turning of the patient, encouraging the patient to breathe deeply and cough and in thoracic cases the proper use of oxygen are essential

The safe use of curare depends entirely upon the knowledge of the anesthetist administering it. Its action and physiological effects should be studied by everyone who plans to use it

#### CONCLUSIONS

1. The use of curare in apneic doses is a safe procedure in the hands of a competent anesthetist. Its safety depends entirely upon the knowledge of the anesthetist administering the drug
2. The uterine muscle is probably unaffected by curare
3. Curare probably does not pass through the placenta.
4. No antidotes are of any value after the administration of large doses of curare except efficient artificial respiration until the intercostal muscles are contracting strongly
5. Curare has no delayed action or prolonged action when administered intravenously

6. The advantages of the use of curare with nitrous oxide anesthesia are (a) It allows the use of the cautery inside the pleural cavity while the patient's respirations can be controlled by the anesthetist. (b) It produces profound relaxation of the abdominal muscles for long periods of time with less change in pulse and blood pressure than other anesthetics. (c) The condition of the patient receiving this type of anesthesia remains good during surgery. (d) Fewer postoperative complications occur than with other types of anesthesia

7. The disadvantages of this technique are (a) In order to be a safe procedure it must be used only by well trained anesthetists. (b) Since the curare is administered intravenously extra equipment and hands are necessary. (c) It is necessary to use an endotracheal tube in every patient.

8. Further investigation is needed on the following points (a) lethal dose (b) action on uterine muscle and passage through placenta in human beings (c) production of unconsciousness or analgesia or both.

#### SUMMARY

A series of experiments in the administration of curare to unanesthetized dogs in doses of from 40 milligrams to 4 grams (2 to 200 c.c.) is reported

A series of 175 cases in which apneic doses of curare were administered to patients undergoing major surgical procedures with nitrous oxide anesthesia is reported and compared with a similar series of cases in which other types of anesthesia were used

#### REFERENCES

- BERNARD, C. *Leçons sur les substances toxiques*. Paris, 1857
- COLLE, F. *Anesthesiology* 1945, 7, 90.
- FETTERBERG, S., and PICK, E. P. *Proc. Soc. Exp. Biol. N. Y.*, 1942, 49, 654-656
- GROSS, E. G., and COLLIER, S. C. *Anesthesiology* 1945, 6, 3, 238.
- FAKTO, A. *Arch. ges. Physiol.* 1940, 233, 40-46.
- STEFANOFF, H. B., HARRISON, P. and BACKUS, F. E. *J. Thorac. Surg.* in press.
- WHITTAKER, R. J. and FISHER, A. J. *Ohio M. J.* 1944, 40, 1, 55-57.
- Idem. *Anesthesiology* 1945, 6, 124, 90.

# PREINFUSION—A STUDY IN THE PREVENTION OF HEMORRHAGIC SHOCK

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THE best treatment of shock is its prevention, for shock is more easily prevented than treated. This is the consensus of most workers who have studied shock in man or animal. We had noticed earlier that dehydrated animals succumbed to hemorrhagic shock sooner than well hydrated animals, and that they tolerated concentrated plasma or albumin solutions less than well hydrated animals (13). This observation led to our present work. We have attempted during the last 2 years to prevent hemorrhagic shock in dogs either by preinfusion or by increasing the quantity of fluid reinfused during experiments with graded repeated hemorrhages. No systematic study on this problem was known to us until our work was completed when Ingraham and Wiggers reported 'fluid priming' with saline solution as having a favorable effect in hemorrhagic shock in dogs. Prinzmetal and collaborators mention briefly that saline solution given to mice prior to scalding decreased mortality.

Surgeons have long recognized that dehydrated patients are poor operative risks and preoperative infusions and infusions during severe operations are being used widely. We are concerned here only in this part of preoperative care but we want to stress the importance of an adequate plasma albumin level as an important factor in the retention in the circulation of infused sodium chloride solution. At the same time particular care must be exercised in the calculation of the amount of infusion fluid, because the patient may suffer from an excess of fluid infusion. Patients may appear normal clinically before operation but yet may go into shock easily. This may be due to lack of fluid reserves or to a condition

of impending shock, where disease may have depleted reserves and diminished the resistance of the patient. Yet, blood pressure and pulse and most other determinations may yield normal values. Estimation of the blood volume and of the thiocyanate space may reveal a deficiency but these tests are difficult and normal standards and deviations are equivocal. For this reason the value of a preinfusion should be weighed for every patient on whom a major operation is planned.

## METHODS

The method employed for the production of hemorrhagic shock in the unanesthetized dog has been described previously (1). In short, it consists in the hourly withdrawal of 25, 23, 21, 19, and 17 per cent of the measured blood volume and of the reinfusion of the amounts withdrawn (minus 2 per cent of each hemorrhage which is used for determinations) after an interval of 30 minutes between bleeding and reinfusion. The condition of the animals with regard to resistance to shock could be estimated by determining the arterial carbon dioxide content 30 minutes after the first hemorrhage. These critical carbon dioxide values permitted the prediction of the period of survival and the grouping of the animals according to their resistance to the experimental procedure.

In the present work the following modifications of the graded hemorrhage were employed in different groups of animals. (A) Preinfusion of an amount of fluid equivalent to 15 percent of the control plasma volume. The duration of the preinfusion was 30 minutes. In one group of animals the first hemorrhage was performed 5 minutes after the end of the preinfusion and in another group the first hemorrhage was performed 2 hours after the preinfusion. (B) Infusion of an amount of fluid equivalent to 15 percent of the con-

From the Sempel Deutsch Serum Center and from the Department of Gastro-Intestinal Research of Michael Reese Hospital.  
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TABLE I—EFFECT OF PREINFUSION WITH SA LINE OR WITH GELATIN ON THE CRITICAL ARTERIAL PLASMA CARBON DIOXIDE OF DOGS SUBJECTED TO ONE HEMORRHAGE OF 25 PER CENT OF THEIR BLOOD VOLUME

No. of Dogs	Procedure	Per cent of dogs with critical arterial plasma CO <sub>2</sub> of		
		Below 80	80-90.5	90 and above
5	All controls	27	49	24
	Control subgroup	20	44	27
5	Control subgroup	3	67	30
	Control subgroup 2	23	42	5
Preinfusions given before first hemorrhage				
26	Saline 3 minutes before	9	27	34
5	Gelatin 3 minutes before		44	56
6	Saline 2 hours before	3	20	3
7	Gelatin 2 hours before		47	53

control plasma volume in addition to the 23 per cent routinely administered at the time of the first reinfusion. The preinfusion fluid or the additional fluid infused were either saline solution 0.9 per cent, or gelatin solution. The gelatin employed was pigskin gelatin specially manufactured for biological use 8 per cent in 0.9 per cent saline adjusted to pH 7. The gelatin solution was sterile pyrogen free and nontoxic. Blood pressures were recorded continually from one carotid artery. Blood was withdrawn from one cannulated femoral artery. The following determinations were performed. During the control period and following the last (5th) hemorrhage plasma volume hematocrit hemoglobin sedimentation rate, total plasma proteins (including gelatin) albumin and globulin and arterial plasma carbon dioxide content. Arterial plasma carbon dioxide content was determined also 30 minutes after each hemorrhage, and 30 minutes after each reinfusion. The methods employed in these determinations have been described (11, 17).

The effectiveness of the preinfusion or of the larger first reinfusion were determined by comparing survival times and critical carbon dioxide values with the corresponding data of control experiments with simple graded hemorrhage as described above. Con-

trol experiments were repeated regularly during the presently reported series of experiments in order to rule out seasonal or other variations. All data were treated statistically by the chi square test, by the T test (7) or by the u test (22) and when the differences are called significant in this paper it means that they were statistically significant as indicated by these tests.

## RESULTS

*A Preinfusion* In Table I the effect of preinfusions on the critical carbon dioxide values are compared with the "critical" carbon dioxide values in 215 control animals not receiving a preinfusion. The control subgroups 1 to 3 in Table I are unselected groups of control animals used consecutively but each group of experiments was performed at different times of the year. The size of each group was of the order of magnitude of the groups that received preinfusions. The distribution of the critical carbon dioxide values in the 3 smaller control groups did not differ statistically from the distribution obtained in the total control group of 215 animals.

We have presented evidence (1) that the arterial plasma carbon dioxide values, taken  $\frac{1}{2}$  hour after a rapid hemorrhage of 25 per cent of the measured blood volume can be used to predict the resistance of the animal to further hemorrhages and to judge the effectiveness of blood or plasma substitutes. The lower this critical carbon dioxide the less resistant the dog will be to further hemorrhage or to substitution therapy. Comparing the distribution of carbon dioxide values in the control group with those of all preinfusion groups, it is evident that a shift of distribution to the right, i.e. a greater incidence of higher carbon dioxide values, has occurred. This is particularly true and significant in the case of the gelatin preinfusions 5 minutes or 2 hours before the first hemorrhage. Saline preinfusion was significantly effective only when given 5 minutes before hemorrhage, but not, when given 2 hours before the hemorrhage.

The higher plasma carbon dioxide values following preinfusions signified that the prob-

By Dr. H. Silverstone, Department of Cancer Research at Michael Reese Hospital.

ability of survival would be increased. However it was considered possible that some of the fluids given as preinfusions might produce only a temporary rise of the carbon dioxide which thus might not truly indicate actual survival as established by the control experiments. In order to answer this question we have tabulated our experiments according to the length of survival in Table II. The experiments with 5 hemorrhages and 5 reinfusions lasted 5 hours including the preliminary control period. Thus, "died during the experiment" denotes death between 1 and 4½ hours after the first hemorrhage. "Died during the night" denotes that the animal died between 3 and 15 hours after the termination of the experiment. "Survived +24 hours" denotes that the animal lived 24 hours or more after the termination of the experiment. In general the latter group of animals survived indefinitely, and most of those that died succumbed to pneumonia or to other diseases that had no direct relation to the experiment. In some animals an early infectious process like distemper may have been present before the experiment.

The control group of 41 dogs did not receive a preinfusion, and was subjected to the standard procedure of repeated hemorrhage and reinfusion of their own blood, as described above under "Methods." Preinfusion with 0.9 per cent saline 2 hours before the first hemorrhage did not benefit the animals at all but preinfusion with saline solution 5 minutes before the first hemorrhage increased survival through the experimental period somewhat. Preinfusion with gelatin solution administered 5 minutes before the first hemorrhage, significantly increased ultimate survival. Preinfusion with gelatin, given 2 hours before the first hemorrhage, did not increase ultimate survival, but increased survival through the experimental period.

Animals which, ½ hour after the first hemorrhage, have plasma carbon dioxide values of 20 volumes per cent and below have very little probability of survival under the conditions of our control experiments, than those with carbon dioxide values above 20 volumes per cent. The percentage of dogs with carbon dioxide values above 20 per cent

TABLE II—EFFECT OF PREINFUSION WITH SALINE OR WITH GELATIN ON SURVIVAL OF DOGS SUBJECTED TO GRADED HEMORRHAGE AND REINFUSION WITH THEIR OWN BLOOD

No. of Dogs	Procedures	Per cent of dogs that		
		Died		Survived +24 hours
		During experiment	During night	
4 (7) *	Control	44	20	36
Preinfusions given before first hemorrhage				
26 (83)	Saline 5 minutes before	16	16	48
5 (100)	Gelatin 5 minutes before	24	6	60
6 (87)	Saline 2 hours before	5	20	5
7 (100)	Gelatin 2 hours before	8	25	47

(\*) Per cent of dogs with plasma carbon dioxide values above 20 volumes per cent.

(shown in brackets in Table II) was greater in those animals that received preinfusions than in the controls. Seventy-one per cent of the 41 control dogs of Table II have carbon dioxide values above 20 volumes per cent. When preinfusions had been given the following changes were observed: 85 per cent of the 26 dogs preinfused with saline solution 5 minutes and 87 per cent of the 16 dogs preinfused with saline 2 hours before the first hemorrhage had carbon dioxide values above 20 volumes per cent. The corresponding values were 100 per cent of all dogs preinfused with gelatin 5 minutes or 2 hours before the first hemorrhage.

Corresponding to the tendency to elevate the carbon dioxide value, the preinfusion tended to increase the survival time of the experimental animal.

**B. Additional infusion.** In the preceding experiments, preinfusion was given before the first (critical) hemorrhage and before the critical posthemorrhage carbon dioxide determination had been performed. Therefore the effect of such preinfusion on the resultant critical carbon dioxide values could be indirectly determined only by comparison with expectancy in normal controls as explained above. In order to evaluate the effect of infusion on the survival of dogs with a known critical carbon dioxide level uninfluenced by previous infusions a different procedure

was designed. Dogs were subjected to the first hemorrhage and the critical carbon dioxide was determined. Then at the time of the first reinfusion a volume of 8 per cent gelatin solution amounting to 15 per cent of the measured control plasma volume, was given in addition to the returned 23 per cent of the dog's own blood. In order to test the value of this procedure rigidly only animals with a critical carbon dioxide below 20 volumes per cent were used. The control and the experimental group contained 16 dogs each. The mean survival time of the animals that died in less than 24 hours was  $4.2 \pm 1.1$  hours for the control group and  $7.2 \pm 1.2$  hours for the experimental group. Only 4 animals of the control group and 6 animals of the group with additional infusion survived the experimental period of  $4\frac{1}{2}$  hours. The difference between these values approaches significant difference. In view of this it is believed that additional infusion may have some value. We did not find a significant increase in indefinite survival by this procedure. As already explained the probability of survival of animals with low arterial posthemorrhage plasma carbon dioxide values is small and possibly experimental conditions in these experiments were too severe. The mean carbon dioxide values following the second hemorrhage were significantly higher than those following the first hemorrhage in the animals which received the additional infusion while those of the control group were lower.

#### DISCUSSION AND CONCLUSIONS

While we feel that we have demonstrated the usefulness of preinfusion we want to stress that we do not advocate indiscriminate or excessive use of infusions before or during operations. Others have covered the field of water balance adequately and we refer to their papers (2-6 8 15 16 18 21). Our results indicate also that in the case of persons exposed to the dangers of shock proper water reserves are essential. If a surgical patient has lost blood or excessive body fluid before operation or if a seriously sick patient is in impending shock or already in shock before operation he must be treated according to the estimated or measured losses of fluid hemo-

globin, plasma proteins, and salts, and does not fall into the category of preinfusion cases. In the preparation of surgical patients for major operations, most surgeons use 0.9 per cent saline or 5 per cent glucose or a mixture of both. If our experience in the dog can be applied to the human, gelatin solution can be recommended as superior to the crystalline solutions. This is especially true, when the solutions are given up to 2 hours before operation. It is generally agreed that crystalloid solutions rapidly leave the circulation of an animal in shock (8) and we have confirmed this earlier in our work (14). In normal man, infused saline solution cannot be found in the circulation approximately 2 hours after infusion (9). When there is an increased permeability of the capillaries or when the plasma proteins fall below a critical level, saline is especially contraindicated as an infusion fluid. Infusion of an excessive amount of saline not only tends to produce edema in a patient with a critically low albumin level, but it also further depletes the plasma proteins by washing them out into the tissue spaces as the saline rapidly leaves the circulation (2). In our experience infusing gelatin solutions to nephrotic patients with a marked edema and a critically low albumin level at times was followed by diuresis and reduction of edema. Gelatin solutions never were found to produce edema in man or in the dog.

It would seem practical therefore, to recommend the use of gelatin as preinfusion fluid before operations, and as infusion fluid during operations beginning the preinfusion only shortly before operation. In our previous work (12) and in present work under publication we have gained the impression that in man and in the dog the preparation of gelatin used was harmless even in large amounts. We have not used regularly repeated massive injections of gelatin however and it may be that difference of opinion with regard to noxious effects of gelatin infusion may be related to this factor in combination with the brand of gelatin employed (20). We have used a volume of 15 per cent of the measured plasma volume for preinfusion. This amount was found by experimentation to be optimal when infused over a 30 minute period. It

seems reasonable to assume that, in case of man, 15 per cent of the plasma volume may be taken as a starting point for the establishment of the amount of preinfusion to be used routinely. Thus in a person weighing 60 kilograms, assuming a blood volume of  $1/13$ th of the body weight a total blood volume of 4.62 liters, and a plasma volume (assuming a hematocrit value of 45) of 2.54 liters are calculated. A preinfusion of 15 per cent of the plasma volume would constitute 381 cubic centimeters of a gelatin solution. This is not a large volume and we know that some surgeons use much larger volumes of saline or saline glucose solution, preoperatively. However some give the solutions subcutaneously and we have no experimental results to discuss this. We can state however, that the practice of giving solutions 12 hours in advance of an operation as used by some surgeons, does not offer any advantage in the light of our results on the dog. We have found that gelatin solutions, due to their colloidal properties, stay in the circulation for longer periods of time than do crystalline solutions and that therefore smaller volumes of gelatin than of crystalline solution may be infused in the preoperative patient.

We want to suggest that gelatin solution for preinfusion or for infusion during operation is better than saline or glucose infusion but not better than infusion of blood or plasma. However, where economic considerations or expediency of administration plays a rôle as in emergency accident cases we have used gelatin solutions extensively supplemented occasionally by packed red cells and have had gratifying results.

#### SUMMARY

Preinfusions of saline solution 0.9 per cent or of gelatin solution 8 per cent, given immediately before the first of a series of graded hemorrhages and reinfusions in the dog increased significantly the mean critical plasma carbon dioxide values 30 minutes after the first hemorrhage. Survival times were

prolonged significantly by the gelatin solution but not by the saline solution.

In the case of preinfusions given 2 hours before the first hemorrhage only the gelatin solutions were found beneficial in raising plasma carbon dioxide values and prolonging survival times.

When dogs with low 'critical' plasma carbon dioxide values were reinfused with their own blood plus an extra volume of gelatin solution, their survival times were prolonged.

The application of the data to the surgical patient is discussed.

#### REFERENCES

1. ARIMOTO F., NECHELES, H., LEVINSON S. O., and JANOTA MARTHA. *Am. J. Physiol.*, 1945, 143, 198.
2. BLALOCK, A. *Principles of Surgical Care*. St. Louis: The C. V. Mosby Co. 1940.
3. CARE, J. L. *Surg. Gyn. Obst.*, 1944, 79, 458.
4. COLLIER, F. A., DICK, V. S. and MADDOCK W. G. *J. Am. M. Ass.*, 1936, 107, 1522.
5. COLLIER, F. A., and MADDOCK, W. G. *Surg. Gyn. Obst.*, 1940, 70, 340.
6. ELKINGTON J. R., GILMOUR, M. T., and WOLFE W. A. *Ann. Surg.*, 1939, 110, 1050.
7. FISHER, R. A. *Statistical Methods for Research Workers*. London: Oliver and Boyd, 1934.
8. HARRIS, H. N. and McCLELL, R. D. *Ann. Surg.*, 1941, 114, 801.
9. HILL, D. E., McMICHAEL, J. and SHARPEY SCHAEFER E. P. *Lancet*, Lond., 1940, 259, 774.
10. INGRAHAM, R. C., and WIGGERS, H. C. *Am. J. Physiol.*, 1945, 144, 505.
11. JANOTA, MARTHA. *J. Lab. Clin. M.*, 1943, 28, 1981.
12. JANOTA, M., NECHELES, H., WESTON, R. E., WEISBERG V. and LEVINSON S. O. *Exp. Med. Surg.*, 1943, 1, 298.
13. LEVINSON S. O., JANOTA, MARTHA, WESTON R. E. and NECHELES, H. *Surg. Gyn. Obst.*, 1943, 77, 475.
14. LEVINSON, S. O., NEUWELT F. and NECHELES, H. *J. Am. M. Ass.*, 1940, 114, 455.
15. MADDOCK, W. G. and COLLIER F. A. *Ann. Surg.*, 1940, 113, 520.
16. Idem. *J. Am. M. Ass.*, 1937, 108, 1.
17. NECHELES, H., LEVINSON, S. O., JANOTA, MARTHA, WESTON R. E. and WEISBERG V. *Surg. Gyn. Obst.*, 1943, 77, 337.
18. PETERS J. P. *Body Water: The Exchange of Fluids in Man*. Springfield, Ill. Charles C. Thomas, 1935.
19. PRINCETAL, M., HECHTER, S. O., MARGOLIS C., and FEIGEN G. *J. Am. M. Ass.*, 1943, 122, 720. *J. Clin. Invest.*, 1944, 23, 205.
20. ROSSIGNOL ROBBINS, R. S., MILLER L. L. and WHITFIELD, G. H. *J. Exp. M.*, 1944, 80, 145.
21. SCUDDER, J. and SELT E. N. *England J. M.*, 1941, 215, 679.
22. SMITH J. H. *Tests of Significance: What They Mean and How to Use Them*. Vol. 10, no. 1. Chicago: The Univ. of Chicago Press, 1939.



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#### REFERENCES

1. ARIMOTO, F., NECHELES, H., LEVINSON, S. O. and JANOTA, MARTHA. *Am. J. Physiol.*, 1945, 143, 198.
2. BLALOCK, A. *Principles of Surgical Care*. St. Louis: The C. V. Mosby Co. 1940.
3. CARR, J. L. *Surg. Gyn. Obst.*, 1944, 79, 438.
4. COLLIER, F. A., DICK, V. S., and MADDOCK, W. G. *J. Am. M. Ass.* 1936, 107, 1522.
5. COLLIER, F. A. and MADDOCK, W. G. *Surg. Gyn. Obst.* 1940, 70, 340.
6. ELLINGTON, J. R., GILMOUR, M. T., and WOLFE, W. A. *Ann. Surg.* 1939, 110, 1050.
7. FISHER, R. A. *Statistical Methods for Research Workers*. London: Oliver and Boyd, 1934.
8. HARRIS, H. N., and McCURR, R. D. *Ann. Surg.* 1941, 114, 801.
9. HILL, D. K., McMICHAEL, J. and SHARPEY SHAFER, E. P. *Lancet*, Lond., 1940, 239, 774.
10. INGRAHAM, R. C. and WIGGERS, H. C. *Am. J. Physiol.* 1945, 144, 505.
11. JANOTA, MARTHA. *J. Lab. Clin. M.*, 1943, 28, 1281.
12. JANOTA, M., NECHELES, H., WESTON, R. E., WEISSMAN, V. and LEVINSON, S. O. *Exp. Med. Surg.* 1943, 1, 208.
13. LEVINSON, S. O., JANOTA, MARTHA, WESTON, R. E. and NECHELES, H. *Surg. Gyn. Obst.*, 1943, 77, 475.
14. LEVINSON, S. O., NEUWELT, F., and NECHELES, H. *J. Am. M. Ass.* 1940, 114, 455.
15. MADDOCK, W. G. and COLLIER, F. A. *Ann. Surg.* 1940, 112, 520.
16. *Ibid.* *J. Am. M. Ass.* 1937, 108, 1.
17. NECHELES, H., LEVINSON, S. O., JANOTA, MARTHA, WESTON, R. E., and WEISSMAN, V. *Surg. Gyn. Obst.*, 1943, 77, 337.
18. PLETTERS, J. P. *Body Water: The Exchange of Fluids in Man*. Springfield, Ill.: Charles C. Thomas, 1935.
19. PRIDEMETAL, M., HECHTER, O., MARCOLES, C., and FEIGEN, G. *J. Am. M. Ass.* 1943, 122, 720. *J. Clin. Invest.*, 1944, 23, 295.
20. ROBSCHTITZ ROBBINS, R. S., MILLER, L. L. and WHITFIELD, G. H. *J. Exp. M.*, 1944, 80, 145.
21. SCUDDER, J. and SELF, E. N. *England J. M.*, 1941, 225, 679.
22. SMITH, J. H. *Tests of Significance: What They Mean and How to Use Them*. Vol. 10, no. 1. Chicago: The Univ. of Chicago Press, 1939.

# EDITORIALS

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APRIL, 1947

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### CONGENITAL ATRESIA OF THE ESOPHAGUS WITH TRACHEOESOPHAGEAL FISTULA

THE last decade has witnessed the inclusion of several types of intrathoracic anomalies in the realm of congenital lesions amenable to surgical correction. Among these are certain malformations of the esophagus, heart, and great vessels. The most frequent type of esophageal anomaly occurs in a characteristic form in approximately 90 per cent of the cases. This form consists of an atresia of the esophagus at a level corresponding to the junction of its upper and middle thirds. In addition there is a fistulous communication between the trachea and the upper end of the lower esophageal segment. Recognized by Gibson two hundred and fifty years ago, the lesion resisted surgical correction until 1939, when Leven and Ladd independently and almost simultaneously employ-

ed similar techniques and successfully circumvented the anomaly by a multiple stage operation consisting of gastrostomy, ligation and division of the tracheoesophageal fistula, and cervical esophagostomy. This procedure proved to be life-saving although it presented the additional problem of an eventual antithoracic esophagoplasty. Two years later the reconstruction of intrathoracic esophageal continuity by means of a single stage operation was successfully accomplished. This procedure has proved to be practicable and more satisfactory than has any other for a large majority of the cases for which surgical correction is undertaken.

With the realization that surgical correction offers considerable promise of cure, there has been an awakening of interest in the diagnosis of the anomaly. Even so, the period of time has been so short since surgical correction became available that the true incidence of the anomaly has not as yet been determined. It is known, however, that among the residents of the relatively small county in which the author resides, eight cases have been verified in the last eleven years, an incidence rate of one in 2,196 newborn infants.

The diagnosis of the typical form of the anomaly presents no great difficulty, as the atresia of the upper esophagus can be readily determined by the failure of a catheter to pass into the stomach. As the remote possibility of a partial esophageal obstruction with a diameter less than that of the catheter must be excluded, the completeness of the obstruction can be determined by roentgenography following the ingestion of iodized oil. In the presence of a complete esophageal obstruction the finding of air in the gastrointestinal tract

is indicative of a fistulous communication between the trachea and the lower esophageal segment

The most frequent variation of the anomaly consists of an esophageal atresia without air in the gastrointestinal tract. The failure of air to enter the stomach is due to a tracheoesophageal fistula of smaller than average size or more commonly to a rudimentary lower esophagus which does not communicate with the trachea. Tracheoscopy is helpful in such cases in order to determine whether a fistula is present or absent. A considerably less frequent variation consists of the typical anomaly with an additional fistula between the proximal esophagus and trachea. The superior fistula in this instance can be recognized by roentgen examination with ingested iodized oil or by endoscopy. Tracheoesophageal fistula unassociated with atresia is also infrequent. The diagnosis is not evident from the passage of a catheter since the esophagus is patent but is readily apparent on endoscopy or on roentgen examination with iodized oil with the patient in a prone position.

The important factors in the evaluation of operability are the size and general condition of the patient and the presence of any other anomalies. The incidence of prematurity in infants with esophageal atresia is considerably greater than in normal infants; those premature by more than three or four weeks and whose weight is less than four and a half pounds have in general a less favorable prognosis than full term infants of normal size. The outcome following surgical correction is particularly dubious in the listless premature infant who has a feeble cry and is unable to clear the respiratory tract of secretions. In the full term infant atelectasis or pneumonitis can usually be corrected thereby presenting no contraindication to operation. Associated congenital anomalies with the exception of a

certain few of the cardiovascular system have been infrequent and are usually compatible with life.

The most rational procedure for the correction of the typical anomaly consists of an intrathoracic restoration of esophageal continuity. This operation is preferably performed through a right sided extrapleural approach. In spite of the small size of the infants, the exposure is entirely adequate. Division of the azygos vein is not required except in the rare instances in which the fistula enters the trachea at its bifurcation. The operation consists of transection of the lower esophagus at its junction with the trachea and closure of the opening into the trachea by suture. The lower end of the upper esophageal segment is opened to a diameter corresponding to the small diameter of the lower esophageal segment and an anastomosis is made. The practicability of this plan in a large percentage of the cases is evidenced by the fact that since 1939 an intrathoracic anastomosis has been possible in approximately 76 per cent of the forty two patients operated upon in a clinic where intrathoracic reconstruction is attempted if at all feasible. An intrathoracic anastomosis has usually been possible when air is present in the gastrointestinal tract before operation (83.3 per cent) and it has only rarely been possible in those cases without air in the stomach or intestines (20 per cent).

There is necessarily a predisposition to leakage at the site of the anastomosis if too great tension is present or if the wall of the lower esophageal segment is unusually thin. The resultant fistula to the exterior by way of the extrapleural wound invariably heals spontaneously. Although a stricture forms at the site of the anastomosis in such cases it is short and can be dilated successfully with a good functional result. A less frequent but more serious possibility following leakage of



civilian surgeons and training institutions and little opportunity for further training was offered him.

When General Omar Bradley assumed responsibility of the Veterans Administration and placed General Paul R. Hawley in charge of the hospital program they realized that a change of policy would be necessary to meet the greatly increased demands placed upon Veterans hospitals by the addition of all World War II veterans. It would have been impossible, under any circumstances, to secure the services of a sufficient number of full time physicians as Veterans Administration employees to meet existing needs alone without considering the rapidly expanding program. Therefore they sought the co-operation of the medical schools of this country and established what is spoken of as the Deans' committee program. Under this program, those medical schools, through their deans which are so geographically located and adequately staffed to undertake the program have assumed responsibility for the professional care of patients and for a resident training program in a number of Veterans Administration hospitals.

Under the supervision of Doctor Paul B. Magnuson, acting assistant medical director for Research and Education, the program has been expanded so that fifty-six class A medical schools in the country already are participating and a large number of Veterans hospitals are so administered.

Although individual variations in the Deans' committee programs exist in different medical schools, it is believed that the basic aims and functions are quite similar. The program now in operation at the Veterans Administration Hospital, Hines, Illinois, is fairly representative of most such programs and a brief discussion of its operations will be presented. This discussion will be limited to the surgical division of the hospital.

In order to render the best professional care to patients and to establish a well functioning resident training program it was necessary to establish general and specialty surgical services and attempt to place patients on services best suited to the care of their disease. After carefully analyzing figures on the admissions and duration of hospital stay of patients with varying surgical demands, it was decided that the needs of the Hospital could best be served by dividing the one thousand available surgical beds as follows: general surgery, 300; orthopedic surgery, 150; urology, 100; otolaryngology (including malignant tumors of these anatomical regions), 100; ophthalmology, 50; plastic surgery, 50; vascular surgery, 50; tumor service, 150; women's surgery, 50. Independent services in thoracic surgery and neurological surgery were established in another section of the Hospital.

It is the responsibility of the Deans' Committee representing Northwestern University, the University of Illinois and Loyola University Colleges of Medicine to recommend the appointment of a sufficient number of attending surgeons to render the best possible professional care and to train the residents adequately. It is required that all attending surgeons be veterans of World War II, be certified by their respective qualifying board or have equivalent training and be a faculty member of a participating medical school. Each surgeon must assume responsibility for the patients placed under his care and he must spend an adequate amount of time at the Veterans Hospital to carry out his responsibilities. The great majority of surgeons spend five half days per week at the Hospital. Each one has assigned to him one or more residents and a designated number of beds depending upon the number of patients that can satisfactorily be cared for by one surgeon and his resident staff. This varies with different special



surgeons, a large staff of consultants are available for lectures and demonstrations in fields in which these consultants have gained renown.

Men who desire training in the special fields of surgery are first assigned to general surgical services for a varying length of time in order to teach them the principles of surgery and of surgical technique before assigning them to their chosen field.

Of nearly one hundred and thirty residents on duty at this Hospital, sixty are being trained in surgery and the surgical specialties. With similar programs in a large number of Veterans Administration hospitals being administered by Deans' committees of various medical schools a great many World War II

veterans are having opportunities for graduate training and specialization which they would otherwise be denied.

The chief function of Veterans Administration hospitals is to administer the best possible care to men who have served their country in the armed forces and who are in need of such service. The newly created program not only is offering excellent training opportunities but is providing the veteran patient with the services of the best medical talent in the country, and is rendering him the best obtainable professional care. The greater efficiency resulting in a more rapid turnover of patients is permitting existing facilities to care for a far greater number of veterans than was true in the past.

CHARLES B. PUESTOW





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## CORRESPONDENCE

### ANTERIOR TRANSPLANTATION OF POSTERIOR DELTOID FOR SHOULDER PALSY AND DISLOCATION IN POLIOMYELITIS

—A Correction.

*To the Editor* In connection with my article on the transplantation of the origin of the posterior deltoid for Shoulder Palsy and Dislocation from Poliomyelitis," it should be pointed out that Dr Frank R. Ober of Boston referred to this method which he had evidently used several times in "Lectures on Reconstruction Surgery of the Extremities of the American Academy of Orthopedic Surgeons, 1944. Although this reference was included in my article specific reference to the date of Dr. Ober's

publication was not available except to those readers who wished to develop the matter thoroughly through familiarity with the references included.

In a personal communication from Dr. Ober dated January 22, 1947, he states that he had performed the operation at least 12 years ago, which would antedate my performance of the operation on April 6, 1942. I feel that Dr. Ober should have been credited for prior publication of the method. My purpose in publishing this case report was to establish the permanency of the end-result and to point out the utility of the operation in the cure of recurrent paralytic dislocation of the shoulder for which purpose it was quite effective in the case recorded.

PAUL H. HARMON, M.D.

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**VARICOCELE SEMIOLOGIA Y CIRUGIA.** Dr. Ricardo Bernardi. Buenos Aires: Libreria "El Ateneo" Editorial, 947.  
**PENICILLIN IN SYPHILIS.** By Joseph Earle Moore, M.D. Springfield, Ill.: Charles C. Thomas, 946.

**RADICAL SURGERY IN ADVANCED ABDOMINAL CANCER.** Alexander Brunschwig, M.D. Chicago: The University of Chicago Press, 947.

**PRACTICAL PHYSIOLOGICAL CHEMISTRY.** Philip B.

Hawk, Ph.D., Bernard L. Oser, Ph.D. and William H. Sumner, Ph.D. 8th ed. Philadelphia, Toronto: The Blakiston Co., 1947.

**THE PERIPHERAL CIRCULATION IN HEALTH AND DISEASE; A STUDY IN CLINICAL SCIENCE.** By Robert L. Edwards, M.D. Foreword by J. R. Leatham, C.M.E. Ch.M., F.R.C.S.E. Baltimore: The Williams and Wilkins Co., 946.

**PHYSICAL EXAMINATION OF SELECTIVE SERVICE REGISTRANTS IN THE FINAL MONTHS OF THE WAR.** An analysis of National and State Data. January 1944—August 1945. Washington, D.C.: National Headquarters Selective Service System, June 1946.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

## THE SURGICAL FORUM

OWEN H. WANGENSTEIN M.D. F.A.C.S. Minneapolis, Minnesota

THE Forum on Fundamental Surgical Problems was instituted by the Board of Regents of the American College of Surgeons to provide an opportunity especially to the younger surgical group for the presentation of the results of original clinical and experimental research. The success of the undertaking appears to have been well established in its first session held in conjunction with the Clinical Congress in Boston in October 1941. The long war years interrupted further meetings until the December 1946 assembly of the Clinical Congress in Cleveland. The promise held out by the Boston meeting 5 years earlier for a keen interest on the part of practicing surgeons in the type of program provided for in the Surgical Forum was again demonstrated in the Cleveland sessions.

The Surgical Forum affords a large surgical audience the opportunity to become acquainted with the work of many productive clinical and experimental investigators through the medium of the concise presentation at the same time it accords a number of young well trained surgeons their first opportunity of a hearing before a national surgical organization. In the past, not infrequently young surgeons have found it necessary to have their work receive recognition before another audience before surgeons would deign to hear them. The late William J. Mayo felt keenly that the wisdom of age and experience should be exchanged freely with the enthusiasm of youth and that both old and young would benefit by the barter. In the main the most original contributions to surgery are made by young men. For the improvement of surgery as well as the enlightenment of surgeons with

greying hair and other marks of advancing years it is important that young productive workers in surgery be provided an opportunity early in their careers for active participation in surgical gatherings—before the ravages of time dampen their enthusiasm.

Furthermore surgeons are not long the best company for one another. Surgeons need the vitalizing influence which comes from association with workers in other fields of medicine. Hence, programs constituted year after year only from the membership of a like-minded group of men such as surgeons are likely to reveal traces of nutritive deficiencies. No group of medical men can suffer isolation long without exhibiting unmistakable evidences of want. Recognizing the great importance to surgeons of the life-giving spirit and vital sustenance to be gained through association with fellow workers in the broad domain of medicine the Board of Regents of the American College of Surgeons has authorized inclusion of papers of general interest to surgeons emanating from the pens of investigators in other provinces of medicine. The interests of the membership of a large organization are served best by provision for the most original and stimulating papers that come within the scope of concern of its auditors and that are pertinent to the occasion. It is unimportant whether the papers come from within the membership or by invitation to nonmembers. In subsequent sessions it is to be hoped that surgeons may have the opportunity of hearing similar presentations from the fruitful labors of young bacteriologists, biochemists, physiologists and pathologists especially in fields where the work touches the interests of the surgeon.

It is the professed purpose of the Surgical Forum to attempt to bring before its assembly

Chairman, Committee on Forum on Fundamental Surgical Problems.



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## COLLECTIVE REVIEW

### THE COURSE OF HYPERTENSION AFTER NEPHRECTOMY FOR ADVANCED UNILATERAL RENAL DISEASE

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IT is now more than 8 years since Butler reported successful treatment of hypertension in 2 children by nephrectomy for advanced unilateral pyelonephritis and since Walters and one of us (Barker) reported a similar result after removal of a kidney seriously damaged by chronic atrophic pyelonephritis in an adult. Since that time there have been a number of reports on the incidence of unilateral renal disease among patients who had hypertension and on the results of removal of the affected kidney. It is apparent that excellent results have followed nephrectomy in some cases and that there has been no effect on the hypertension in others.

For a patient whose primary complaints or symptoms are definitely related to an advanced surgical lesion of one kidney and who has incidental hypertension the immediate therapeutic problem is simple since nephrectomy probably would be necessary whether or not hypertension was present.

However in the treatment of a patient whose presenting problem is hypertensive disease and who does not have symptoms or physical signs suggestive of localized renal

disease the internist and urologist are confronted with two questions. First, should a urographic examination be made? Second if it is made and if local or diffuse disease of one kidney is found should the patient be subjected to nephrectomy primarily as treatment for the hypertension?

The incidence of so-called surgical renal lesions in cases of hypertension was at first considered to be high some observers stating that the lesions occurred in approximately 40 per cent of cases. It soon became apparent, however that in some cases of hypertension minor lesions of the kidney were found which were coincidental and not etiologic factors. This group included such renal lesions as ptosis, pyelectasis of slight or moderate degree, urinary infection and renal lithiasis without significant renal destruction. It has also become apparent that significant lowering of blood pressure rarely has followed nephrectomy unless the kidney was badly diseased as the result of either chronic infection such as pyelitis and severe hydronephrosis or extensive chronic renal tuberculosis. Even when such advanced lesions of the kidney have been found in patients who have hypertension, the effect on the blood pressure of removal of the involved kidney has been rather variable.

From the Division of Medicine and the Section on Urology  
Mayo Clinic.  
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to 2 1946.

There are many factors involved in determining the exact incidence of surgical renal lesions associated with hypertension and the incidence is difficult if not impossible to determine. A previous review (2) of a large series of cases of hypertension in which careful urologic studies were made at the Mayo Clinic, showed that renal lesions amenable to surgical treatment occurred in less than 1 per cent of patients who had hypertension. In reviewing our cases of hypertension with renal lesions, this approximate incidence would seem to be corroborated.

In the sifting-out of renal lesions in cases of hypertension the most valuable single method of diagnosis is the excretory urogram. The urogram usually will make visible the existence of a renal lesion which may be surgical. Generally other data will be required to complete the diagnosis. No diagnostic method is available which will offer specific data as to whether or not hypertension would be eliminated if the kidney were removed. The question has been raised as to whether an excretory urogram should be made routinely in every case of hypertension. It has been our practice to make excretory urograms for hypertensive patients who (1) give a history of disease of the urinary tract (2) have microscopic hematuria or pyuria, or other manifestations suggesting disease of the urinary tract, or (3) are less than 20 years of age, if no other cause for hypertension is apparent, such as coarctation of the aorta. We have made excretory urograms for a great many other patients with hypertension who could not have been included in the above groups, but not for all and it is possible that in a few cases hypertension of renal etiology was overlooked. We have felt that excretory urograms are not of value for patients with hypertension who are more than 60 years of age or for those who have definite azotemia.

One of the most difficult problems in cases of hypertension has been to determine whether a renal lesion detected in the course of clinical examination of a patient with hypertension could be an etiologic factor or was merely coincidental. All the clinical data in such cases have been carefully weighed in the decision as to the advisability of surgical

treatment. In many cases the hypertension was known to have existed for many years, and the possibility of renal etiology seemed minimal. In other cases the renal lesion was of such a minor type that it was very evidently coincidental, and could not possibly have been an etiologic factor. In a few selected cases, although the renal lesion seemed to be a questionable etiologic factor surgical treatment was advised. Where there was a very definite renal lesion which might well be an etiologic factor operation was, of course, always advised. In the course of routine examination many instances of advanced hypertension with definite surgical lesions of the kidney were observed, but because of the patient's general condition, or because of clinical evidence of bilateral renal disease, performance of renal surgery was not advisable.

#### POSTOPERATIVE COURSE OF HYPERTENSION AFTER RENAL SURGERY

This report is based on a review of 61 cases. All the patients came to the Mayo Clinic primarily because of hypertension. All were found to have advanced disease of one kidney and minimal if any evidence of disease in the other kidney. All underwent removal of the diseased kidney. There were no deaths in the hospital during the postoperative convalescence. Blood pressures were checked several times from 2 to 4 weeks after nephrectomy to determine the immediate effects of nephrectomy on the hypertension. Blood pressures were checked again 2 to 4 years after nephrectomy either during a subsequent examination of the patient at the clinic or by the patient's home physician. Thirty-two patients, or slightly more than half of the total number, were examined 5 or more years after nephrectomy. The remainder either could not be traced or insufficient time had elapsed since nephrectomy in which to permit a 5 year follow up study. Results have been graded as follows: *Good*—if blood pressures, expressed in millimeters of mercury were 150 systolic and 100 diastolic, or less. *Fair*—if blood pressures were significantly reduced, but still were above 150 systolic and 100 diastolic. *Poor*—if there was no significant effect on the blood pressure and *Death*—if patients died during

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TABLE I.—POSTOPERATIVE RESULTS 61 HYPERTENSIVE PATIENTS WHO UNDERWENT UNILATERAL NEPHRECTOMY

Result	Time after operation		
	Immediately (1 to 4 weeks)	Two years plus	Five years plus*
Good	31		
Fair	13	25	10
Poor	17	10	5
Death	0	20	11
Total	61	61	61

\*Figures in this column based on 31 traced patients.

TABLE II.—POSTOPERATIVE RESULTS 29 PATIENTS WHO HAD RENAL ATROPHY AND FIBROSIS AMONG 61 HYPERTENSIVE PATIENTS WHO UNDERWENT UNILATERAL NEPHRECTOMY

Result	Time after operation		
	Immediately (1 to 4 weeks)	Two years plus	Five years plus
Good	12		
Fair	5	10	4
Poor	12	5	3
Death	0	11	5
Total	29	27	27

\*Figures in this column based on 5 traced patients.

the period of the follow up study. The results for the entire group are given in Table I. In reviewing the results of operation it is interesting to note the comparative condition of the patient at different periods after the operation. When the blood pressure was taken within 2 to 4 weeks after operation it was found that the result was either good or fair in 44 cases or 72 per cent. However when these patients were examined 2 years after operation there were only 35 patients for whom the results were good or fair or 57 per cent. Five years after operation the number of patients whose condition was described as good or fair was only 15 or 47 per cent of the 32 who were followed for that period (Table I).

Attention has been called previously to the fact that an estimate of results of renal surgery for hypertension cannot be exact unless the patients are examined as late as 2 years after operation. It was thought that if the patient's condition is satisfactory at that time, the chances are that the benefit will be permanent. However, the reduction in the percentage of good results at the end of 5 years in comparison with the percentage of good results 2 years after operation shows that this assumption was fallacious. In other words even though elimination of the kidney has a very definite effect in lowering blood pressure immediately after the operation and as long as 2 years after operation other factors may arise to cause a return of hypertension. The comparatively temporary removal of the etiologic factor in hypertension by renal surgery was not fully appreciated. That factors remain

which may reassert themselves after the immediate benefit of renal surgery has elapsed must be admitted. Nevertheless, the fact that the blood pressure of 15 patients was approximately normal 5 years after operation demonstrates conclusively that the diseased kidney which was removed was a definite etiologic factor in the hypertension. It is also evident that elimination of the etiologic factor of hypertension as accomplished by nephrectomy was in many cases of only temporary value and that an underlying factor existed which reasserted itself to permit a return of the hypertension.

Careful review of the 26 cases in which the results of operation were classified as poor or death revealed data which were of considerable interest. It was rather noticeable that in most cases in which there was evidence of some involvement of the opposite kidney, there was little or no reduction in hypertension after nephrectomy. Cicatricial deformity as shown in the urogram or in the outline of the 'good' kidney is observed in many of these cases. In several cases there was less than normal function in the good kidney as shown by the results of various clinical tests of renal function. Elevation of blood urea even though moderate retardation of the secretion of phthalein, or deficiency in clearance of urea should constitute a warning against removal of one kidney as treatment for hypertension alone unless there is renal pathologic change which urgently indicates nephrectomy. In fact, several patients with clinical

TABLE III—POSTOPERATIVE RESULTS 26 PATIENTS WHO HAD HYDRONEPHROSIS AMONG 61 HYPERTENSIVE PATIENTS WHO UNDERWENT UNILATERAL NEPHRECTOMY

Result	Time after nephrectomy		
	Immediately (to 4 weeks)	Two years plus	Five years plus
Good	14		3
Fair	7	4	
Poor	3	7	3
Death		3	3
Total	26	26	8

Figures in this column based on 5 traced patients.

or urographic evidence of disease in the good kidney were observed whose general condition became worse after nephrectomy. Roentgenograms showed minute areas of calcification or small stones in both kidneys in several cases. The well kidney had been subjected to previous operation for stone in 2 cases.

The group of cases in which there was a definite reduction in blood pressure but not a return to normal is interesting. In many of these the systolic blood pressure observed before nephrectomy was more than 200 millimeters of mercury and the diastolic 120. Five years later although the blood pressure was reduced it remained between 160 and 170 systolic, and between 90 and 100 diastolic. Associated with the reduction in blood pressure there was almost invariably an improvement in the patient's general condition and well-being. In the absence of any other form of treatment, it would be logical to assume that removal of the kidney was the differential factor. It would seem very probable that the reduction in blood pressure was caused by elimination of a pressor factor which had been present in the removed kidney. In several cases of severe hypertension the blood pressure decreased almost to normal for a variable period after nephrectomy but when the patient was observed 2 to 5 years later a moderate increase in blood pressure was noted but the pressure was at a much lower level than before the operation.

In a number of cases in which the results were classified as poor the hypertension re-

TABLE IV—POSTOPERATIVE RESULTS 6 PATIENTS WHO HAD RENAL TUBERCULOSIS AMONG 61 HYPERTENSIVE PATIENTS WHO UNDERWENT UNILATERAL NEPHRECTOMY

Result	Time after operation		
	Immediately (to 4 weeks)	Two years plus	Five years plus
Good	5	3	
Fair			
Poor			
Death			
Total	6	6	

\*Figures in this column based on 5 traced patients.

mained at approximately the same level after nephrectomy but the patient's general condition was very definitely improved. Some type of renal infection had been present in most of these cases, and it is evident that removal of this infection was the cause of improvement in the patient's general condition. From the standpoint of the hypertensive disease, it is probable that both the fair results and temporarily good or fair results of only 2 years' duration can be considered of sufficient benefit to the patient to justify nephrectomy. Even a partial lowering of the blood pressure, or a temporary lowering of blood pressure for a period of 2 years, prevents part of the inevitable strain on the cardiovascular system produced by the hypertension, and thus delays the inevitable breakdown of the heart or large vessels.

The series of 61 cases can be broken down into three groups according to the nature of the disease in the kidney which was removed. In 29 cases there was marked renal atrophy and fibrosis (Table II). In each of these cases the kidney which was removed weighed less than 115 grams, and in 21 of the 29 cases the kidney weighed less than 70 grams. In most of the cases the lesion was considered to be chronic atrophic pyelonephritis. In a few it was probably congenital hypoplasia with secondary pyelonephritis. In 26 cases there was advanced hydronephrosis with evidence of previous or active infection, and with considerable destruction of the renal parenchyma by cicatrization (Table III). The function of these kidneys was markedly impaired. In the

TABLE V—RESULTS 2 YEARS AFTER NEPHRECTOMY AMONG 61 HYPERTENSIVE PATIENTS ACCORDING TO PREOPERATIVE LABILITY OF BLOOD PRESSURE

Blood pressure status	Results	
	Good or fair	Poor or death
Relatively labile	18	11
Relatively fixed	17	15

6 other cases there was advanced tuberculosis with destruction of more than 50 per cent of the renal parenchyma, sometimes with almost complete destruction of the renal parenchyma (Table IV)

The results in the three groups of cases are given in Tables II, III and IV. No definite difference in the results was noted in the three separate groups.

Of the entire 61 patients 25 were male and 36 were female. There were almost four times as many female as male patients in the group with chronic atrophic pyelonephritis and there were a few more males than females in the group with hydronephrosis. Of the entire group 64 per cent of the males and 53.7 per cent of the females still had good or fair results after 2 years.

We have been impressed by the fact that both good and poor results have followed nephrectomy on patients who had very similar renal lesions. From the standpoint of the data in this group of cases failed to yield information which would lead to a prediction as to which patients might be expected to present good and which poor results after removal of the badly diseased kidney. In this series of 61 cases the known duration of the hypertension, the known duration of the renal disease, the results of urinalysis, and the electrocardiographic observations failed to give information which would aid in the prediction of good or poor results after nephrectomy. Studies of the relative lability or fixation of the blood pressure including the cold pressor test and studies of the blood pressure after the patient had rested in bed for a period of 24 hours and failed to show differences which might aid in the prediction of results (Table V).

TABLE VI—RESULTS OF NEPHRECTOMY AS SHOWN BY RETINAL EXAMINATION 2 YEARS AFTER OPERATION 61 HYPERTENSIVE PATIENTS WHO UNDERWENT UNILATERAL NEPHRECTOMY

Keith-Wagener classification	Results	
	Good or fair	Poor or death
Group I	6	4
Group II	30	9
Group III	8	8
Group IV	4	5

\*See text for explanation of this classification.

The patients were divided into four groups on the basis of retinal examination according to the Keith-Wagener classification, namely group I—those who did not have sclerosis of the retinal arteries or retinitis; group II—those who had sclerosis of the retinal arteries but no retinitis; group III—those who had sclerosis of the retinal arteries and retinitis but without edema of the optic discs; and group IV—those who had sclerosis of the retinal arteries, retinitis and edema of the optic discs. Results which followed nephrectomy in these various groups are shown in Table VI. There were both good and poor results in all groups but relatively more good results were obtained in group II. There was no significant variation in results obtained among individuals in various age groups although results were slightly better for individuals less than 20 years of age and for those between the inclusive ages of 30 and 39 years.

It is obvious that since hypertension usually occurs in the absence of severe unilateral renal disease and that severe unilateral renal disease not infrequently is found in patients who do not have hypertension, the combination of the two conditions at times may be entirely coincidental, possibly in as many as 20 to 30 per cent of cases in which both conditions are found. Even if unilateral renal disease may have been the cause of the hypertension, it would seem that in a given case sooner or later irreversible vascular changes may take place diffusely in the body and in the good kidney which would prevent relief of the hypertension even if the original cause is removed. These two possibilities may explain the poor results which



followed nephrectomy in cases in which all observations seemed similar to those in other cases in which good results were obtained.

In review of the pathologic data evidence of infection either active or dormant, was noted in the tissues of all kidneys removed. In all cases of hydronephrosis, extensive pyelocystitis also was present. It has been shown both experimentally and on the basis of clinical records, that unilateral retention of urine with back pressure such as occurs with hydronephrosis in itself would not be a cause of hypertension. It would seem, therefore that the changes in the renal tissue as a result of infection probably are the important factors which favor the intrarenal secretion of pressor substances. So far no one has been able to determine the exact histologic changes which cause secretion of pressor substances. Of the various hypotheses suggested as the cause of pressor secretion intrarenal circulatory imbalance (Page and his co-workers) would seem to be most plausible. The microscopic appearance of the tissues in two atrophic pyelonephritic kidneys which have been removed for hypertension may be very similar and the hypertension may persist in one case and it may disappear in the other. There are no specific clinical, urographic, or pathologic data which would give definite preoperative indication as to the possibility of eliminating hypertension if the kidney is removed.

#### SUMMARY

An analysis has been made of 61 cases of hypertension in which advanced unilateral

renal disease was found and the affected kidney was removed as treatment for the hypertension.

Follow up studies in this group of cases have shown that 2 years after nephrectomy results were good in 25 cases, or 41 per cent; fair in 10 or 16.4 per cent; poor in 30, or 49 per cent, and that 6 patients, or 10 per cent were dead.

The condition of 32 patients was followed for 5 years. At the end of this time good results were present in 10 cases, or 31 per cent; fair results in 5 or 15.6 per cent; poor results in 17 or 54.4 per cent and 6 patients, or 19 per cent, were dead.

Both good and poor results were noted among patients in different age groups, in both sexes and among patients who had various degrees of severity of hypertensive disease.

Clinical analysis of these cases from the standpoint of the hypertension failed to reveal information which was of value in preoperative prediction of the effect of nephrectomy on the subsequent course of the hypertension.

No specific urologic or pathologic observations were noted in the affected kidneys which would indicate whether good or poor results would follow nephrectomy.

#### REFERENCES

1. BARKER, N. W. and WALTERS, WALTER. *Proc. Mayo Clin.*, 33, 13 118-121.
2. BRAARCH, W. F. *Canad. M. Ass. J.* 1942, 45: 9-15.
3. BUTLER, A. M. *J. Clin. Invest.*, 1937, 16 850-877.
4. PAGE, I. H., HELLMER, O. M., KOWALEWITZ, K. G., FORTH, P. J. and KIRBY, G. F. *J. Exp. M.* 1941, 73 7-41.

# ABSTRACTS OF CURRENT LITERATURE

## SURGERY OF THE HEAD AND NECK

### HEAD

Cámpa, J. R. F. Corbellas, M. F. and González, J. M. L.: Eosinophilic Granuloma of the Frontal Bone (Granuloma eosinófilo del frontal) *Sem. med.*, B. Air 1946, 53 366.

A case of eosinophil granuloma of the right frontal bone is reported by the authors. The patient complained of an extremely intensive pain over the right eyebrow. On examination edema of the right frontal region and a tumorlike process in the right frontal bone were found. The roentgenograms revealed an osteolytic process in the right round shape with a slightly irregular outline there were no signs of any focal reaction. From the roentgenological point of view myeloma and tuberculosis of the bone were considered.

In view of a slight fever sulfa drugs and penicillin had been given but diplopia appeared and the process showed a progression. Under local anesthesia a horizontal incision was made and a biopsy specimen was obtained.

Deep x-ray therapy caused disappearance of the symptoms. A roentgenogram taken 60 days after therapy was discontinued showed a marked reduction of the size of the lesion and an osteogenic reaction which gradually obliterated the cavity. The histological diagnosis was eosinophil granuloma. The frontal bone is the most frequent site of such lesions, as well as the failure of anti-infectious study allowed the exclusion of pyogenic, tuberculous, or tumoral etiology of the condition in this case. The histological findings suggested allergy as a possible etiologic factor. Eosinophil granuloma is a benign lesion distinct from Hand Schüller-Christian's disease. Deep x-ray therapy is the proper treatment of this condition.

Robinson, M.: Temporomandibular Joint. *J. Am. Dent. Ass.* 1946 33 1960

The action of the jaw is a reflex nonlever action. The anatomic and histological structure of the temporomandibular joint shows that it is not meant to bear heavy stresses. The jaw is not a lever of the third class. The muscles of mastication are so placed that the resultant force of their actions can be borne by the teeth. The joints being left free from trauma during stress. Heavy stress is developed in the denture only during isometric muscular contraction. The normal stresses in the mandible are regulated by a positional and a masticatory reflex activity in the fifth cranial nerve, in its motor and mesencephalic nuclei. The disc is not fibrocartilage but a special

ized connective tissue which is capable of repair  
NOAR D. FABRICANT M.D.

Kivimäki, J.: Recurrent Dislocation of the Mandibular Joint. *Ann. Chir. Gyn. Fenn.*, 1946, 35 99

Arthroses of the mandibular joint are characterized by pain tenderness and crackling sounds in opening and closing of the mouth. In advanced cases they often result in repeated or habitual luxation or subluxation. Although the etiology of the arthroses is unknown malocclusion and incorrect bite caused by the loss of several molars or pre-molars probably are predisposing factors. Infections of alcohol and iodine in the joint proved unsatisfactory.

The treatment of choice is surgery (ante-position of the articular disc). Recently prosthetic therapy in the form of reconstruction of the bite has been suggested. It is however more expensive and takes more time than operative treatment.

WILHELM M. SCHMIDT, M.D.

### EYE

Richards, J. M., and Romaine, H. H.: Keratoconjunctivitis Sicca after Stevens-Johnson's Disease. *Am. J. Ophth.* 1946, 29 1111

In 1923 Stevens and Johnson reported a case of the purulent conjunctival form of erythema exudativum multiforme. Since then, others have reported this condition but have not mentioned keratoconjunctivitis sicca.

These authors report a case of exudative erythema multiforme which occurred in a woman following the use of belladonna and phenobarbital. The prodromal symptoms were typical of measles, but progressed to a state in which diffusely confluent erythematous maculopapular eruption enveloped the face the neck, the trunk, and the extremities in association with scattered large, confluent thin walled bullae. The patient became dehydrated prostrated and hyperthermic. The period of general involvement lasted about a week. The mucous membranes were involved with a resultant edema, necrosis and mucopurulent discharge. There was destruction of the corneal epithelium and conjunctiva with consequent adhesions. Later there was a progressive infiltration and opacification of both corneas. As the stage of inflammation changed to centralization the typical signs of keratoconjunctivitis sicca appeared. There was corneal stippling and little lacrimation. Treatment was of no avail and corneal ulcers continued to reoccur. The vision in the left eye was markedly reduced and the right eye was enucleated because of a perforated ulcer.

ROBERT H. JOHNSON, M.D.

Castroviejo, R.: Indications for Keratoplasty  
*Am J Ophth.*, 1946, 39: 681

The surgical procedures used for the treatment of corneal opacities are keratoplasty and keratectomy the former usually being preferred because of the better results. The temporary contraindications to this surgery are inflammation, burns in which the eye has not become quiet, and glaucoma which has not been treated by the appropriate surgery.

The author divides the cases of keratoplasties and keratectomies into three main groups on the basis of their prognosis. The first group is made up of the favorable cases in which the final vision averages better than 20/50. This group includes those cases with a central corneal opacity surrounded by healthy tissue keratoconus, and interstitial keratitis when the opacity is not too dense and extensive and when the transplant will remain in contact with fairly healthy corneal tissue.

The second group is composed of those cases less favorable for keratoplasty but likely to result in a considerable improvement of vision. In this group are most of the corneal dystrophies, the complete superficial opacities of the cornea with healthy epithelium and no superficial vascularization, superficial tear-gas burns with no vascularization and herent leucomas, descometocoles, and interstitial keratitis with somewhat denser opacities.

The third group is unfavorable because the transplant is likely to become opaque. Included in this group are the extensive corneal scars which go to the limbus or which have superficial vascularization extensive leucomas in which the transplant would be surrounded in more than half its circumference by dense scar tissue band-shaped opacities, dystrophia adiposae deep corneal burns due to tear gas, and corneal opacities in aphakic eyes.

Fuchs's epithelial dystrophy extensive corneal opacities with calcareous degeneration corneal opacities caused by pemphigus, and corneal opacities with extensive anterior synechiae are not improved by keratoplasty or keratectomies. The author also advises against operating on very unco-operative patients.

ROBERT H. JOHNSON M.D.

### EAR

Munzco, J. C.: Peripheral Facial Paralysis in Acute Otitis Media (La parálisis facial periférica en la otitis media aguda). *Sem med.*, B Air 1946, 53

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Peripheral facial paralysis is of particular interest to the otologist because of the intimate anatomic relation of the peripheral tract of the facial nerve to the ear, the diagnostic, prognostic, and therapeutic indications of the condition, and its physical consequences, social and economic, for the patient. The facial nerve emerges from the sulcus of the bulbar protuberance the motor and sensory roots uniting into a common trunk, and joins the auditory nerve in its entrance at the internal auditory meatus, then it continues through the fallopian aqueduct down

to the stylomastoid foramen, and after a short intraparotid course divides into two terminal branches, the temporofacial and the cervicofacial, which innervate the cutaneous facial except the superior elevator of the eyelid muscles and the neck of the corresponding side. The nervus intermedius of Wernberg runs in the aqueduct and terminates at the geniculate ganglion and separates from the seventh nerve as a mixed nerve. Besides the terminus, branches there are 10 collateral branches, 5 of which are intrapetrousal passing through the walls of the aqueduct. The facial nerve in its course comes in contact with the auditory trigeminal, and vagus nerves, and its superficial cervical plexus. Branches are also sent to the muscles of the stapes and palate, sensory fibers to the pinna, external auditory meatus, and tympanic membrane, gustatory nerves to the anterior two-thirds of the tongue, and secretory fibers to the sudoriparous glands of the face, and the salivary and lacrimal glands. Vasodilator fibers are also distributed. The stylomastoid artery and vein accompany the facial nerve in its intrapetrousal course, the artery giving branches to the tip of the mastoid and tympanic cavity and it must be remembered that this neurovascular group completely fills the canal.

From the etiopathogenic and surgical viewpoint of intrapetrousal facial paralysis the nerve may be divided into three segments: the first or labyrinthine segment, the second or tympanic segment and the third or mastoid segment. The facial nerve is in direct anatomic relation with the temporal bone and its anomalies of pneumatization. The tympanic portion presents little resistance to aggression because the osseous lamina separating it from the middle ear is very thin and at times dehiscence. Embryologically the aqueduct is membranous and the nerve is separated only by fibromucous membrane of the middle ear later this groove is transformed into the osseous canal, but in the newborn it is open in part at the portion between the oval window and the horizontal semicircular canal and this dehiscence may persist throughout life. The tympanic portion presents a raised part, the eminence of the facial canal, which is inextensible and compresses the nerve during inflammations or periostitis. Small osseous cells near the geniculate ganglion may propagate infection in case of osteitis. The mastoid portion has a length of from 6 to 12 mm., a diameter of 4 mm. at the extreme superior end and a diameter of 6 mm. at the stylomastoid foramen. Processes affecting its superior third produce pressure early. In pneumatic and post-mastoidectomy mastoid processes, the osseous cells invade the walls of the aqueduct and separate its contents by thin laminae of bones, or excessive pneumatization near the internal jugular bulb may cause dehiscences. Occasionally invasion is limited to the superior third of the mastoid portion the cells encircle it in front on the inside, and behind, and if there is mastoiditis, the facial nerve may be harmed. The aqueduct may present compact osseous walls in its entire course and the nerve is very rarely injured.

at its exit at the stylomastoid foramen in case of apical mastoiditis. The facial nerve may transmit infection to the meninges in the same manner that the auditory nerve carries infection to the optic nerve. The middle ear and the mastoids and the aqueduct and its contents are continuous structures, therefore the virulence and type of otic infection and the mucosal reaction are blamed for the paralysis due to compression and varying degrees of toxic neuritis during acute otitis media. Intact nervous trunks are very resistant to suppuration even for months without functional disturbance but very susceptible to apparently light compressions.

In autopsies revealing osseous caries and dehiscences, the nerve bathed in pus during life never presented symptoms of facial paralysis. The cause of compression of the facial nerve in acute otitis media is not clear it may be due to vascular congestion in inflammatory exudates or to edematous tumefaction in addition to an inextensible osseous wall. Adhesions of the nerve sheath to the periosteum of the aqueduct tend to localize the compression narrowing of the duct results from periostitis and pressure by the contents of the tympanum on the fibromucosa in case of dehiscences. Paralysis is not due to direct nerve infection but to a modification of the neurovascular apparatus produced by inflammation a toxic paralysis of the motor nerves of the vessels in the aqueduct followed by edema and degenerative lesions of the nerve. Osteitis of the facial canal is a very rare cause of paralysis, and if it occurs the nerve is deprived of its osseous covering and is exposed to inflammatory granulation tissue and infection which is likely to lead to its ultimate destruction.

Kettel performed mastoidectomy only in 37 cases for peripheral facial paralysis and found no osteitis in 7 cases. Demelius found none in 2 of 7 cases, in the 5 others the osteitis was of low grade and in 3 cases it was severe. Many mastoidectomies reveal great zones of osteitis but facial paralysis is not an absolute sign of mastoiditis. In the majority of cases it is of toxic origin. Paralysis appearing at the beginning of acute otitis media is caused by inflammation of the tympanic cavity and after the second week may be caused by mastoiditis with empyema. Tuberculosis scarlet fever pneumococcus mucosus malleus and influenza otitis media are the important etiologic agents in peripheral facial paralysis. Early age is a factor and males are more susceptible than females. The incidence varies. Kopetzky found it in 3 per cent. Danelius in 1 per cent. Pollmann in 14 (0.7) of 1,823 cases Kettel in 50 (0.5%) of 9,891 cases and the author in 5 (0.59%) of 7,844 cases.

Symptoms of peripheral facial paralysis may appear any moment in acute otitis media more commonly in the first and third weeks. It rarely is the first symptom and if it appears before tympanic perforation, tuberculosis should be suspected. The otitis may be slight and insignificant passing as a nervous complication of another cause. It appears

early in the young as the fallopian aqueduct is very thin at times dehiscant and very vulnerable to early toxemia and osteitis. There are very slight or no prodromal symptoms or the condition is preceded by auricular pains including half of the face with involuntary contraction of the facial muscles. The condition may also appear at the commencement of its complete symptomatology when there is a corresponding intrapetrosal lesion of the nerve.

Treatment is essentially directed to the otitis media. For paralysis with an intact tympanic membrane early and ample paracentesis for efficient drainage and decompression is indicated, if there is a perforation mastoidectomy should be done. Conservative treatment of the otic infection is indicated if it follows a normal course and there are no definite signs of mastoid complication. Paralysis is a relative indication for mastoidectomy since it is not a sure sign of mastoiditis. Once mastoid complication is recognized immediate mastoidectomy is enough to banish the greater part of the paralysis and no operation should be done on the fallopian aqueduct. A reasonable length of time for observation should be allowed and then if faradic treatment is negative, decompression of the nerve in the aqueduct should be considered. The prognosis is generally favorable.

A. B. VICENCO, M.D.

#### NOSE AND SINUSES

Pomon, S., Syracuse & R. Bolotow, N. and Pullen, M.: Plastic Repair of the Defected Nasal Septum. *Arch Otolaryng.* 1946 44 141

The author challenges the contemporary orthodoxy which still adheres to the concept that maintenance of the profile projection of the nasal pyramid is dependent mainly on support furnished by the septum.

The author proves that the saddle nose created by a too generous removal of the nasal septum is not the result of removing the supports but is due to the development of internal stresses arising from cicatrization of the deskeletonized connective tissue.

The operation is described in great detail with many figures. The first steps are like those of the orthodox method of resection of the nasal septum but the author excavates the columella and places a thin cartilage graft in the bed and holds it in place with two sutures placed behind the graft. The obstructing cartilage is removed with scissors or a swivel knife as far ventrad or caudad as necessary. A quadrilateral piece of cartilage is placed beneath the perichondrial flaps and anchored by two mattress sutures.

The purpose of the cartilaginous replacement is not to furnish support since the graft having no abutment above or below can sustain no weight. Like the columellar batten it is replaced to prevent contraction of the connective tissue in the process of healing and thus the consequent distortion and saddling of the dorsum is eliminated.

JOHN F. DEXTER, M.D.

Young, F.: The Repair of Nasal Losses. *Surgery* 1946 20 67a.

The object of any reconstructive surgical procedure is to restore or improve function, and, especially if the restored part is a facial feature, to approach the normal as closely as possible. This may be difficult with the nose which may have been partly destroyed by accident disease or by the treatment of any disease.

The surgeon should be thoroughly familiar with the form, structure and function of the nose. A brief review is given of the structure and function of the nose, and its relation to the face. Some emphasis is placed on the importance of a good appearance of the nose as a poor one may be a great social and economic handicap.

In the reconstructive surgery of the nose it is important to save as much normal tissue as possible as it is better than any that can be substituted. For grafting the skin of the forehead is the best as the color and texture of that skin is similar to that of the nose. The use of skin to replace destroyed nasal mucosa has its disadvantages, but skin is the best substance available.

Young gives a brief description of his plastic repair of nasal losses which is usually done in several operations. A number of diagrams are included to show the stages in his procedures. Photographs are included of several cases showing the appearance before and after the reconstructive surgery.

WILLIAM A. ANDERSON, M.D.

Mohs, F. E.: Chemosurgical Treatment of Cancer of the Nose; A Microscopically Controlled Method. *Arch. Surg.* 1946, 53 337.

The chemosurgical treatment of cancer of the nose has the great advantage of thorough microscopic control of the excision. This control is responsible for the unprecedented reliability and conservatism of the method.

The reliability of the method is indicated by the unusually high proportion of successful results, declares the author. Thus, for basal cell carcinoma, successful results were obtained in 98 per cent of 202 cases observed for 6 months or more, in 97 per cent of 109 cases observed for a 3 year period, and in 94.3 per cent of 53 cases observed for a 5 year period.

For squamous cell carcinoma the rate of cure was 93.9 per cent for the 33 cases observed for a 6 month period, 87.5 per cent for the 16 cases observed for a 3 year period, and 81.8 per cent for the 11 cases observed for a 5 year period. These results were obtained despite the fact that many of the cancers were far advanced and more than one-third had recurred after previous irradiation or surgical treatment.

The method is conservative, since only 1 or 2 mm of tissue are removed beyond the points of actual carcinomatous invasion. The method is also useful in the treatment of various benign neoplasms and of precancerous lesions of the nose.

NOAH D. FARRICAST, M.D.

## MOUTH

Lee, F. C.: Orbicularis Oris Muscle in Double Harelip. *Arch. Surg.* 1946, 53 407.

During the operations on 3 patients with double harelip a modification of one of the usual plastic procedures was evolved. The essential feature of this change was to join the sphincter muscles of each side across the premaxilla and, to this end, it was necessary to cut deeply into the lip at right angles to its edge in order that a flap of sufficient length could be sewn to the corresponding structure of the opposite side. What was not known at the time was how much sphincter oris muscle was present. It is the purpose of this article to give the anatomy of the muscle in double harelip.

In order to study the orbicularis oris muscle, serial sections were made of the left side of the upper lip of a 5 month human specimen having double harelip.

It was found that this muscle is well developed at the corner of the mouth but quickly becomes thin and fragmented as the ala of the nose is reached. It is moderately effective in forming a barrier to keep the buccal glands in a posterior position in the lip.

No support was found for the view that there is a large concentration of purely sphincter muscle from at the corner of the mouth. JOHN F. DEERY, M.D.

Dorrance, G. M., and Bransfield, J. W.: The Push-Back Operation for Repair of Cleft Palate. *Plast. Reconstr. Surg.* 1946, 1 145.

The "push-back" operation, first devised for congenital insufficiency of the palate has been employed by the authors in the treatment of all varieties of cleft palate for a period of 20 years. During the time many minor changes have been made but the main idea behind the procedure has remained unchanged. The authors have seen some of the cases in which the method was employed, with or without modifications, by at least 20 different surgeons, and they believe they are now in a position to evaluate the final results which have been obtained.

Despite the fact that the authors have never known of the loss of a flap in cases in which their method was followed, they are constantly receiving inquiries as to whether or not the posterior palmar arteries should be divided. Many surgeons insist on saving the vessels. Many surgeons who use the principle of the push back do not advise the use of skin grafts to line the under surface of their flaps.

The purpose of this article is to give the indications for the push back operation, as well as the operative details and to attempt to show the necessity for following out the various steps which are recommended.

NOAH D. FARRICAST, M.D.

Adams, W. M.: The Use of the Masseter Temporalis, and Frontalis Muscles in the Correction of Facial Paralysis. *Plast. Reconstr. Surg.* 1946, 6.

Numerous techniques utilizing muscle transplantation in the correction of facial paralysis have been

reported, with varying results. Many of these have been far from satisfactory. Since nerve grafting is impossible in so many of these cases at the present time the author believes that some form of muscle substitution is the only treatment which will give these patients not only support but the maximum amount of motion in the paralyzed side of the face.

In the reconstructive centers of both the Army and the Navy a large number of satisfactory and encouraging results have been obtained and these have given an increased impetus to utilize muscle substitution in facial paralysis. The transplantation of flexor muscle tendons, to do the work of the extensors has, in many cases, elicited results which appear to be startling.

Two cases are reported which give further evidence of the effectiveness obtained by the use of muscle flaps in the correction of facial paralysis. At best the procedure is a compromise. However muscle transplantation gives not only the same support accomplished by fascia strips but in addition affords voluntary motion without the distorting movements associated with nerve substitution.

NOAH D. FABRICANT, M.D.

Newman S. C., and Seabrook, D. B.: Management of Injuries to Stensen's Duct. *Ann Surg* 1946 124: 544

In the past surgery for the repair of lacerations or injuries to Stensen's duct has been unsuccessful. There have been occasional cases in which good re-

sults have been obtained in the immediate repair of injuries of this type but reports of success in the treatment of the more chronic types of fistula have been few.

The authors encountered a number of cases of injury to Stensen's duct while on duty at an Army general hospital during the years of 1943, 1944 and 1945 and as a result of their experience they have developed a general plan for the operation and care of patients with injuries of this type. No claim to originality is made since the operation has been described in principle by others. A detailed description of the procedure is given.

NOAH D. FABRICANT, M.D.

## NECK

Grelland R.: Thyrotoxicosis at Ullevål Hospital in the Years 1934-1944 with a Special View to Frequency of the Disease. *Acta med scand.*, 1946 125: 108.

There was a gradual increase in the number of cases of thyrotoxicosis observed at the Ullevål Hospital from 1934 to 1942 with peaks in 1939 and 1941. In 1944 there was a sudden decrease in the number of cases back to the 1937 level. During the years from 1940 to 1944 there was an increase in the number of elderly patients and of men. The average duration of the disease for the 10 year period was 10½ months. An enlarged thyroid gland was found in 88 per cent, exophthalmos in 40 per cent, tremor in 72 per cent, and auricular fibrillation or flutter in 26 per cent. There were 222 women and 31 men in the study, a proportion approximate to that of a much larger study from several Scandinavian hospitals. The increases in the total cases during 1939 and 1942 and in the proportion of men were attributed to the tensions produced by the war.

In this series the systolic blood pressure was from 25 to 30 mm. above normal with no change in diastolic pressure. The mean pulse pressure was 71 mm. Hg. The heart beat was powerful and rapid with clear tones in 43 per cent, systolic murmur in 57 per cent, and of these 57 per cent 4 per cent also exhibited a diastolic precordial murmur. Twenty six per cent of 204 cases examined electrocardiographically exhibited continuous or paroxysmal fibrillation or flutter, 10 per cent exhibited myopathy, 26 per cent tachycardia, and 38 per cent a normal electrocardiogram. Auricular fibrillation in a majority of cases was associated with a previous history of acute rheumatic fever. The percentage of cases of toxic adenoma with auricular fibrillation was 31, whereas among the hyperplastic goiters there were only 17 per cent with auricular fibrillation. Thirty five per cent of all cases presented had enlarged hearts.

Although 30 per cent of the cases exhibited glycosuria, there was associated diabetes mellitus in only 2.8 per cent of the cases.

Blood cholesterol ranged from 68 to 226 mgm. per 100 c.c. (average 134 mgm.)

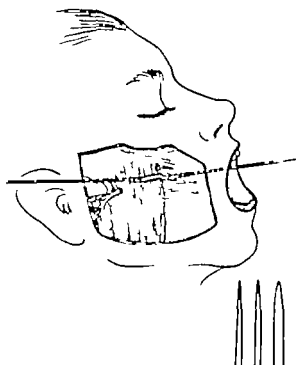


Fig. 1 (Newman and Seabrook) The intraoral and external probes are in position. The mass of scar tissue and the claustrated portion of the distal segment have been excised. The metal dilators, drawn to scale, are shown in the lower right hand corner. (Courtesy of J. B. Lippincott Co.)

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The object of any reconstructive surgical procedure is to restore or improve function, and especially if the restored part is a facial feature, to approach the normal as closely as possible. This may be difficult with the nose which may have been partly destroyed by accident, disease or by the treatment of any disease.

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NOAH D. FARRINGTON, M.D.

Adams, W. M.: The Use of the Masseter Temporalis, and Frontalis Muscles in the Correction of Facial Paralysis. *Plast. Reconstr. Surg.* 1946 1: 6.

Numerous techniques utilizing muscle transplants in the correction of facial paralysis have been

reported, with varying results. Many of these have been far from satisfactory. Since nerve grafting is impossible in so many of these cases at the present time, the author believes that some form of muscle substitution is the only treatment which will give these patients not only support but the maximum amount of motion in the paralyzed side of the face.

In the reconstructive centers of both the Army and the Navy a large number of satisfactory and encouraging results have been obtained and these have given an increased impetus to utilize muscle substitution in facial paralysis. The transplantation of flexor muscle tendons, to do the work of the extensors, has, in many cases elicited results which appear to be startling.

Two cases are reported which give further evidence of the effectiveness obtained by the use of muscle flaps in the correction of facial paralysis. At best, the procedure is a compromise. However muscle transplantation gives not only the same support accomplished by fascia strips but in addition affords voluntary motion without the distorting movements associated with nerve substitution.

NOAH D. FABRICANT, M.D.

Newman, S. C., and Seabrook, D. B.: Management of Injuries to Stensen's Duct. *Ann Surg* 1946 124: 544.

In the past surgery for the repair of lacerations or injuries of Stensen's duct has been unsuccessful. There have been occasional cases in which good re-

sults have been obtained in the immediate repair of injuries of this type but reports of success in the treatment of the more chronic types of fistula have been few.

The authors encountered a number of cases of injury to Stensen's duct while on duty at an Army general hospital during the years of 1943, 1944, and 1945, and as a result of their experience they have developed a general plan for the operation and care of patients with injuries of this type. No claim to originality is made, since the operation has been described in principle by others. A detailed description of the procedure is given.

NOAH D. FABRICANT, M.D.

## NECK

Grelland, R.: Thyrotoxicosis at Ullerål Hospital in the Years 1934-1944 with a Special View to Frequency of the Disease. *Acta med scand* 1946 125: 108.

There was a gradual increase in the number of cases of thyrotoxicosis observed at the Ullerål Hospital from 1934 to 1942 with peaks in 1939 and 1941. In 1944 there was a sudden decrease in the number of cases back to the 1937 level. During the years from 1930 to 1944 there was an increase in the number of elderly patients and of men. The average duration of the disease for the 10 year period was 10½ months. An enlarged thyroid gland was found in 88 per cent, exophthalmos in 40 per cent, tremor in 72 per cent and auricular fibrillation or flutter in 26 per cent. There were 222 women and 31 men in the study, a proportion approximate to that of a much larger study from several Scandinavian hospitals. The increases in the total cases during 1939 and 1942 and in the proportion of men were attributed to the tensions produced by the war.

In this series, the systolic blood pressure was from 25 to 30 mm. above normal with no change in diastolic pressure. The mean pulse pressure was 71 mm. Hg. The heart beat was powerful and rapid with clear tones in 43 per cent, systolic murmur in 57 per cent and of these 57 per cent 4 per cent also exhibited a diastolic precordial murmur. Twenty-six per cent of 204 cases examined electrocardiographically exhibited continuous or paroxysmal fibrillation or flutter, 10 per cent exhibited myopathy, 26 per cent tachycardia, and 38 per cent a normal electrocardiogram. Auricular fibrillation in a majority of cases was associated with a previous history of acute rheumatic fever. The percentage of cases of toxic adenoma with auricular fibrillation was 31 whereas among the hyperplastic goiters there were only 17 per cent with auricular fibrillation. Thirty-five per cent of all cases presented had enlarged hearts.

Although 30 per cent of the cases exhibited glycosuria there was associated diabetes mellitus in only 2.8 per cent of the cases.

Blood cholesterol ranged from 68 to 226 mgm. per 100 c.c. (average 134 mgm.)

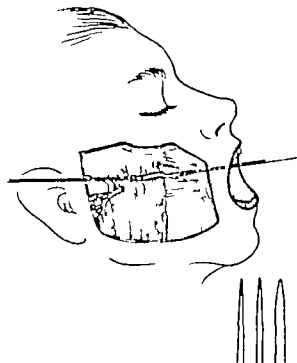


Fig. 1 (Newman and Seabrook). The intraoral and external probes are in position. The mass of scar tissue and the claustrated portion of the distal segment have been excised. The metal dilators, drawn to scale, are shown in the lower right hand corner. (Courtesy of J. B. Lippincott Co.)



Of 200 patients subjected to surgery only 1 died (0.5 per cent). The author states that the low mortality is attributable to the careful selection of patients and elaborate preoperative control and treatment.

There was little evidence that heredity, infection, administration of iodine, or the use of thyroid preparations were factors in the production of thyrotoxicosis. It was thought that the decrease in incidence of the disease during the last year of the period (1944) was due in part to undernutrition of the patients.

Psychic factors were considered important in the causation of symptoms.

CLINTON H. THURMAN, M.D.

Sikkema, S. H., Thewills, E. W., and Meyer, O. O.: Sternal Marrow Studies in Thyrotoxicosis Treated with Thiouracil and a Review of the Literature Regarding Thiouracil Effects on the Blood. *Blood. J. Hemat.* 9:46 431

The danger of the occurrence of leucopenia and agranulocytosis during thiouracil therapy has been repeatedly emphasized.

The authors present serial studies of the peripheral blood and sternal marrow in thyrotoxic patients before and after treatment with thiouracil and after thyroidectomy. They also review a total of 1,914 cases of thyrotoxicosis reported in the literature and discuss the effect of thiouracil on the blood and marrow in these cases.

Dameshek has stated that in agranulocytosis the bone marrow shows an immediate reaction with reduced numbers of granulocyte precursors and shortly thereafter a loss of mature, and then immature granulocytes takes place. If the patient survives the granulocyte precursors reappear and this is the stage which has frequently perhaps erroneously been termed maturation arrest—the mature granulocytes then reappear.

The dosage-time factor and the time factor, as well as hypersensitivity have been considered as causes of leucopenia and agranulocytosis by other authors.

The authors present a study made on 27 cases of definite thyrotoxicosis at the Wisconsin General Hospital at Madison. Studies were made of the peripheral blood and sternal marrow before treatment, after the administration of iodine, after iodine therapy and thyroidectomy, after thiouracil therapy and after thiouracil therapy and thyroidectomy.

Two patients presented complications—one, in the form of leucopenia, and the other in the form of agranulocytosis. The latter patient recovered from the agranulocytosis but developed a thyroid crisis and died.

No significant changes were found to occur regularly in the blood or marrow of patients receiving thiouracil. In certain unpredictable cases, leucopenia or agranulocytosis occurs. In both cases reported the reaction followed a period of borderline leucopenia. Not all patients with such counts progress to

a serious reaction but all patients receiving thiouracil should have leucocyte and differential counts 3 times a week and daily counts when the count drops to a borderline level (about 5,000).

Analysis of the blood and marrow findings in the 2 cases with a severe reaction shows they are consistent with the series of events described by Dameshek. The patient with agranulocytosis had a normal count before thiouracil therapy. She had 1,600 leucocytes with 16 per cent neutrophils the day preceding symptoms and on the first day of the symptoms the marrow showed a complete absence of young and adult neutrophils (as was the case in the peripheral blood). In the first few days of beginning recovery the peripheral blood showed more young than adult neutrophils. Terminally she had 16,000 leucocytes with 78 per cent total neutrophils, and final marrow examination (14 days after the previous one) revealed a reduction of the percentage of blasts to the normal range, but the increase then was chiefly in the myelocytes and metamyelocytes with only a slight return of the adult neutrophils by that date.

In the case with neutropenia the original blood and marrow observations were within normal range. The second marrow study was done 3 days before fever began—the first clinical indication. The marrow showed definite reduction in myelocytes and the metamyelocytes were few. By the time of the third sternal puncture, the patient had recovered clinically and the values were back to normal. In both cases the sequence of events is more readily correlated with the concepts of Dameshek than with the relatively prevalent idea of maturation arrest at the myelocyte stage.

The cases presented do not add much to the understanding of the mechanism of development of agranulocytosis. In the case with agranulocytosis the probable importance of the dosage-time factor has to be considered as the patient had had thiouracil for 113 days in four courses over a period of 7 months. In the case with neutropenia, sensitivity could be considered as there was an increase in eosinophils and the drug had been given for only a short time. It may be that all cases do not develop by the same mechanism.

The series is too small for definite conclusions, but in some respects tends to confirm the previous observations of others such as the following: thiouracil affects chiefly the neutrophils and particularly the younger ones, and agranulocytosis begins with alarming suddenness.

The authors believe that serial sternal marrow and blood studies fail to show any regularly occurring changes after thiouracil therapy. Changes are seen only in the few relatively unpredictable cases in which leucopenia and agranulocytosis develop. The studies support the views of Dameshek on the course of events rather than the concept of maturation arrest at the myelocyte stage.

Patients receiving thiouracil should have frequent leucocyte and differential counts.

EDWARD R. DOWDICK, M.D.

# SURGERY OF THE HEAD AND NECK

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Cattell R B: A More Optimistic Approach to Cancer of the Thyroid *West J Surg* 1946 54 444

This is the report of the experiences at the Lahey Clinic with thyroid cancer the results of which the author believes warrant a more optimistic view of the disease. Previous to January 1946 487 patients with cancer of the thyroid were treated surgically or by combined surgical and radiation therapy.

The author stresses the fact that the removal of discrete adenomas of the thyroid is of great importance in the prevention of thyroid malignancy. Twenty-six patients were found to have carcinoma in a gland removed for hyperthyroidism.

All tumors of the lateral aberrant thyroid must be considered as potentially malignant and may show definite cancer. Microscopically these tumors usually show papillary cystadenoma or papillary adenocarcinoma. The author strongly advises radical neck dissection in these cases including removal of the homologous thyroid lobe. Radiation therapy is given subsequently. Of 47 such patients 1 died of recurrent malignancy 22 months after a radical operation and radiation therapy 5 patients are now living with pulmonary metastases.

In extensive thyroid cancer as much of the gross malignancy as possible is removed tracheotomy is performed and the tube is kept in place until after the completion of the postoperative radiation therapy.

ap) Radical neck dissection is not indicated in these extensive cases. The 5 year survival rate of 231 cases of carcinoma of the thyroid is given it varied from 80 per cent in the cases of papillary adenocarcinoma to 17 per cent in the cases with giant cell carcinoma.

I J LEHMANN JR., M.D.

LeJeune F E: Intralaryngeal Operation for Cancer of the Vocal Cord *Ann Otol Rhinol* 1946 55 531

It has been the author's experience that in certain cases of carcinoma of the larynx operation by intralaryngeal dissection can be performed with results which are equally as good as those obtained by laryngofissure if not better provided certain fundamental requirements are rigidly observed. He has operated on 39 patients with early carcinoma of the vocal cord by the intralaryngeal route and the base of the lesion was treated by electrocoagulation following the operation.

Nineteen of the patients have survived the 5 year period 15 patients are alive and well from 1 to 5 years and 3 patients have had recurrences.

The advantages of intralaryngeal extirpation are believed to be (1) simplification of the operation (2) no external incision (3) preservation of continuity of the thyroid cartilage (4) better postoperative phonation (5) shorter hospitalization and (6) good prognosis.

I M L C ROBINSON, M.D.

# SURGERY OF THE NERVOUS SYSTEM

## BRAIN AND ITS COVERINGS CRANIAL NERVES

Groff, R. A.: The Management of War Wounds of the Cranial Cavity. *Am. J. Surg.* 946, 72: 434.

Differences in climate appear to have little bearing on the methods of treating battle wounds of the head. This report originated in the China Burma India theater and coincides in principle with reports of similar cases in the other theaters of war. This is a general over-all survey of opinion in the theater; neither the specific cases nor the numbers of the cases forming the basis of the opinions are mentioned.

Certain interesting points of treatment are brought out as for instance the use of the head-down position during the early transport stages and during shock was found beneficial. Not only was shock recovered from more quickly but the position facilitated the drainage of secretions and vomitus from the trachea and bronchi. Dehydration in the tropics must be carried out if at all with caution. The cases described by the author were on the contrary given from 500 to 1,000 c.c. of normal salt solution, with or without 5 per cent glucose solution. This did not materially increase the intracranial pressure and was considered beneficial to the general welfare of the patient. Air evacuation was found satisfactory and only 1 patient required oxygen; shock did not appear to be more conspicuous.

Several technical points were brought out:

1. The necessity for water tight closure of the scalp and the necessity for roentgenograms of the skull, complete débridement with the removal of metallic objects larger than 1 cm. in diameter; a necessity. Small inaccessible metallic fragments may be left.

2. When operation is done under local anesthesia too much time need not be consumed in waiting for all signs of shock to pass off; the condition of the patients continues to improve, with suitable therapy during operation.

3. The interval between wounding and operation should not be prolonged, although the results are often better after than before 12 hours have elapsed. Wounds as old as 5 days can be closed. Dusting with sulfa powders was given up as being of no value. The dural closure controversy was here decided in favor of the American plan, i.e. closure with or without the use of transplanted tissue. There is a general résumé of the surgical technique which seems to be in accordance with the generally accepted practice of those doing the best work. ADRIEN VEX BRUGNON, M.D.

Muntoni, E.: Experimental Study of Subdural Hematoma. (Studio sperimentale dell'ematoma sottodurale). *Sperimentale* 1944, 96: 8.

The study of subdural hematoma has become more important as the possibility of successful surg-

ical treatment has increased. The author made an experimental study by opening the skulls of dogs, creating subdural cavities which after from 5 to 15 days were filled with blood. Photographs of the operation and the resultant cavities are given.

A detailed comparative histological study was then made of the membrane which always forms in human subdural hemorrhage and the artificially created membrane in these cavities. Photomicrographs of the findings are given. The subdural reactions were substantially the same in the two conditions but clinically the artificially created lesions underwent a slow regression while in the clinical hematoma there was a progressive increase in size with a free interval between the occurrence of the stroke and the development of the clinical symptoms. This may have been due to the fact that the clinical hematomas were not produced entirely by the trauma; there may have been secondary factors such as changes in the blood and in the brain tissue; there may also have been localized inflammations which favor the occurrence of hemorrhage. Such constitutional factors cannot be reproduced in experimental work.

It is believed that the only histologically demonstrable difference between subdural hematoma and pachymeningitis is that in the former there is communication between the vascular lacunae and the newly-formed vessels which can never be demonstrated in the latter. The author's histological findings seem to show that the vascular lacunae are only newly formed vessels cut in different directions in different sections. AUDREY G. MORGAN, M.D.

Hule, V.: Primary Melanocytoblastoma of the Central Nervous System. (Primitiv melanocyto-blastomy v tsistefnoi sostaviv nervov). *Lik. listy* 946, 1: 355.

A 40 year old woman without evidence of hereditary or acquired taint developed the picture of a space-usurping growth of the cerebellopontine region on the right side. The condition finally cured a spastic paralysis of both sides, but particularly of the left arm and leg with inability to walk, difficulty in speech, and a clouded and finally stuporous mentality.

At autopsy a large pigmented (black) tumor of the right pontine region involving the right pedunculus cerebri, the lateral ganglia and the floor of the fourth ventricle was found. The aqueductus syphilis was deviated to the left and there was a huge internal hydrocephalus of all the ventricles. The tumor itself was made up of elongated cells arranged in whorls, which suggested a meningioma. Cells and intercellular spaces were filled with dark pigment. There was no sharp delimitation from the nervous tissue. Nests of tumor cells were found to be discrete and at a distance from the main mass of the tumor. The

tumor mass itself displayed numerous clear areas which had become markedly dilated by the fixing process and now exhibited the structure of a honey-comb type of tumor.

This type of tumor is rare and the author believes that it arises from the leptomeninges which are of neuroectodermal origin and that the tumor cells correspond in origin to the Schwann cells of the peripheral nervous system. The tumor is probably of embryonic origin, tends to appear in early childhood and may be related to malformations of the central nervous system. It does not form metastases.

JOHN W. BRENNAN, M.D.

### SPINAL CORD AND ITS COVERINGS

Ingebrigtsen R.: On Dislocation and Fracture-Dislocation of the Spinal Column. *Acta. chir. scand.* 1946 94 455

The author reports 5 cases of fracture dislocation of the cervical spine. Four of the patients had spinal cord symptoms in the form of paraplegias and hemiparesis; the fifth patient had no neurological symptoms. The fifth and sixth cervical vertebrae were involved in 4 cases and the sixth and seventh in 1 case. Open reduction of the fracture dislocation was performed immediately after admission of 3 of the patients in the Surgical Department of the Oslo University Clinic, and was followed by respiratory death. The fourth patient was operated upon 55 days after the injury; he had been treated with direct skeletal traction for 2 weeks prior to the open reduction. His functional recovery was excellent.

The author also reports on a case of fracture dislocation of the eleventh and twelfth thoracic vertebrae, with signs of a cauda equina lesion. The dislocation was reduced immediately and the patient made a satisfactory partial recovery, enabling him to return to his former occupation.

Even though 3 of the 5 patients with spinal cord lesions died following early operation, the author recommends open reduction for all dislocations of the spinal column without laminectomy and as soon as possible after the injury. He also states that this procedure when done early will prevent the occurrence of post-traumatic vascular disturbances of the spinal cord and avoid changes in the passage of the cerebrospinal fluid. However, he does not report the presence or absence of a spinal subarachnoid block or other changes in the cerebrospinal fluid.

GEORGE PERRET, M.D.

Hyndman O. R.: Pathological Intervertebral Disc and Its Consequences. A Contribution to the Cause and Treatment of Chronic Pain Low in the Back and to the Subject of Herniating Intervertebral Disc. *Arch. Surg.* 1946 53 247

To fully understand the pathological changes in intervertebral discs in relationship to the clinical picture it is necessary to have a specific terminology. The author uses the term degenerating discs to imply that the pathological changes within the disc are con-

tinuous but at this stage have not compressed the nerve root. In a herniating disc there is a definite bulge of the annulus. However, herniation is usually the result of advanced stages of degeneration. Thus it is possible to visualize a separate clinical syndrome—one of low back pain and the other of sciatica. That these may overlap is easily understandable.

The symptomatology in the degenerating disc is that of chronic low back pain and reflex pain down the posterior aspect of the thigh. However, this seldom extends below the knee and is not purely segmental in distribution. This usually occurs periodically—especially the day following strenuous work. Some relief is obtained by sleeping on a firm mattress. There is no evidence of nerve root damage such as paresthesias, anesthetics or reflex changes and the pain is not aggravated by coughing or sneezing.

In the herniating disc, chronic low back pain had preceded the sciatic radicular pain in about 75 per cent of the patients. The radiating pain extends in the sciatic distribution. The pain likewise occurs periodically but when present is associated with more severe spasms of the erector spinal muscles and splinting of the spine. Coughing and sneezing usually result in exacerbation of the pain. Evidence of nerve root damage is almost invariably present.

In differentiating the reflex and radicular pain, the author has used Steindler's method of injecting the points of maximum tenderness with procaine hydrochloride. The relief of pain suggests that it is reflex in origin and hence a diagnosis of myofascial syndrome is made. Another point is that in patients with degenerating disc the pain is partially relieved by getting up and about, whereas in the herniated disc the pain is aggravated by further movements or continued activity.

There are 10 significant features often present in the neurological examination. These are as follows—(1) absence of the lordotic curvature of the lumbar spine, (2) physiological scoliosis, (3) spasm of the erector spinae muscles, (4) painful limitation of the back movements, (5) pain on straight leg raising and the equivalent of Kernig's test, (6) slight atrophy of the calf muscle in long-standing cases, (7) sensory changes compatible with nerve root damage, (8) tenderness to palpation and percussion over the affected region of the spine, (9) tenderness along the course of the sciatic nerve, (10) alteration of the patellar and Achilles reflexes. However, reflex and sensory changes in the presence of a history previously described make a diagnosis of a herniating disc mandatory and it has not proved of sufficient value to differentiate between discs at the fourth or fifth interspaces. A number of rare symptoms are presented, such as pains in the neck, phantom limb, foot, and rectum.

Although roentgenograms are not diagnostic, there are several corroborative factors. A collapse of an interspace may be found in normal individuals and hence reliance cannot be placed on this finding.

alone. A posterior lippling is believed to be of greater importance particularly in long-standing cases. It is well to keep in mind that x-ray evidence of arthritis does not rule out a herniated disc.

The author is convincing in his reasoning that trauma is usually a secondary or aggravating factor. The annulus must be weakened by the degenerative process before trauma may produce herniation. This does not negate the possibility that trauma may be a causative factor in initiating the degenerative process; however in such cases the history should to some extent help decide the issue.

The operative procedure consists of separating the paravertebral muscles subperiosteally from the spinous processes and laminae. After rounding away the lower third of the fourth and fifth arches bilaterally, the ligamentum flavum is removed as completely as possible. In the degenerative disc the interspace is thoroughly curetted. Only in a completely sequestered nucleus may the remainder of the disc be left intact. Exploration is always done bilaterally and at both the fourth and fifth interspaces. Spinal fusion is not performed for the herniated disc. Bed rest for at least 2 weeks is considered advisable.

Stress is placed upon the frequency of herniating discs in the intervertebral canal. These may easily be overlooked. An extensive search or exploration is not carried out when the disc is not found in the more common sites.

Results are difficult to evaluate although improvement is usually obtained in all cases when appraised at the end of 6 months. In sequestered discs the sciatica is relieved in practically 100 per cent of the cases. The degenerated disc is a more serious problem and is often associated with back pain for several months after surgery. However in this group the sciatic pain is usually relieved immediately. In most industrial cases the disability is reduced from an almost total to a 5 to 10 per cent disability.

JACK I. WOOLF, M.D.

#### PERIPHERAL NERVES

Cannon, B. W. and Love, J. G.: Tardy Median Palsy; Median Neuritis; Median Thenar Neuroma Amenable to Surgery. *Surgery* 94:6 20 3 0.

In 9 of the 38 cases in which the syndrome of a tardy median palsy with or without neuritic pain was encountered at the Mayo Clinic operations were performed for the condition. At operation the transverse carpal ligament was divided and neurolysis was performed on the compressed median nerve. The results in these surgical cases have been satisfactory.

Zachary, R. D.: Tendon Transplantation for Radial Paralysis. *Brit. J. Surg.* 1946, 33 358.

The author reviews and summarizes the results obtained following tendon transplantation for radial paralysis in 53 patients admitted to the Wingfield Morris Hospital during the period from 1940 to 1945.

Two groups of cases are presented for comparison. In the first group (24 cases) both the flexor carpi radialis and flexor carpi ulnaris were transplanted into the extensors of the digits. In the second group (29 cases) the flexor carpi ulnaris alone was transplanted to the extensors; the flexor carpi radialis was left *in situ* for stabilization of the wrist.

Although the operations were performed by different surgeons the techniques were standard. The transplanted tendons were threaded through the paralyzed tendons and sutured with black silk. The wrist was held in extension during the operation and until a plaster cast had been applied. After a period of 3 weeks the cast was removed, and an anterior plaster splint applied. For the next 3 weeks this splint was worn at night, and for a variable period during the day. Throughout this period, the transplanted muscles were given faradic stimulation and voluntary exercise.

In 5 cases (group I) in which both flexors had been transplanted, the palmaris longus was absent, and the results were poor. Not one patient could actively flex the wrist to neutral position or extend the thumb or fingers completely. However, when the wrist was maintained passively in a neutral position, full active extension of the fingers was possible. It was evident, therefore, that a functionally good wrist would be resulted if it could have been maintained in a stable position.

In cases in which both flexors were transplanted, but the palmaris longus was present, results were better but, in many cases, still not completely satisfactory. An average of 50 per cent of function was obtained in the entire group of 24 cases.

In the second group of 29 cases, in which only the flexor carpi ulnaris was transplanted, and the flexor carpi radialis was left *in situ* for stabilization, the results were much better. Twenty-seven of the patients could extend the fingers to neutral position, 18 could extend the thumb completely and all could flex the thumb strongly to the neutral position. The average functional result was 91 per cent.

It is concluded, therefore, that in tendon transplantation for radial paralysis, it is important to preserve an active wrist flexor to stabilize the wrist.

ROBERT L. GARNER, M.D.

Barnes, R., Baeslich, P., Wylburn, G. M., and Kerr, A. B.: A Study of the Fate of Nerve Homografts in Man. *Brit. J. Surg.* 1946 34 34.

The present article was written with the idea of discouraging the use of nerve homografts for the repair of large nerves of the extremities in man, and to show the condition of homografts which have proved to be unsuccessful.

The authors have placed 8 large homografts measuring from 7 cm. to 25 cm. in length. In no case were they satisfied with the results. Seven of the 8 grafts were removed after varying lengths of time— from 140 to 904 days after grafting.

The nerve grafts were re-innervated for lengths varying from 10 to 25 mm. The authors do not be-

have there is any relationship to vascularity, but accept the suggestion of Seddon and Holmes that neurotization occurs only during the latent period before the host acquires an active immunity to the homograft. They believe that success might be greater if the nerve fibers reached the peripheral stump while the graft was still in a condition to act as a scaffold. They observed a fascicular necrosis which was later followed by a fascicular fibrosis. It was difficult to distinguish the older grafts from the surrounding tissue, which suggested that ultimately there is a total replacement of graft by the tissues of the host.

DANIEL RUDE, M.D.

Wertheimer, P.: Repair of Traumatic Loss of Substance of the Nerve Trunks of the Limbs. A Physiopathological Study (*Réparation des pertes de substance traumatiques des troncs nerveux des membres. Étude physiopathologique*). *J. chir.*, Paris 1946 62: 258.

This is a very brief report on the abundant literature of the last few years on the repair of traumatic nerve losses. The important work of American and English authors during the war has especially increased our knowledge of the problems involved.

The author mentions the recent research concerning the structure of nerve protoplasm, the endoneurial circulation of tissue fluid, the phenomena of diffusion and osmosis observed in the nerve trunks and the work on the arterial supply of nerves which is of special importance for the repair of injured nerves. The fact that nerves show great resistance to ischemia is explained by the presence of a longitudinal intraneural network of anastomoses.

Much work has been done on degeneration and regeneration of the nerves. After severance two processes start: destruction and disappearance of the myelin at the distal stump and proliferation of the Schwann cells. This proliferation reaches its maximum on the twentieth day, then decreases gradually. Regeneration can occur only if the axillary cylinders of the proximal end are permitted to come in contact with and penetrate into the Schwann tubes of the distal end. This is dependent on the physical, chemical, and circulatory factors.

WERNER M. SOLTZ, M.D.

### SYMPATHETIC NERVES

Weddall, G. Macbeth, R. G. Sharp, H. S., and Calvert, C. A.: The Surgical Treatment of Severe Epistaxis in Relation to the Ethmoidal Arteries. *Brit. J. Surg.* 1946 33: 387.

Occasionally epistaxis is so severe that it fails to respond to local measures such as packing and coagulation, and surgical intervention is resorted to.

The blood supply of the nasal cavities is derived from two chief sources: the sphenopalatine and facial arteries which arise from the external carotids, and the anterior and posterior ethmoidal arteries which are branches of the ophthalmic artery which, in turn, springs from the internal carotid.

The sphenopalatine and facial arteries enter the nasal cavities through their lateral walls while the ethmoidals enter through the roof. The former are more accessible to local treatment through the nares than are the latter. However many cases of epistaxis are due to injury or disease in which there is distortion of the nasal cavities, which makes them even less amenable to local therapy.

In the past, uncontrolled epistaxis has usually been treated first by ligation of the external carotid artery in the neck and then by ligation of the internal carotid if the former failed. Ligation of the external carotid is designed to stop bleeding from the sphenopalatine artery while ligation of the internal carotid is designed to check hemorrhage from the ethmoidals.

The authors believe that while the former procedure is often justified the latter is justified only when there is rupture of an intracranial aneurysm into an accessory air sinus. In other cases in which it is desired to simply control bleeding from the ethmoidals ligation of the internal carotid usually does little good because of the large collateral circulation from the opposite side through the circle of Willis. Also the procedure is rather dangerous because of the possibility of producing cerebral ischemia.

The procedure recommended by the authors is as follows: the approximate site of the hemorrhage is determined. If it is from the lateral wall of the nasal cavity, the external carotid artery in the neck is ligated. If however it arises from the roof of the nasal cavity the authors suggest ligation or coagulation of the ethmoidal arteries in the orbit.

The operative technique is described. It is considered a fairly simple and safe procedure.

Seven cases of epistaxis are reported in which the hemorrhage was not controlled until the ethmoidal arteries on the affected side had been occluded. In two of these, the common carotid had been ligated in the neck without relief of the hemorrhage.

ROBERT E. GREEN, M.D.

Fontaine, R., Forster, E., and Stefanini, C.: Late Results of 63 Splanchicectomies Done for Various Diseases Except Chronic Arterial Hypertension (*Résultats éloignés de 63 splanchicectomies pour diverses affections en dehors de l'hypertension artérielle chronique permanente*). *Lyon chir.* 1946 41: 379.

The authors, trained by R. Leriche, report the results of 63 splanchicectomies done on 47 patients during the years from 1940 to 1945. By splanchicectomy they usually mean a section of the greater splanchnic nerve with resection of the external horn of the celiac ganglion and of the first 2 or 3 lumbar sympathetic ganglia. The lesser and least splanchnic nerves were also cut whenever they could be identified.

This procedure was done bilaterally on 9 patients and unilaterally on 5 patients suffering from thromboangitis obliterans (*arteritis obliterans*). Remission of all symptoms was observed in 5 cases. 7 other cases were much improved by the procedure while

in 2 the improvement was only temporary. The cause of this disease is still unknown and the authors are aware that their treatment is not etiologic. Although they believe that thromboangitis obliterans may be due to endocrine disturbances especially of the adrenal glands they find that they get better results with splanchnicectomies than with the removal of the adrenal glands. The section of the splanchnic nerves denervates the adrenals while the lumbar sympathectomy improves locally the collateral circulation in the involved extremity.

Their results are not as good in Raynaud's disease. They report on 3 cases, 2 of which showed improvement following bilateral splanchnicectomy upper lumbar sympathectomy removal of the left adrenal gland and extirpation of both stellate ganglia. Realizing that Raynaud's disease cannot be cured with certainty by an intervention on the sympathetic chain or its postganglionic fibers, the authors come to the conclusion that this disease must be associated with the autonomic function of the arterioles and the capillaries. They believe that the surgical procedures are done too far away from the seat of the abnormal vasoconstrictive phenomena.

They have found that by doing a bilateral splanchnic block they were able to benefit greatly those patients suffering from dysphagia due to megacystophagus. Therefore, they performed a unilateral splanchnicectomy in 1 of 2 patients suffering from megacystophagus, and a bilateral thoracic splanchnicectomy with removal of the tenth and eleventh dorsal sympathetic ganglia in the other. Their results were not good and the patients had to have a cardiectomy. Because of the beneficial effect of amyl nitrite inhalations and of repeated local infiltrations of the splanchnic region, the authors conclude that to be

effective in cases of megacystophagus, the denervation should be done on the most peripheral nerve first and they advocate a periesophageal sympathectomy.

Their results were much better in 11 cases of patients with megacolon. In these cases they did a unilateral or bilateral resection of the splanchnic nerves and of the first and second lumbar sympathetic ganglia. They report excellent results in 8 cases, great improvement in 2 cases and poor results in 1 case.

The authors also report 12 cases of painful hydronephroses treated by unilateral splanchnicectomy with resection of the upper 2 lumbar sympathetic ganglia, or by splanchnicectomy associated with removal of the aorticorenal ganglion. Both types of procedure gave identical results their effect on pain is usually immediate and lasting, but their action on the dilatation of the pelvis of the kidneys and the ureters is less certain and not constant. The results were good in 9 cases, fair in 2 and poor in 1 case.

The authors also report on 2 cases of hiccups vomiting without organic cause in which a left splanchnicectomy and upper lumbar sympathectomy was done with good results in 1 case. A bilateral splanchnicectomy was also done as a last resort in 1 case of chronic pancreatitis and resulted in the disappearance of the pain. Two patients with visceral crises were also treated by thoracic splanchnicectomies and resection of the tenth and eleventh dorsal sympathetic ganglia the pain was relieved in 1 of them.

The authors have not included in this series the results of similar operations done on 25 other patients for similar afflictions within the last year. Their operative mortality was 1 per cent.

GEORGE PERROT, M.D.

# SURGERY OF THE THORAX

## CHEST WALL AND BREAST

Webster J. P.: Mastectomy for Gynecomastia through a Semicircular Intra-Areolar Incision. *Ann Surg* 1946 124 557

Gynecomastia or abnormal enlargement of the male breast is a condition in which the appearance of the breast simulates that of the female. The condition may be unilateral or bilateral. The author presents an operation for its correction which has been employed on 32 breasts in a series of 17 cases. There are three classes of benign hypertrophy of a permanent nature which necessitate treatment: (1) penducular connective tissue hypertrophy with out adipose tissue change (2) increase in the amount of both of these elements and (3) adipose tissue hypertrophy alone.

The author discusses the three classes of cases and then discusses the methods of treatment advocated which are radiotherapy, endocrine therapy and operation. Surgical removal of the excess breast tissue seems to be the best method for the correction of the condition. The indications for operation are to remove the threat of subsequent malignant changes in the enlarged breast to relieve pain and to prevent the psychic trauma caused by the feminine appearance of the breasts. The author discusses the operative technique very completely and summarizes as follows:

Mastectomy through a semicircular intra-areolar incision for the correction of gynecomastia is a procedure which offers many advantages over operation through other types of incision. The results of this procedure on 32 breasts were almost uniformly excellent: the insufficient reduction in the size of the breasts in 8 cases and the deformities of the nipples from necrosis in 1 case being the only exceptions. The final appearance in all cases may be favorably compared with the results obtained by other procedures. The absence of noticeable scars such as occur with extra-areolar incisions together with the reduction of the breasts to normal size and contour removes the cause of the patient's psychic disturbance. Since the normal appearance of the male pectoral region is achieved by this operation with almost no evidence of operative interference, the patient can indulge in normal activities and expose his chest without fear of ridicule or need of explanation.

The operation requires careful technique and meticulous hemostasis together with considerable skill, judgment and patience on the part of the operator to remove a proper amount of tissue along optimum planes and to close the wound satisfactorily in the depths as well as on the surface. It is believed, however, that this type of operation, which leaves inconspicuous scars should be employed when mastectomy for gynecomastia is to be performed.

PAUL MERRILL, M.D.

## TRACHEA LUNGS, AND PLEURA

Kay E. B.: Pulmonary Actinomycosis. *Ann Surg* 1946 124 535

Patients with pulmonary actinomycosis present a challenge with regard to therapeutic measures. In a series of 1,330 cases of active actinomycosis collected by Cope the thorax was involved in 15 per cent. The author discusses earlier treatments and shows that they were unsatisfactory. He presents a case report which serve to illustrate the chronicity of pulmonary actinomycosis and its resistance to therapy. Both cases were subjected to pneumonectomy plus chemotherapy and the author gives the following summation:

Two case histories of patients with pulmonary actinomycosis are presented. Both patients were treated with an intensive course of sulfadiazine and penicillin therapy used both alone and in combination almost continuously over a period of a year. This therapy appeared to be of value only during the periods of exacerbation and had no permanent effect upon the progress of the disease as a whole. After a year's therapy in both patients without significant benefit apparent successful results were attained following pneumonectomy. During the postoperative period intensive therapy with sulfadiazine and penicillin given both systemically and intrapleurally was used. It is believed that patients with pulmonary actinomycosis who fail to improve following intensive adequate courses of chemotherapy should be treated by pulmonary resection while the disease is still limited to the lung and before the development of multiple thoracic sinuses.

PAUL MERRILL, M.D.

Santy Bérard, Galy, Magnin and Papillon: Stenosis of the Large Bronchi in the Course of Chronic Tertiary Pulmonary Tuberculosis in the Adult (Sténoses des grosses bronches au cours de la tuberculose pulmonaire chronique tertiaire de l'adulte). *Arch. méd. chir. app. resp. Par.*, 1942-1945 15 189.

The authors discuss stenosis of the large bronchi in the course of pulmonary tuberculosis and describe 10 cases illustrated with roentgenograms and drawings. This stenosis may occur in a bronchus which drains a tuberculous area, or in a tributary bronchus which drains a normal area. There are certain clinical signs such as attacks of coughing resembling whooping cough, asthmatic attacks and wheezing but diagnosis is made largely by roentgen examination and bronchoscopy. Atelectasis frequently occurs in conjunction with this condition. Residual stenosis and bronchiectasis may persist at the base after the healing of the primary apical lesion.

The question of treatment in these cases of bronchial stenosis is a difficult one. The authors do not



think it necessary to give up artificial pneumothorax because of the occurrence of a bronchial stenosis. The decision depends rather on the course of the parenchymatous lesions and on whether any substitute treatment is available. There has been a great deal of discussion as to whether thoracoplasty should be performed on a cavity in the field of a stenotic bronchus. The question is not yet definitely settled. In the one case in which the authors attempted such a thoracoplasty it was a failure, but they do not believe the stenosis of the bronchus was entirely responsible for the failure. For the treatment of the stenosis itself, powdering with cocaine or adrenalin followed by aspiration of the pus and intra-tracheal instillation of antiseptic oil have been recommended. This treatment brought about improvement in 2 of the authors' cases: 1 patient developed intolerance for novocain and in 1 case the patient died in spite of the treatment. Dilatation with bougies improves drainage but in the majority of cases does not bring about definite obliteration of the cavity. Surgical removal of the affected and bronchiectatic lobes seems to be the logical treatment in spite of its severity. Although the mortality is high the patient is certain to die if not treated.

The question of whether the bronchial lesions are specifically tuberculous has been much discussed. In the 3 of the authors' cases in which careful histological examinations were made no specific tuberculous lesions were observed.

AUDREY G. MORGAN M.D.

Brantigan O. C.: Open Pneumonolysis. *J. Thorac. Surg.* 1946 5: 541.

The advances in medicine and surgery that favorably influence the results in open pneumonolysis are many. These advances, when applied clinically have eliminated most of the morbidity and mortality associated with past attempts at open pneumonolysis. Pneumothorax should not be carried out when the patient has a large tension cavity. Also when either fibrotic or tuberculous bronchial stenosis exists, pneumothorax should not be instituted nor should it be continued when atelectasis occurs. The necessity of doing open pneumonolysis is thus eliminated in this group of patients in whom complications are frequent and serious under pneumothorax therapy alone. Fewer patients need open pneumonolysis because the closed release of adhesions is highly effective. Thus, when a patient is selected for an open operation no surprise or unexpected contraindications will be found when the pleural cavity is opened.

Rigid indications and contraindications for open pneumonolysis were adopted in an endeavor to keep the operation free of morbidity and mortality. The following indications have been used.

The patient, of course, must be a suitable candidate for pneumothorax. Thoracoscopy must be carried out before a decision is made. If possible a release of the adhesions will be effected. If closed release cannot be done or if the adhesions are re-

leased incompletely the remaining adhesions are studied with open pneumonolysis in mind. The patient is acceptable for open pneumonolysis if the adhesions are not too extensive and numerous, if the area of lung adherent to the parietal or mediastinal pleura is not greater than the surface area of the operator's palm, and if there is no evidence of pleural exudate, tubercles, or pleuritis. The patient's physical condition must be good enough to withstand the operation. Open pneumonolysis is contraindicated if the conditions are contrary to those enumerated namely if extensive adhesions, large areas of lung adherence, pleuritis, pleural tubercles, or pleural exudates are present, or if the patient obviously could not withstand operation. Thick pleural effusions will contraindicate open operation but small transient effusions will not.

Perhaps the indications for open pneumonolysis have been held entirely too rigid. When thoracoscopy alone was done only 19.8 per cent of the cases were recommended for open operation. It is possible that more should have been recommended. Hope in 1937 subjected to open pneumonolysis only 7 of 220 patients who underwent a closed release of their adhesions or examination alone. However the rigid indications undoubtedly accounted for the absence of postoperative morbidity and mortality and the for the good end results. If the indications are to be relaxed at all it seems that one might accept more complicated adhesions and larger areas of adherence of the lung to the chest wall for operation. It does not seem feasible that one-half of the pleural surface can be denuded without complications. In such cases thoracoplasty surely would be indicated rather than open pneumonolysis.

From close observation it appears that patients tolerate the administration of general anesthesia better than local anesthesia. However, there is less difficulty with re-expansion under local anesthesia when the patient struggles on recovery from the general anesthesia.

The supine position with an anterior incision is used because there is less chance of aspirating bronchial secretions into the other lung.

The third interspace is selected for the incision. It gives the best exposure. One is sometimes tempted to use the second or fourth interspace, but if this course is followed the exposure is jeopardized. If the exposure is not adequate the adjacent costal cartilage may be divided. A division of the third costal cartilage allows more exposure in the apex, whereas division of the fourth costal cartilage permits greater exposure inferiorly. The breast is elevated superiorly. The skin, breast, fat, and pectoralis major muscle are raised as a single flap. This places the muscle incision inferior to the incision through the interspace.

The lung is always handled with great care in order to eliminate trauma. The adhesions are released in the endothoracic fascial plane, as pointed out by Eloesser and Carter. This step prevents injury to the lung. Much attention is given to hemostasis.

All bleeding points are controlled by suture ligatures of silk. No attempt is made to close the pleura or the intercostal space.

In this small series as in all other series in which pulmonary tuberculosis is treated disease in the contralateral lung reduces the chances for favorable end results. It appears that obliterative pleuritis occurs rather frequently after open pneumonolysis, but it is possible that the judicious use of oleothorax will control the obliterative pleuritis.

JOHN E. KIRKPATRICK, M D

Cory R. A. S.: Report of a Clinical Trial of Oxidized Gauze in 7 Thoracoplasties *J Thorac Surg.* 1946 15 367

After using oxidized gauze in 7 thoracoplasties the author draws the following conclusions.

Oxidized gauze (soluble cellulose) is a distinctly valuable addition to the hemostatic armamentarium. It provides, in an easily handled form a packing material which can be safely left in a wound with no fear of its remaining as an irritating or permanent foreign substance.

Its use in clean wounds does not delay the healing nor does it interfere with the strength of union of the tissues.

When soaked with blood it has no strength of fiber, but rapidly becomes a sticky mass which is admirably adapted to packing deep narrow cavities either in soft tissues or between raw surfaces of the bones.

The author expresses no opinion upon its suitability for use in contact with serous membranes nor does he attempt to say what effect it might have in the presence of deep sepsis in a surgical wound. However there is no doubt whatever of its value in thoracoplasty.

JOHN J. MALONEY M D

Lindskog G. E. Bronchogenic Carcinoma. *Ann Surg* 1946 124 667

In spite of the rapid advances, since 1933 in the technique of surgical resection for the eradication of primary pulmonary cancer the treatment of bronchogenic cancer is still disappointing and challenges further effort.

The author presents his experiences in the treatment of 100 consecutive cases of primary pulmonary cancer seen over a 5 year period ending December 1943.

Of the 100 patients, 82 were males a ratio of 4.5 males to 1 female. One patient was colored the expected racial distribution. The average was 54.8 years the youngest patient being 22 and the oldest above 70 years of age.

In 60 of the patients the first observed symptom was cough, pain in the chest, or a gripe like "cold." Six had early dyspnea, and 4 showed hemoptysis as an early complaint. Three had an acute pneumonic onset, 9 had vague complaints of weakness and weight loss, and 14 had initial symptoms related to metastases or extension of the tumor beyond the lung.

In 98 patients the average duration of symptoms prior to admission was 6.7 months. There was no significant difference in duration between operable and inoperable cases. The primary lesion was on the right in 51 cases and on the left side in 47 cases. The upper lobes and stem bronchi above the upper lobe orifice were involved in 69 per cent of the cases. In 2 cases the primary focus could not be determined.

Positive tissue diagnosis was obtained in 82 cases—in 77 living patients and in 5 at autopsy. In the remaining 18 the methods employed to give a positive biopsy failed or the patients refused to submit to the indicated procedures. These patients exhibited a typical clinical course and all subsequently died.

In 63 patients the condition was inoperable when first seen and 3 patients refused treatment. In 36 of these the carcinoma was proved by biopsy of metastases or by involvement of important nerves in 3 patients the carina or trachea was found to be invaded in 18 presumptive evidence of inoperability was present (roentgenographic or bronchoscopic evidence of mediastinal distortion), 7 patients were moribund and 1 patient had had radon treatment elsewhere, with no trace of the original lesion.

Surgical exploration was carried out in 32 cases. In 10 of these extension to hilar or mediastinal nodes or to the parietal pleura was observed. Local extension to the parietal pleura was not considered a contraindication to resection and a block resection of the locally involved area was carried out in several cases.

Of the 12 resections 10 pneumonectomies and 2 total upper lobectomies were carried out. Complications were observed in 10 of these: a putrid abscess in 1 patient, local parietal pleural extension in 3 patients, tuberculous hilar nodes in 1 patient, an obstructive pneumonitis with pneumococcal empyema in 1 and a massive pleural effusion without gross pleural involvement in 1. Invasion of the hilar (intratracheal) nodes was observed in 3 patients and contralateral metastasis was proved later in 1 patient.

The average age of the patients was 54 and the oldest patient was 68 years of age.

Thirty-eight patients who were given only diagnostic or symptomatic care survived for an average period of 5 months. Twenty-nine patients received high voltage roentgen therapy, radon implantation or both. All are dead after an average survival of 7.4 months. Treatment was of doubtful value as a means of prolonging life but was effective in producing relief from pain, decrease of dyspnea, improved aeration and bronchial drainage as well as in a psychotherapeutic way.

There were no operative deaths among the 30 patients in whom exploration without resection, had been carried out. Nine patients who had had no subsequent x-ray treatment survived for an average period of 8 months. Patients who had been treated by irradiation lived for an average period of 11.8 months.

Three patients died in the hospital following total pneumonectomy at 12, 42 and 80 days after oper-

think it necessary to give up artificial pneumothorax because of the occurrence of a bronchial stenosis. The decision depends rather on the course of the parenchymatous lesions and on whether any substitute treatment is available. There has been a great deal of discussion as to whether thoracoplasty should be performed on a cavity in the field of a stenotic bronchus. The question is not yet definitely settled. In the one case in which the authors attempted such a thoracoplasty it was a failure but they do not believe the stenosis of the bronchus was entirely responsible for the failure. For the treatment of the stenosis itself powdering with cocaine or adrenalin followed by aspiration of the pus and intra-tracheal instillation of antiseptic oil have been recommended. This treatment brought about improvement in 2 of the authors' cases. 1 patient developed intolerance for novocain, and in 1 case the patient died in spite of the treatment. Dilatation with bougies improves drainage but in the majority of cases does not bring about definite obliteration of the cavity. Surgical removal of the affected and bronchiectatic lobes seems to be the logical treatment in spite of its severity. Although the mortality is high the patient is certain to die if not treated.

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Surgical exploration was carried out in 32 cases. In 20 of these extension to hilar or mediastinal nodes or to the parietal pleura was observed. Local extension to the parietal pleura was not considered a contraindication to resection and a block resection of the locally involved area was carried out in several cases.

Of the 12 resections 10 pneumonectomies and 2 total upper lobectomies were carried out. Complications were observed in 10 of these: a putrid abscess in 1 patient, local parietal pleural extension in 3 patients, tuberculous hilar nodes in 1 patient, an obstructive pneumonitis with pneumococcal empyema in 1 and a massive pleural effusion without gross pleural involvement in 1. Invasion of the hilar (intratracheal) nodes was observed in 3 patients and contralateral metastasis was proved later in 1 patient.

The average age of the patients was 54 and the oldest patient was 68 years of age.

Thirty-eight patients who were given only diagnostic or symptomatic care survived for an average period of 5 months. Twenty-nine patients received high voltage roentgen therapy, radon implantation or both. All are dead after an average survival of 7.4 months. Treatment was of doubtful value as a means of prolonging life but was effective in producing relief from pain, decrease of dyspnea, improved aeration and bronchial drainage as well as in a psychotherapeutic way.

There were no operative deaths among the 20 patients in whom exploration without resection had been carried out. Nine patients who had had no subsequent x-ray treatment survived for an average period of 8 months. Patients who had been treated by irradiation lived for an average period of 11.8 months.

Three patients died in the hospital following total pneumonectomy at 12, 42 and 80 days after oper-

ation. Six of the patients who had undergone resection died subsequently of metastases at intervals of from 3 to 26 months after operation.

Four patients are living—one 55 years after pneumonectomy for a squamous cell carcinoma, one, 45 years after pneumonectomy for a squamous cell carcinoma, and one, 25 years after lobectomy for a squamous cell carcinoma. One patient with anaplastic carcinoma of the mediastinum is alive and working 35 years after roentgen treatment. This last patient is the only one of the irradiated group in whom a lasting effect was obtained.

Two patients were submitted to pneumonectomy for solitary carcinoma metastases from the uterus and urinary tract with survivals of 24 and 5 months, respectively. The author did not include these cases in his statistical survey.

ROBERT R. BROULOW M.D.

Carnes, O. J., Cesanelli A., and Triccerri F. E.: Surgical Treatment of Lung Cancer. Personal Experience (*Nuestra experiencia en el tratamiento quirúrgico del cáncer de pulmón*). *Praxis méd. arg.* 1946 33 63.

Between the end of 1943 and May 1946 107 patients with bronchogenic carcinoma were seen by the authors. Of this number 21 (21.4%) were considered suitable for exploration and 12 of the latter group were operable (57.1% of the cases explored). Eleven pneumonectomies and 1 lobectomy were done. There were 3 deaths (25%) from resection and 1 (4.76%) from an exploratory thoracotomy. A bronchopleural fistula occurred three times after resection, and empyema occurred in 25 per cent of the resected cases.

The contraindications to exploration are demonstrable metastases, laryngeal, cervical sympathetic, or diaphragmatic paralysis, hemorrhagic pleural effusion, skeletal involvement and general debility of marked degree. The bronchoscopic signs of inoperability include involvement of the trachea and widening or fixation of the coryna.

The authors urge early diagnosis, including exploratory thoracotomy for the lesions peripherally located which are otherwise inaccessible for accurate diagnosis.

Twelve brief case reports and numerous illustrative roentgenograms are appended.

HIRAM T. LAMSTON M.D.

Langer L. and Bracco A. N.: Segmental Pulmonary Resection. Its Indications (Resecciones pulmonares segmentarias. Sus indicaciones). *Praxis méd. arg.*, 1946 33 854.

This article is based on the experiences in the service of Richard H. Overholt of Boston. The technique of segmental resection is being described in an article by Overholt and Langer (in press) and is based on such interventions carried out on 32 patients with bronchiectasis (22), chronic abscess (4), tuberculosis (4), hamartoma (1), and myxoliposarcoma (1). No deaths occurred. The only significant

postoperative complication was empyema, which occurred in 15 per cent.

The authors review the concept of bronchopulmonary segmental arrangement, applying it to the intralobar areas. They adopt essentially the nomenclature of Huber and Jackson. Attention is called to the occurrence of interlobar vascular communications.

The segments are identified by bronchoscopy, bronchography, and at operation by occluding the corresponding bronchus and inflating or deflating the lung to indicate the segmental boundary in the parenchyma.

Segmental resection is useful for such conditions as bronchiectasis, chronic abscess, benign or undifferentiated tumors, and isolated metastatic neoplasms. Tuberculosis, possibly simple bronchial cysts, localized emphysematous bullae, and even actinomycosis or hydatid cysts are suggested as other possibilities.

The segmental approach is useful in providing a means of eradicating the areas of disease without sacrificing normal functional lung; however, the caution is sounded that resection should be adequate by including all the involved areas, particularly in bronchiectasis. This conservation of lung may permit operations for multilobar involvement.

In tuberculosis the actual extent of disease is found at operation frequently precludes the restriction of resection to lobular segments, even though the procedure may be used in selected enormous lesions, tuberculosis, and in obtaining pneumonectomy when the disease has crossed an interlobar fissure.

The various indications are discussed, and case reports are given and illustrative roentgenograms and photographs are appended.

HIRAM T. LAMSTON, M.D.

## ESOPHAGUS AND MEDIASTINUM

White, M. L. Jr. and Birdsong, M.: Congenital Esophageal Atresia with Tracheoesophageal Fistula. *Surgery* 1946 20 548.

Although congenital atresia of the esophagus with tracheoesophageal fistula is not rare interest in the condition has recently revived a stimulus from successful reports of operations for the uniformly fatal lesion. In 1929, Vogt summarized the variations of this anomaly in the following classification which is still widely accepted:

Type 1: complete absence of the esophagus (extremely rare); type 2: blind end to both upper and lower segments of the esophagus, with no tracheal communication from either segment (rare); type 3a: upper segment with tracheal communication and a blind lower segment (rare); type 3b: a blind upper segment and a communication between the lower segment and the trachea (common type); type 3c: communication of trachea with both upper and lower segments (rare). Thus there is only one type of type 1, type 3b which comprises about 50 per cent of the cases. Inasmuch as all attempts at

reconstructing a functional esophagus were failures until 1911 the report of a single case is thought justified

The patient was a white female infant. It was noticed at birth that there was much pharyngeal mucus which required aspiration and a marked but temporary laryngeal stridor. After 24 hours with every feeding the child would regurgitate and become somewhat cyanotic. Because of repeated regurgitation of everything taken by mouth a small catheter was passed into the esophagus on the morning of the fourth hospital day, and an obstruction was met about halfway down the length of the esophagus. The patient was taken to the x-ray department and 2 c.c. of iodized oil were injected into the esophagus by catheter. A complete atresia of the esophagus with a large bulbous upper segment extending as far down as the second dorsal vertebra was noted on fluoroscopy. Roentgenograms confirmed the fluoroscopic findings and also showed a large amount of gas in the stomach and intestinal tract. There was no evidence of pneumonia. The diagnosis of atresia of the upper portion of the esophagus with tracheoesophageal fistula of Vogt's type 3b was made and the patient was prepared for immediate operation.

Under local infiltration anesthesia the large upper blind pouch of the esophagus was easily identified and dissected free as was the lower segment also since it extended almost to the upper segment. Although much smaller in diameter it appeared to have a lumen adequate for anastomosis. The lower segment was attached to the trachea about  $\frac{1}{4}$  cm. inferior to the upper segment. A tracheoesophageal fistula at this point was isolated after transfixion the ligatures were placed in the wall of the fistula close to the trachea. The fistula was divided opening the lumen of the distal segment of the esophagus. The lumen of the upper segment was entered by amputating the bulbous tip of the upper segment.

A No. 8 French urethral catheter was passed into the stomach through the distal segment of the esophagus and its upper end was passed through the upper segment into the pharynx where it was retrieved by the anesthetist. The two ends of the esophagus could then be brought together over the catheter and held by traction sutures.

The diagnosis in the case reported was suspected when the child began to vomit her food immediately after ingestion, and in the intervals to eject continually a small amount of foamy saliva. Cyanosis especially at feeding time was also a noteworthy symptom. These are classic signs of the type 3b tracheoesophageal fistula.

There would seem to be no difficulty in choosing between the one-stage direct anastomosis and the indirect method from the point of view of functional end results. With the former the patient has, following a single procedure an esophagus approximating the normal with the latter he has, after a prolonged convalescence marked by multiple plastic operations, only a substitute for an esophagus. The data are as yet too incomplete to permit any positive

conclusions on the relative operative risk of the two primary procedures. There seems only one reason for the indirect approach namely an anatomic condition that will not permit direct anastomosis which unfortunately is frequently encountered.

This case is believed to be the fourth recorded case which did not include a supplementary gastrostomy. When gastrostomy can be avoided, the postoperative course is transformed from a difficult feeding and nursing problem of indefinite duration into one of parenteral maintenance for a few days followed permanently by normal oral feedings. Penicillin, by lessening the incidence of anastomotic leaks will probably decrease the need for gastrostomy.

The three important points in the postoperative care are the prevention of infection the control of body temperature and the maintenance of nutrition.

There should be the closest co-operation between the thoracic surgeon and the pediatrician in the handling of these cases.

STEPHEN A. ZIEMAN M.D.

James, R. M. Diverticula of the Lower Thoracic Esophagus. *Ann. Surg.* 1946 124 637

Diverticula of any portion of the thoracic esophagus are rare only 116 being reported in the literature up to 1934. This probably does not represent the true frequency of the disease. Improvement in roentgenological examinations of the esophagus will undoubtedly lead to more frequent recognition of this condition. Giant diverticula remain of interest.

Thoracic esophageal diverticula are described as of the traction or pulsion variety. The former are congenital and result from fixation of a point on the outer esophageal wall to an inflammatory tuberculous node

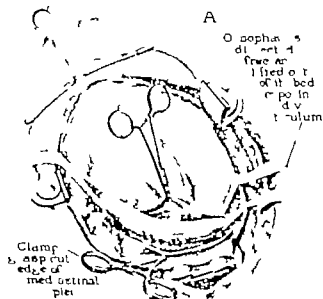


Fig 1 (James) Exposure obtained (Courtesy of J B Lippincott Co.)

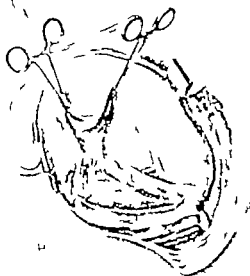


Fig. 2 (Jones) Diverticulum freed and held up by clamps.

Their wide open mouths seldom catch food and they are generally asymptomatic except for a rare perforation. The pulsion type are said to result from herniation of the mucus membrane through the muscular wall. The diverticula removed in this series had rather thick walls formed of squamous epithelium, submucosa, muscularis mucosa, and a layer of fibrous tissue. In all cases there was marked infiltration of inflammatory cells in the submucosal area.

The etiology of these diverticula is unknown. Some are associated with cardiospasm and are regarded as a rare complication of that condition. Some additional factor either congenital weakness or degenerative change in the esophageal wall may be responsible.

Barrett has suggested a third type of esophageal diverticulum, the traction-pulsion in which a combination of etiologic factors is said to exist.

The outstanding symptom is difficulty in swallowing. It may be first noted with liquids or be more troublesome with solids. Substernal pain sometimes referred to the interscapular region is nearly always present. Vomiting or regurgitation occurred in all cases. Loss of appetite, weight loss and sometimes extreme dehydration may follow. The symptoms seem to occur in episodes with the patient free of discomfort for long periods.

Diagnosis is based on the clinical history and demonstration of a diverticulum on barium study of the esophagus. In 2 cases a fluid level on the plain chest roentgenogram led to discovery of the lesion.

Diverticula discovered on routine examination need treatment. Those associated with symptoms should be treated surgically.

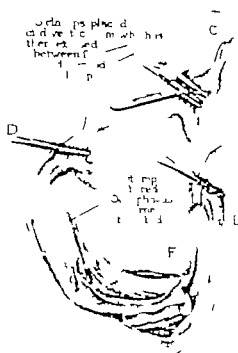


Fig. 3. Method of excision and suture.

The symptoms probably are initiated at times by an inflammatory swelling. Patients with large diverticula should be encouraged to be operated on while still in good condition. There is danger of ulceration, perforation and hemorrhage. When the operation is delayed too long, the patient becomes severely ill with malnutrition and dehydration and the danger of operation is much increased.

Preoperative malnutrition and dehydration should be corrected by continuous feeding through a duodenal tube. The esophagus and diverticulum should be washed out with a tube on several occasions for 24 hours preoperatively. The tube in the esophagus at operation aids in identification of the esophagus and diverticulum. It is used after operation for aspiration of air and fluid from the stomach for the first day or two and later for feeding. Swallowing is permitted after the fifth day. Intratracheal closed anesthesia is necessary because of the danger of opening into the right pleural cavity during the dissection. Blood should be replaced as necessary.

A posterolateral approach through the seventh or eighth intercostal space is satisfactory. The mediastinal pleura is incised for 3 inches in the region of the diverticulum and the esophagus and diverticulum are gently isolated and lifted forward on tapes (Fig. 1). The sac usually arises from the posterior aspect of the esophagus and joins it by a neck several centimeters in diameter (Fig. 2). Then 3 Kocher forceps are placed across the neck of the diverticulum which is then divided with a cautery between the 2 distal clamps. The second clamp is removed and the

fringe of tissue left is oversewn with a running suture of chromic catgut on an atraumatic needle. The third clamp is removed and the first layer of sutures is invaginated with a row of Lembert sutures (Fig. 3). There is no encroachment on the lumen. The divided mediastinal pleura is sutured behind the isolated portion of the esophagus in order that infection if it should occur will involve the pleural cavity rather than the mediastinum. The chest is closed with a water sealed intercostal drain to the site of operation. The author suggests the use of penicillin post-operatively for from 5 to 7 days to lessen the danger of local or pulmonary complications.

The author then gives the case reports of 6 cases of diverticula of the thoracic esophagus. The first 4 were operated on without a mortality. The patients had complete relief of symptoms. Preoperative and postoperative roentgenograms are shown.

ROBERT R. BIGELOW M.D.

Sweet, R. H.: Carcinoma of the Midthoracic Esophagus. *Ann. Surg.* 1946 124 653

Any operative treatment for carcinoma of the esophagus should be undertaken with the aim of prolonging life, effecting a possible cure, and relieving the distressing obstruction produced by the growth.

Until recently the Torek operation was the only available method of removing a carcinoma of the midesophagus. The Torek operation fails to provide for removal of the subdiaphragmatic pericardial nodes and the left gastric nodes both of which were involved by tumor in 50 per cent of the author's series of 32 cases. With the Torek operation the principle of cancer therapy (wide excision of the primary tumor and of as many of the regional lymph nodes as possible) is violated. It fails to provide satisfactory palliation as has been shown in the author's report of 14 cases. All but 1 of the patients died of recurrence or metastases and 10 patients died before the external esophagus was completed.

A satisfactory technique has been developed for radical resection of the local disease and of at least 3 of the 4 groups of regional nodes usually invaded. The author states that use of the method offers greater promise of a cure and in addition the intrathoracic esophagogastric anastomosis permits the patient to swallow normally. Because of the palliation afforded by this procedure it is believed to be far superior to the Torek operation.

The author describes his technique for esophagectomy with high intrathoracic esophagogastric anastomosis. Under intratracheal ether-oxygen anesthesia an incision is made over the entire length of the eighth rib which is resected. Often one or more ribs posteriorly must be divided to provide access to a high tumor or to perform a high anastomosis.

First the resectability of the growth must be determined by incising the mediastinal pleura and beginning the dissection anterior to the esophagus. Here invasion of the left main bronchus, extensive involvement of the region around the inferior pulmonary vein or fixation to the aorta may make the

tumor inoperable. If adhesions to these structures can be divided dissection of the posterior attachments is begun. In the author's cases this procedure was delayed in order to avoid interference with the blood supply of the midesophagus as the result of dividing one or more of the esophageal arteries arising from the aorta. After the posterior attachments are divided the tumor must be freed from the right mediastinal pleural reflection. Sometimes a portion of this pleura must be excised. This was done without complication in 3 of the 32 cases reported. With the closed method of anesthesia the lung is kept expanded, and the chest is closed without any attempt to repair the pleural defect. In a few cases a small portion of the adjacent lower lobe of the right lung (if it is fixed to the growth) must be removed. The lung defect is closed with a continuous suture of catgut on an atraumatic needle.

After the esophagus is dissected free from the level of the aortic arch downwards the diaphragm is opened from the esophageal hiatus to the costal margin. The phrenic nerve is crushed for diaphragm immobilization. The upper two-thirds or more of the stomach is then freed in order to allow the fundus to be brought to a high level in the chest for anastomosis. The gastroligament is divided and the left gastropiploic vessels and the vasa brevia are cut and tied. The spleen is retracted and the gastrosplenic omentum is divided as far as the pylorus being careful to avoid injury to the right gastropiploic vessels. The attachments of the cardia and lower esophagus, including branches of the superior suprarenal, inferior phrenic and the pericardiophrenic vessels, are then cut. The left gastric artery is cut and tied close to its origin from the celiac axis and then the stomach fundus can be placed without difficulty in the apex of the chest.

The stomach is divided between the clamps at the cardia with care to remove the lymph nodes near the lower esophagus, cardia and left gastric vessels. The distal portion is inverted by means of two layers of continuous sutures of fine chromic catgut reinforced with a layer of interrupted silk sutures. A rubber glove is tied over the lower end of the esophagus. After the stomach is mobilized, the mediastinal pleura is incised and the esophagus in the superior mediastinum is freed by blunt dissection.

Whenever possible, dissection behind and above the arch of the aorta is avoided, and the anastomosis is performed just below the arch.

At a high level on the fundus of the stomach a circular incision of appropriate size is made through the serosal and muscular coats. A suitable site for the anastomosis is chosen several centimeters above the upper limits of the growth and an outer layer of mattress sutures comprising the first layer of the posterior half of the anastomosis is placed and tied. A Wertheim clamp is placed on the esophagus several centimeters distal to the site of the anastomosis and the muscularis of the posterior esophageal wall is incised. The resulting muscle edge of the esophagus is sutured to the muscle edge of the stomach



The posterior half of the esophageal mucosa is then incised and the circular portion of the stomach out-lined by the initial incision is excised. The gastric contents are aspirated. The posterior layer of mucosal sutures is then applied. With bent blade scissors the anterior wall of the esophagus is incised and the specimen is removed. With the use of fine silk throughout the anterior three layers of the anastomosis are completed. A series of interrupted sutures are used to fasten the stomach to the parietal pleura to relieve pull on the anastomosis. The diaphragm edges are fastened to the pyloric antrum and approximated. Penicillin (50 000 units) is injected half in the thoracic and half in the abdominal cavity before closure. The incision is closed anatomically with silk sutures. A catheter for closed suction drainage is brought out through a stab wound one interspace lower posteriorly.

At completion of the operation the stomach is dependent for its blood supply on the right gastric and the right gastroepiploic arteries. The continuous arcades of the gastroepiploic arteries the anastomosis between the right and left gastrics, and the intercommunicating branches in the stomach wall are essential for nutrition of the anastomosis site hence great care in handling the stomach throughout the entire operation must be exercised. The esophagus has a segmental blood supply. If the anastomosis can be made below the arch the nutrition at the cut end will be adequate because of the small arteries arising from the arch and bronchial arteries. If the superior esophagus must be mobilized its only blood supply arises from the inferior thyroid artery. Therefore the esophagus when pulled anterior to the arch of the aorta must be divided at a high level within the chest in order to avoid necrosis at the cut end. Even though it is more difficult from a technical standpoint to do this, it may mean the difference between success and failure of the operation.

The thoracic duct was tied and divided in 3 of the cases with no ill effects. In a fourth case the duct was injured but not tied. This patient died of a chylothorax.

To avoid stricture at the anastomosis the author recommends (1) avoidance of using crushing clamps on either the gastric or esophageal side (2) the use of knife and scissors to cut the esophagus and stomach instead of cautery or chemical caustics, and (3) the use of fine interrupted sutures instead of constricting running sutures. A circular opening in the stomach wall for the anastomosis may also be of importance.

During 1944 and 1945 66 patients with mid thoracic carcinoma were seen and 41 were operated on. In 9 of these resection was impossible. Thirty-two (48.5%) had resections with high intrathoracic esophagogastric anastomosis. The high resectability is due to the feeling that the growth should be removed whenever possible, for palliative reasons. Of the 9 patients in whom resection was impossible 8 recovered and left the hospital only to die a few months later. The ninth patient died soon after operation, of widespread lymphatic invasion.

Of the resected cases one-half of the patients were over 65 years of age. In 14 of the 32 patients it was impossible to do the anastomosis below the arch of the aorta. Complications developed in 13 patients only 3 of whom were in the group with anastomosis below the arch. There were 2 postoperative deaths as compared to 6 in the group with the anastomosis above the arch.

Cardiac disorders caused the death of 5 patients, only one of these being in the subaortic anastomosis group. Three patients developed sepsis—empyema, mediastinitis and a wound infection of Staphylococcus aureus which responded to penicillin. Chylothorax developed in 2 patients. In 1 the condition came on rapidly and was fatal. In the other, it developed slowly and the patient died several months later of metastases. One patient developed a sublethal pulmonary embolus and recovered after superficial femoral vein ligation. One patient died after a pulmonary atelectasis and failed to respond to treatment. One patient recovered from a trivial tory surgical shock. ROBERT R. BARNER, M.D.

#### MISCELLANEOUS

Robertson R.: Crushing Injuries of the Chest. *J. Thorac. Surg.* 1946, 15: 324.

Crushing injuries of the chest are commonly encountered in civilian practice and for the most part are not adequately treated. They may cause shock and death from the following disturbances of the delicately balanced cardiorespiratory function: (1) hemorrhage (2) cardiac tamponade (3) respiratory failure (mechanical asphyxia) and (4) acute pulmonary edema.

In the treatment of crushing injuries of the chest it is essential to diagnose the pathological condition accurately and to understand clearly its effect on the physiology of the respiration and circulation. A crushing injury of the chest may fracture numerous ribs and thereby cause paradoxical respiration known as flapping chest wall. A fractured rib may puncture the lung or blood vessels or even in the absence of rib fractures, a sudden crushing injury may tear these structures. The following pathological conditions should be kept in mind: (1) airway obstructions with blood (2) flapping chest wall, (3) hemothorax, (4) tension pneumothorax, (5) massive atelectasis, (6) mediastinal hematoma, (7) mediastinal emphysema, (8) hemopericardium, (9) diaphragmatic hernia, (10) acute gastric dilatation, and (11) air embolism.

Oxygen should be administered immediately at the rate of from 8 to 10 liters per minute, even before cyanosis develops. The first signs of anoxia, rapid pulse, dyspnea and restlessness may appear some time before cyanosis develops. An immediate portable x-ray examination should be ordered. Prompt interruption of treatment for although the diagnosis will usually be clear on physical examination, some cases will be most misleading and x-ray views will be lifesaving.

Blood obstructing the airway should be removed by suction with a catheter passed through the nose into the bronchus.

A flapping chest wall with painful and paradoxical respiration can be relieved by adhesive strapping encircling the chest. Morphine may be given intravenously with caution to relieve pain. Depression of the cough reflex is not a disadvantage in the early treatment but tends to prevent further hemorrhage. Loss of blood is replaced by transfusions with large quantities of citrated blood, or if this is not avail-

able serum. A hemothorax should not be aspirated for 3 or 4 days, or until danger of intrapulmonary hemorrhage is over when torn pulmonary vessels have had sufficient time to become firmly thrombosed. The hydrostatic pressure of large quantities of blood in the thorax may cause cardiac tamponade but on the other hand it will tend to stop bleeding from the lung and the chest wall therefore if there are signs of cardiac tamponade aspiration should be only in order should be replaced with air sufficient to keep lung collapsed.

Aspiration must be persistent until the lung is completely and permanently re-expanded. Bronchial secretions or hemorrhage should be removed by aspiration rather than hard coughing. A diaphragmatic hernia is almost the only indication for immediate thoracotomy in crushing injuries of the chest. In every general hospital a team trained and equipped to treat crushing wounds of the chest would save many lives.

STEPHEN A. ZIEGLER M.D.

Letta, R. H. The Initial Surgery of Thoraco-abdominal War Injuries. *J. Thorac Surg* 1946 15 349.

The term thoracoabdominal wound denotes injury to the thorax and abdomen by the same missile. Such a wound necessitates actual penetration through the diaphragm, or transmission of sufficient force to produce injury in the other serous cavity. The vast majority of thoracoabdominal war injuries are due to a missile actually traversing the diaphragm. Casualties with separate wounds of the abdomen and thorax present a different problem and these are better termed combined thoracic and abdominal injuries. The discussion is limited to true thoraco-abdominal wounds.

A working diagnosis is readily apparent in the majority of war wounds including thoracoabdominal injuries. A thorough inspection of all surfaces of the thorax and abdomen both anteriorly and posteriorly for wounds of entrance or exit plus the usual examination and roentgenological procedures is sufficient in most cases. The pleura can be assumed with reasonable accuracy, to follow the outline of the periphery of the ribs and costal cartilages. Any missile passing through the area from the level of the twelfth rib posteriorly to the level of the fourth rib anteriorly (on expiration) may or may not

have entered both the pleural and peritoneal cavities. A large number of soldiers are wounded while lying prone, and the increased abdominal pressure further raises the upper limit of the diaphragm.

Resuscitative methods and proper preoperative care are of utmost importance to both the thoracic and abdominal casualty. If the wound is a thoraco-abdominal one certain concessions may have to be made that are not ideal from one or the other viewpoint. Thoracic physiology should be restored to as nearly normal as possible before operation and the length of time this takes within limits is unimportant from the thoracic standpoint. Time is of great importance in cases of abdominal injury. It is therefore often necessary to treat patients with a thoracoabdominal injury somewhat differently than patients with either straight thoracic or abdominal conditions are treated. Replacement therapy with blood plasma and electrolytes can be used quite freely for abdominal cases but there is some danger of overloading the already deranged cardiorespiratory system of the thoracic casualty.

Two other factors need to be mentioned in regard to resuscitative measures for thoracoabdominal cases. The first factor is that of the influence of disturbed cardiorespiratory physiology on the production and prolongation of shock. The second is a similar influence due to severe peritoneal or pleural cavity contamination. The main causes of a disturbed cardiorespiratory balance in the recently injured man are as follows. The presence of blood and/or air in the pleural cavity with diminution of the functioning pulmonary parenchyma, the presence of large pulmonary hematomas, the presence of blood or mucus in the tracheobronchial airway. Shock therapy must be continued during and after operation. It is therefore wise to insert a needle or cannula in the saphenous vein preoperatively because it is not as likely to become dislodged by the necessary manipulations of the patient as if it were in a vein of the arm.

A Levine tube for stomach decompression is best inserted soon after admission as many patients have surprising degrees of gastric dilatation which by elevating their diaphragm further hampers adequate oxygenation. Also the period of time since the ingestion of food is not a good criterion of the amount of material in the stomach since a large residue is often present many hours after eating. This may be due to pylorospasm or lessened gastric motility from the nervous tension of battle.

Endotracheal oxygen-ether by the closed method was the author's choice of anesthesia. Periodic aspirations of material from the trachea and bronchi were essential. Positive pressure was useful to expand the lung periodically during operation and to encourage pulmonary expansion at the end of operation especially if the thorax was closed without drainage.

In selecting the operative approach, prime consideration should be given to the expected intrathoracic

and intra-abdominal damage. There are distinct advantages to the thoracic approach for operations that can be done from above. These can be enumerated briefly as follows. It facilitates repair of some upper abdominal organs such as the spleen and upper portion of the stomach. Colostomies can be done when indicated through a muscle splitting incision at a greater distance from the main incision than is possible through the abdominal exposure. Patients can be carried in a lighter plane of anesthesia as abdominal relaxation is not necessary. The diaphragm can be more easily and satisfactorily repaired from above than from below. In patients with marked pleural contamination the pleural cavity can be thoroughly washed out with saline solution to reduce the degree of infection. The postoperative course is smoother following thoracotomy than it is after a celiotomy since there is less pain and less tendency toward pulmonary complications.

There are certain limiting factors to the transdiaphragmatic approach. Lesions of the terminal 18 inches of the small bowel and the colon except for the transverse splenic flexure and proximal descending portions usually cannot be exposed adequately from above. For cases with minimal thoracic involvement the abdominal approach prevents entrance to both the abdominal and the pleural cavities. It should be pointed out, however, that any except the smallest hole in the diaphragm constitutes a sucking wound of the thorax when the abdomen is open just as much as does a hole through the thoracic cage. Not infrequently patients will develop pulmonary embarrassment from the aspiration of air through the hole in the diaphragm while abdominal repair is being completed. If this condition is permitted to continue and is unrecognized serious results may follow. Also bowel or stomach contents in the peritoneal space may be aspirated into the pleural cavity. Diaphragmatic repair instead of being relegated to the conclusion of the operative procedure should be the first step when using the abdominal approach.

Correction of cardiorespiratory imbalance is the most important phase of the preoperative preparation of casualties with thoracoabdominal injuries. Thoracentesis, intercostal nerve block and maintenance of a free airway are the three essentials of so doing.

The diagnosis of thoracoabdominal injury is often difficult if the wound is in the region of the diaphragmatic sulci. Exploration should be done in any case about which there is reasonable suspicion as to pleural involvement.

The mortality rate in thoracoabdominal injuries is directly proportional to the severity of the wound. The rate increases progressively as the number of injured abdominal organs rises. Likewise right-sided injuries do better than left-sided ones since in the former the liver is frequently the only abdominal organ involved.

In the series of 903 thoracoabdominal injuries treated by the surgical teams of the Second Auxiliary

Surgical Group the overall mortality was 73 per cent. For the severely wounded thoracoabdominal casualty surviving the first postoperative day the syndrome of "post-traumatic uremia" is no great hazard. In a series of 48 cases, with 11 deaths of the fatalities were due to this syndrome.

It has been demonstrated that more patients with thoracoabdominal wounds die of pulmonary complications than succumb to complications within the peritoneal cavity. This indicates that reducing the incidence of pulmonary complications in the immediate postoperative period by careful attention to securing a completely expanded lung against an intact chest wall, and the maintenance of a free airway should result in a lowering of the mortality rate for this group of casualties.

JOHN E. KIRKPATRICK, MD

Minkin, S. L.: The Causes of and Indications for Re-Operation Following Gunshot Wounds of the Chest. *Fractures*, 1945, No. 4, 331.

The author's experience extends over 600 cases of perforating wounds of the chest seen in evacuation hospitals deep behind the front lines. These cases had already been operated upon at least once.

In reviewing the indications for reoperation, the author cites in the first instance an inadequate primary operation. Reoperation was done 6 times in cases in which the first operation had been a Connors operation, and 7 in which the first was a Heller operation. In these patients the condition was too far advanced when the first operation was instituted. Nine patients underwent a secondary operation following a restricted Schede operation which had not been carried out thoroughly and extensively enough because the patient's general condition at operation forbade a more radical procedure, or the first surgeon had failed to appreciate the requirements of the individual case. Five of these proved to be the author's own patients.

The second principal cause of nonhealing wounds and fistulas is the presence of isolated cavities, often multiple, which are connected by narrow fistulous tracts with the main cavity for which the patient was originally operated upon. These are not always detectable even by roentgenological methods. The best method to avoid missing such a condition is a careful probing of the original cavity.

A third indication of re-operation is the presence in the pleural cavity of a foreign body. Foreign substances gain access to the cavity either at the time of injury or operation or during the changing of the dressings (drains, tampons, needles). Re-operation for this cause was performed by the author in 8 instances. In 4 of these the roentgenological examination enabled a preoperative diagnosis of the condition. In the other 4 the foreign material was found by chance during the operation itself (bits of rubber glove, pieces of tampon). In 3 other cases, in addition to these 8, the foreign body lay outside of the pleural cavity in a sinus. 11 of these patients the body was lodged in the peripheral tissues of the lung and per-

tially protruded into the pleura. In all of these patients the secondary operation resulted in immediate cessation of the suppurative manifestations and rapid healing. Such cases demand careful palpation with the finger of the pleural cavity.

A fourth indication is a localized osteomyelitis of the rib. In these cases the surgical technique employed must cover three possibilities. In the first instance in which the fistula does not connect with the pleural cavity the technique does not differ from that for osteomyelitis in any other bone of the body, but when the process connects with a residual pleural pus pocket the procedure should be radical with wide exposure of the affected rib and cavity. The third possibility is the coexistence of costal osteomyelitis and a pleural cavity which are not connected but nevertheless mutually influence each other.

When the osteomyelitic process is located in the cartilage of the rib roentgenography offers the best means of revealing the condition.

As a fifth cause of nonhealing of wounds and fistulas the author admits the possibility of secondary epithelization of the fistulous tract as described by Eggers. The author does not mention any experience with this condition in his material but nevertheless emphasizes thorough removal of the entire fistulous tract at operation and early removal of drains as prophylactic measures. In general, the author prefers to err on the side of premature suppression of drainage especially of the Bulau type of closed drainage, as soon as the discharge of pus has ceased

and the roentgenological examination shows the absence of fluid in the cavity being drained. The drain may be reintroduced if manifestations of fluid retention develop.

As a sixth indication for re-operation the author describes a condition of localized thickening and cicatrization of the parietal pleura. In 4 of his patients such an area seemed to harbor infection, and wide exposure with removal of the entire anterior wall of the cavity or at least localized removal of the thickened area, resulted in prompt cessation of the symptoms and complete healing.

As a seventh indication of nonhealing of wounds and fistulas of the chest is cited the presence of lung abscess and bronchial fistula. These cases will be the subject of a detailed report later on; here the author merely mentions their marked tendency toward spontaneous healing. In only 4 of the 26 patients in this group the bronchial fistulas required a secondary operation.

An eighth indication for re-operation is given as the association of a perforating wound of the chest with a pulmonary tuberculous process. In all of the author's patients with this association the condition had been recognized too late to prevent the fatal termination. The association is merely mentioned in order to emphasize the necessity of early diagnosis and a primary operative procedure (removal of the hemothorax) of the immediate institution of hygienic and dietary measures, and the avoidance if possible of a secondary operative procedure.

JOHN W. BRENNAN, M.D.

# SURGERY OF THE ABDOMEN

## ABDOMINAL WALL AND PERITONEUM

Ivanissevich, O., and Defazio, F.: Gelatinous Disease of the Peritoneum (*Enfermedad gelatinosa del peritoneo*). *Sem med B A* 1946, 53: 554.

A case of pseudomyxoma of the peritoneum also called Pean's disease or gelatinous disease of the peritoneum is reported by the authors. A man 43 years old noticed a gradual increase in the size of his abdomen. Nine months after the onset of the disease an operation was performed and 7 liters of fluid were withdrawn from the abdomen. The examination 6 months after the operation revealed an enormous enlargement of the abdomen which was slightly painful to palpation. Rather large nodules could be palpated through the abdominal wall. Paracentesis furnished fluid containing lymphocytes and endothelial cells. A tentative diagnosis of hydatidosis was made. The operation disclosed microcystic tumor formations, resembling grapes, scattered all over the parietal and visceral peritoneum and omentum. A large gelatinous mass was present in the abdominal cavity. The histological examination of a biopsy specimen established the diagnosis of pseudomyxoma.

Three months after the last operation the patient was readmitted and appendectomy was performed. The appendix was dilated and surrounded by cysts.

Three months later the patient was again admitted to the hospital with complaints of fatigue and progressive weakness. At operation it was found that the pseudomyxomatous nodules assumed the character of a neoplasm. It was impossible to remove all of the tumor formations. The histological examination showed fibrous bands and cavities lined with cylindrical partially calcified epithelium. Eleven months later a small hard, painless tumor was found in the left axilla. Histological examination of this tumor established the diagnosis of metastasis of a mucoid adenocarcinoma.

Eleven months after the last operation the patient was found in a stage of cachexia with a markedly enlarged abdomen. Roentgenogram showed metastases in the lungs.

The author concludes from his observation that pseudomyxoma of the peritoneum should be considered as a cancer originating from cylindrical epithelium. Such formations may develop from a pseudomucinous tumor of the ovary, intestinal diverticulum or mucoid disease of the appendix.

JOSEPH K. NARAT, M.D.

## GASTROINTESTINAL TRACT

Allen, A. W., and Welch, C. E.: Subtotal Gastrectomy for Duodenal Ulcer. *Ann Surg* 1946, 124: 685.

This study is a critical analysis of subtotal gastrectomy for duodenal ulcer performed on 195 pa-

tients. The series includes follow-up studies in 191 cases. The three main indications mentioned are cicatricial stenosis, massive hemorrhage, and intractable pain.

In discussing cicatricial stenosis, the authors point out that many ulcer patients become temporarily obstructed during acute exacerbations. However, these have a more sudden onset of symptoms and enter the hospital in a good state of nutrition. Such patients always respond to gastric drainage and intravenous therapy within a week or 10 days. Gastric resection is performed for the cicatricial type of stenosis rather than gastroenterostomy or pyloroplasty even in elderly patients.

In patients beyond the fifth decade an actively bleeding ulcer does not respond to conservative therapy in one-third of the cases. The younger patients nearly always recover regardless of treatment, whereas a large percentage of the older patients continue to succumb unless subjected to operation early during their bleeding period.

Intractable pain is an indication for surgery in many patients who if they were in a better economic or intellectual status might well have continued on conservative measures. However, there are many intelligent patients who will fall into this category.

Technically the patients who are to undergo gastrectomy are divided into four main groups by the authors. Group I includes the cases in which part or all of the ulcer scar was used in the closure of the duodenum. There were 130 cases in this group with a mortality of 5.4 per cent. Four of the 7 deaths were due to late massive hemorrhage.

Group II included the cases in which the ulcer was far enough distal to the pylorus to allow a transection of the duodenum above the ulcer and leave room for an adequate closure. In these cases removal of the ulcer might have led to disturbance of the bile ducts. There were only 18 patients in this group with 2 deaths, a mortality of 11.1 per cent.

In the 27 patients in Group III the authors performed transection of the antrum proximal to the pylorus with excision of the mucosa from this segment in addition to a generous gastric resection. There were 2 poor results in this group. This procedure has lost favor even in the eyes of Finsterer who suggested the operation originally.

In Group IV there were only 3 patients. It included those patients operated upon in two stages as advocated by McKittrick. The two-stage operation has all the disadvantages of any graded surgical procedure. The authors believe that this plan should be more widely adopted, since the 6-week interval between the two stages gives the inflammatory reaction about the ulcer a chance to heal. At the first stage prepyloric gastrectomy with anastomosis is done, the duodenal stump is dealt with at the second stage.

Transverse incisions were used in patients having a flaring costal angle and in those with low lying stomachs. There were 24 nonfatal complications of which were bland thrombi with pulmonary embolism. In 5 cases there was stomal obstruction and in 3 atelectasis.

Persistent gastrointestinal symptoms of some degree will occur in about one-third of the cases. The most frequent residual symptom is the inability to eat a full meal and discomfort gas or nausea after eating. Less common but more troublesome are the symptoms of the dumping stomach. Such patients have a sense of exhaustion or weakness after meals and occasionally have a rapid pulse perspiration, or vertigo followed by diarrhea or lower abdominal cramps. These symptoms are often alleviated by dietary measures and can be benefited by a high-protein low fat diet. A considerable number of patients gain weight whereas a larger percentage have difficulty acquiring their normal weight and cannot eat enough to gain while carrying on their work. The average weight loss is nearly twice as high in women as it is in men. Patients who have been operated upon for obstructions lose the least weight whereas those in which resection was done for pain or bleeding lose the most. It is interesting to note that postoperative results are better in women than in men.

The authors are convinced that posterior short loop anastomosis is preferable to antecolic anastomosis. It has been shown experimentally that each additional few centimeters of the small intestine proximal to the anastomosis add to the incidence of anastomotic ulcer. There were only 3 anastomotic ulcers in the followed-up series.

In the discussion Dragstedt stated that the authors results bear out his contention that removal of so important a digestive organ as the stomach has a profound effect on the nutritive status of the patient and he believes that eventually resection of the vagus nerves will supplant gastric resection in most instances of ulcer with intractable pain.

HAROLD LAUFMAN, M.D.

Hellmer H: Concerning the Diminution in Size of the Niche in Cancer of the Ventricle. A Difficulty in the Differential Diagnosis between Carcinoma and Ulcer of the Ventricle. (Ueber die Grössenabnahme der Nische bei Carcinoma ventriculi) *Acta radiol* Stockh. 1946 27 153.

The differential diagnosis between juxtaepiloric cancer and ulcer often cannot be made in a single roentgen examination. The size of the niche is not a valid basis for distinction since an ulcer may have a large crater and a cancer a small one. Unless the medical therapy is indicated with subsequent x-ray follow-up. Generally a diminution in size of the crater with medical treatment is thought to rule out cancer and justify the continuation of a conservative regimen. However the author gives an account of 4

cases in which a definite diminution in size of the niche was observed but at operation all of the lesions were proved to be cancer. In 3 cases there was a disappearance of the subjective symptoms along with the diminution in size of the crater.

In Europe it has not been emphasized that shrinkage in the size of an ulcer crater does not rule out cancer. The author cites numerous American writers who have pointed out that the niche in gastric carcinoma may become smaller on a medical regimen. A number of artefacts are discussed which might make a crater seem smaller in one examination than in a previous one. True decrease in size may also occur in gastric malignancy. If the lesion is an ulcer which has undergone malignant degeneration in one portion medical treatment can still cause healing of the nonmalignant portion. If an ulceration of a primary cancer is involved decrease in size may occur by growth of the cancer tissue into the crater by generalized contraction of the stomach in scirrhus cancer or because the crater is a true peptic ulcer developing in a carcinoma and responds like any other ulcer to medical therapy.

The author concludes that a roentgen diagnosis of benign ulcer in the ventricle requires complete disappearance of the niche with nothing remaining in the place to suggest carcinomatous infiltration.

THEODORE B. MASEKILL, M.D.

Zinninger M M: The Surgical Treatment of Bleeding Peptic Ulcer *Surg Clin N America* 1946 26 1140

The management of severe hemorrhage from peptic ulcer is difficult to standardize. It is generally agreed that a patient who has had severe recurrent hemorrhage should be treated by operation during an interval after bleeding has ceased and the effects of blood loss have been corrected. However many patients bleed to death during a hemorrhagic episode. If one could determine early which patients would respond to conservative therapy and which would continue to bleed one could operate on those in the latter group early in the course of bleeding and reduce the number of deaths from hemorrhage.

When a patient vomits blood and presents the symptoms and signs of bleeding into the upper gastrointestinal tract one must consider the likelihood of ulcer and attempt to elicit a history suggestive of this lesion. Other conditions which may simulate bleeding ulcer are esophageal varices secondary to hepatic cirrhosis or portal hypertension, secondary gastritis bleeding tumor hemorrhagic disease, diffuse aneurysm with erosion into the esophagus or duodenum.

The following studies are helpful in establishing the diagnosis routine blood studies, determination of the prothrombin time and blood urea nitrogen, fluoroscopy for evidence of aneurysm attempts to demonstrate esophageal varices by theValsalva technique and roentgenological study of the stomach and duodenum with barium by the Hampton technique.

If the presence of peptic ulcer is established the advisability of early surgery must be considered. If bleeding is moderate and appears to cease promptly the patient should be managed by nonoperative measures.

If the bleeding is massive, continuous, or recurrent and particularly if the patient is past 60 years of age, operation should be performed after adequate blood replacement therapy. The progress of bleeding may be estimated by clinical examination and by frequent blood pressure, red cell, hemoglobin, and hematocrit determinations. Digestion of blood in the gastrointestinal tract produces an elevation of the blood urea nitrogen and affords an excellent guide to the amount of blood loss and to the continuation or recurrence of hemorrhage.

The author's plan for the management of patients with bleeding peptic ulcer is described in detail. Usually these patients may be placed in one of the following groups:

1. Patients with known chronic peptic ulcer who bleed seriously while under treatment. These should be operated upon promptly.

2. Patients with duodenal ulcer who have been operated upon previously. These will usually bleed from a gastrojejunal ulcer and will usually respond to nonoperative treatment. If bleeding persists operation may become necessary and may be quite complicated and difficult.

3. Patients in whom the source of bleeding cannot be definitely established. These will require thorough study and much caution in the selection of therapy.

4. Patients with perforation, obstruction, or other complications in addition to hemorrhage. These require prompt operation.

5. Patients in any of the groups given who suffer repeated severe hemorrhages. These may require surgical treatment unless one can definitely establish that the bleeding is due to some condition other than ulcer.

The type of operative procedure must be selected for each case. The patient is brought to the operating room while receiving a transfusion. A tube is placed in the stomach and anesthesia is induced by intratracheal administration of cyclopropane and oxygen with or without ether. A transverse upper abdominal incision is preferred. Excision of the ulcer with partial gastrectomy is the method of choice, but the condition of the patient may not permit a procedure of this magnitude. Ligation of the vessels from outside the stomach may control bleeding from a gastric ulcer but a duodenal ulcer will require duodenotomy with transfixation suture of the ulcer bed around the bleeding site, followed by closure of the duodenum or by resection. Bleeding from a diverticulum or neoplasm usually requires resection of the offending lesion.

Four brief case reports illustrate some of the more difficult problems encountered in the management of these patients with bleeding peptic ulcer.

EDWARD W. GIBBS, M.D.

Rocadero, P., Mostro, D., and Landabero, P.: Whipple's Intestinal Lipodystrophy (*Lipodistrofia intestinal de Whipple*). *Arch. Soc. Arg.* 1945, 7, 30.

Whipple described the first case of intestinal lipodystrophy in a man of 36 in 1907. In all, 15 cases have been published up to this time, a detailed history of the last one being given in this article. A table is given showing the outstanding features of each case, and the cell findings in the skin and spleen are described in detail and illustrated with photomicrographs.

The case described here was in a man of 27 years who had a history of generalized polyarthritides since he was 19 years of age. The most important digestive symptoms were distention of the abdomen, a feeling of heaviness after meals, and fatty stools. He also had fever, asthenia, and loss of weight. There was moderate anemia, low blood pressure, and absence of hydrochloric acid in the stomach contents. Histological examination showed increased intestinal villi containing fatty cells, lipomatosis of the glass of the mediastinum and peritoneum, and an increase of the adipose cells in the lungs. There wasocrine atrophy of the pancreas with persistence of the islands of Langerhans which were small and contained few alpha cells. There was atrophy of the epidermis and edema of the dermis. The subcutaneous fatty tissue was atrophied. The fats which remained were more sudanophil than normal and had reverted to the embryonic type. There were foci of embolic glomerulonephritis. There were intense sclerosis and colloid cysts of the hypophysis. There were ossification, septic foci, and Gandy-Gamna nodules in the spleen. These are nodules containing iron from the breaking down of the red blood cells. All cases have ended in death.

The various theories as to the causation of this condition are discussed without arriving at any definite conclusion. The disturbance of fat metabolism is probably an increased excretion, possibly due to lack of vitamin A, which has been shown to be insufficient but it remains to be shown whether the changes are primary or secondary to the diabetes. The authors are inclined to believe that they are primary.

ALBERT G. MORSE, M.D.

Roettig, L. C., Glasser, B. F. and Barney, C. O.: Definitive Surgery of the Large Intestine Following War Wounds. *Ann. Surg.* 94, 114, 1931.

The material upon which the authors study is based consists of 96 consecutive cases admitted to the Septic Surgery Section, Rhoads General Hospital, Utica, New York. The patients were soldiers who had been wounded in overseas theaters of operation, in whom some type of reparative surgery was necessary after overseas definitive surgery of the large intestine. One of the important problems in the management of these cases was that of determining the optimum time to institute reparative surgery. The solution varied with each individual case and depended greatly upon the number, extent and

agency of the procedures contemplated. As a rule, major surgery was withheld until all clinical and laboratory evidence of malnutrition had disappeared. Whenever possible the patient was carefully man aged until he had regained all but 10 pounds of his former body weight. Many of the patients had mul tiple wounds of varying severity.

The most important problem of reparative surgery of the large bowel was closure of the colostomy. In the present series, 86 colostomies were repaired. In 6 instances it was necessary to construct a second colostomy proximal to a former colostomy or to a traumatic colostomy in which it was desirable to completely divert the fecal stream for defunctional ization of this portion of the colon. When definite indications for secondary colostomy are present it is the opinion of the authors that it should be per formed unhesitatingly on the basis of obviating ad ditional surgery and added morbidity and of improving the end results.

A total of 14 persistent fecal fistulas were encoun tered 7 of which were the result of unsuccessful at tempts at closure of the colostomy overseas by the extraperitoneal method. The others were the result of surgical and traumatic cecostomies, traumatic colostomies, and rectal perforations. It is desirable to perform a cecostomy preparatory to the repair of a fecal fistula in the transverse or descending colon.

Penetrating wounds of the rectum which had been produced by a missile perforating the sacrum or the sacrum and coccyx were present in 9 patients in 2 of whom healing occurred spontaneously following a proximal colostomy which completely diverted the fecal stream. Perforated capsules of sulfaguanidine (1 gm. three times a day) were inserted into the dis tal loop. The distal loop was irrigated with a 1 to 10,000 solution of acriflavine using 500 c.c. three times a day. Externally, wet dressings of penicillin were applied. However in 7 patients the colostomy did not close spontaneously under this management. Most of these patients developed an osteomyelitis of the sacrum or coccyx. Closure of the fistula oc curred only after removal of the infected bone. There was a marked tendency to eversion and proliferation of the rectal mucosa in front of the sacrum and along the anus tract. The authors state that 3 important steps are required for successful surgical closure of the coccyx and of as much of the sacrum as is safely permissible and necessary to allow adequate exposure. Secondly it is important to achieve as much mobilization of the rectum as possible both laterally and in front of the sacrum. Finally it is important to interpose some fat or muscle tissue between the portion of rectum containing the trans verse closure and the sacrum before closing the transverse wound is then closed tightly without drainage. The cardinal points in the management of recto-vesicocutaneous fistulas are a completely defunc tioning proximal colostomy and a satisfactory supra pubic cystostomy in conjunction with an indwelling urethral catheter. If these two operative procedures

were carried out promptly and satisfactorily the communication between the rectum and bladder usually healed spontaneously, as did the communica tion between the bladder and abdominal wall.

For the most part retained abdominal or pelvic foreign bodies found in conjunction with large bowel wounds were asymptomatic. No attempt was made to remove these. Removal became necessary only when they were responsible for persistent sinus lead ing to the colon or pericecal, colonic or rectal abscess or phlegmon.

Extensive laceration of the anal sphincter was en countered in 7 cases. The repair of these required multiple operations. Despite extensive loss of sphinc ter substance, it was possible to restore satisfactory function in all cases after a defunctioning colostomy had diverted the fecal stream. After plastic repair several weeks of dilatation and sphincter control exercises were instituted then a second operation was performed in which the severed ends of the sphincter were united. When more than one inter ruption of the sphincter was present one transection was repaired at a time. Daily sphincter control exercises and daily dilatation are believed to be very important in the management of these cases.

Preoperative preparation with sulfaguanidine was an important factor in the success of colostomy closure. The distal loop was irrigated three times daily and sulfaguanidine was inserted into the distal loop in perforated capsules. Vitamin K was adminis tered.

Closure of colostomy for the most part was per formed as an intraperitoneal procedure similar to an end-to-end anastomosis.

The most significant postoperative feature ac cording to the authors was oral starvation except for small amounts of liquids and sulfadiazine. The daily caloric, fluid, and vitamin requirements were met by intravenous therapy and parenteral amino acids were given to provide 30 grams of protein daily. By the second postoperative day practically all pa tients passed flatus per rectum. Beginning on the fifth or sixth postoperative day the oral intake was gradually increased until a full diet was reached by the twenty fourth postoperative day. In all a total of 108 large bowel operations were performed with no fatalities. Three patients developed fecal fistulas and of these only 1 patient required surgical cor rection. Nine patients developed wound infection while 4 patients developed a ventral hernia at the site of closure.

The eminently successful results with intraperi tonal closure obtained by the authors recommends it as a procedure to be followed in civilian surgery.

HAROLD LAURMAN, M.D.

Morton, J. J. Jr.: Diverticulitis of the Colon. *Ann. Surg.* 1946, 124, 725.

The author's classification of diverticulitis is as follows:  
1. Diverticulosis  
2. Diverticulitis with spasm.



If the presence of peptic ulcer is established the advisability of early surgery must be considered. If bleeding is moderate and appears to cease promptly the patient should be managed by nonoperative measures.

If the bleeding is massive, continuous, or recurrent, and particularly if the patient is past 60 years of age, operation should be performed after adequate blood replacement therapy. The progress of bleeding may be estimated by clinical examination and by frequent blood pressure, red cell, hemoglobin, and hematocrit determinations. Digestion of blood in the gastrointestinal tract produces an elevation of the blood urea nitrogen and affords an excellent guide to the amount of blood loss and to the continuation or recurrence of hemorrhage.

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Four brief case reports illustrate some of the more difficult problems encountered in the management of these patients with bleeding peptic ulcer.

EDWARD W. GEISS, M.D.

Escudero, P., Mosto, D., and Landsham, J.  
Whipple's Intestinal Lipodystrophy (Lipodystrofia Intestinal de Whipple) *Arch. Soc. Arg.*  
Buenos Aires, 1945, 7: 159.

Whipple described the first case of intestinal lipodystrophy in a man of 36 in 1907. In all, 15 cases have been published up to this time; a detailed history of the last one being given in the article. A table is given showing the outstanding features of each case, and the cell findings in the skin and organs are described in detail and illustrated with photomicrographs.

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AUGUST G. MORAUX, M.D.

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Definitive Surgery of the Large Intestine Following War Wounds. *Ann. Surg.* 1945, 121: 133.

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The cardinal points in the management of recto-vesicocutaneous fistulas were a completely defunctioning proximal colostomy and a satisfactory suprapubic cystostomy in conjunction with an indwelling urethral catheter. If these two operative procedures

were carried out promptly and satisfactorily the communication between the rectum and bladder usually healed spontaneously, as did the communication between the bladder and abdominal wall.

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The most significant postoperative feature, according to the authors was oral starvation except for small amounts of liquids and sulfadiazine. The daily caloric fluid and vitamin requirements were met by intravenous therapy and parenteral amino acids were given to provide 30 grams of protein daily. By the second postoperative day practically all patients passed flatus per rectum. Beginning on the fifth or sixth postoperative day the oral intake was gradually increased until a full diet was reached by the twenty fourth postoperative day. In all, a total of 108 large bowel operations were performed with no fatalities. Three patients developed fecal fistulas, and of these only 1 patient required surgical correction. Nine patients showed wound infection, while 4 patients developed a ventral hernia at the site of closure.

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HAROLD LAUTMAN, M.D.

Morton, J. J., Jr.: Diverticulitis of the Colon. *Ann. Surg.* 1946 124 725

The author's classification of diverticulitis is as follows:

- 1 Diverticulosis
- 2 Diverticulitis with spasm.

3 Diverticulitis with complications (a) perforation (b) sinus and fistula (c) obstruction (d) complicating or masking other disease

Diverticulitis with spasm rarely occurs in patients under 40 years of age. The typical history reveals a middle-aged or older corpulent individual who has been habitually sedentary and constipated and who is suddenly seized with cramplike pain in the lower abdomen accompanied by increasing constipation. The condition is often ushered in by the passage of several loose stools. Signs of inflammation follow according to the degree of involvement.

Of 111 patients, 94 had pain as a predominant symptom, usually in the lower abdomen and on the left side. Constipation was present in 45 patients; diarrhea in 37; distention in 32; fever in 29; and vomiting in 28 patients. Blood in the stools was present in 24 patients. Diverticulitis with spasm is a self-limited disease according to the author and should subside or improve in a period of from 3 or 4 days to a week under good medical care.

In 39 patients with diverticulitis there was perforation. In 3 there was perforation into the free peritoneal cavity with extensive peritonitis 2 of these patients recovered. Of 36 patients with localized abscess subjected to drainage 24 recovered and 12 died in the hospital. Of the 36 patients with localized abscess, 18 had fistula formation or obstructions. These patients were very ill from the start and improved appreciably with rest and therapy. Barium showed extravasation of fluid outside the bowel lumen on three occasions and free air in the peritoneal cavity was twice observed. In 3 instances the abscess had perforated into the extraperitoneal rectal space and extended into the soft tissues so that it simulated an extravasation of urine with swelling and crepitation under the skin in the region of the scrotum and penis.

Twenty-two patients had known fistulas. In 11 openings were present from the sigmoid to the skin in 8 from the sigmoid to the urinary bladder in 2 from the sigmoid to the urethra in 2 from the sigmoid to the small intestine in 1 patient from the sigmoid to the cecum in 1 from the sigmoid to the rectum in 4 patients from the sigmoid to the vagina in 1 there was a sinus to the retroperitoneal tissues in 1 an ischio-rectal sinus and in 1 a sinus into the mesocolon. Most of the complaints of these patients were of leaking fistulous openings, or of symptoms referable to the organ involved, but there were no signs of severe infection.

Obstruction to the bowel was found in 34 patients. In 18 of these there was partial obstruction at the sigmoid area while in 13 there was complete obstruction in the same region. Obstruction may result from scarring and thickening or from adhesions. In 3 patients there was obstruction of the small intestine adherent to the inflammatory mass.

Often, the diagnosis of diverticulitis from carcinoma is practically impossible. Even when the surgeon has the lesion in his hand, he cannot be sure whether it is a chronic inflammation or a neoplasm.

In women, diagnostic difficulties often arise. The gynecologist the left tube and ovary frequently become attached to the inflamed sigmoid, and a diagnosis of solid tumor of the ovary may be made. Such errors can be obviated by careful studies with barium enema. Another pitfall for the gynecologist is the fecal fistula resulting after drainage of a pelvic abscess. Extravasation of urine has been considered in some cases as a differential diagnosis. Frequently associated infection of the prostatic tract is noted. Pyelitis, pyelonephritis, or cystitis may clear up after diverticulitis has been eliminated. The roentgenologist also is often times misled by the differential diagnosis between diverticulitis with obstruction, and cancer. Aids in fluoroscopic diagnosis are such features as modification of the lesion, tenderness of the bowel, and distensibility.

The author offers no new suggestions for treatment but advocates the Dwyer colostomy in the right transverse colon for the purpose of diverting the colon in the treatment of fistulas to the skin or bladder.

HAROLD LAMBERT, M.D.

#### Care II. W.: Late Results in the Treatment of Ulcerative Colitis. *Ann. Surg.* 1948, 127, 72.

This article deals mainly with the evaluation of late results as a guide to the advisability of continuing radical surgery in the treatment of ulcerative colitis. Of a total of 101 patients operated upon, 9 of the 80 surviving patients were personally interviewed by the author. The length of time which had elapsed since operation varied from 10 years to 1 year.

In the author's opinion, the fact that 95 per cent of those individual who underwent radical removal of the colon have gained considerable weight, are relieved of annoying, bloody diarrhea, and are afebrile is significant and encouraging. The average weight gain for these 50 patients is 45 pounds. Some patients gained as much as 120 pounds following the removal of their colons. One patient gained only 16 pounds. In 2 patients it was possible to take down the ileostomy successfully and restore the fecal stream by ileosigmoidostomy.

Ileostomy revision for prolapse had to be carried out to relieve obstruction or to prevent gangrene of the protruding intestine in 11 patients. Of these 5 came to revision on account of obstruction. Aside from prolapse of the ileostomy the greatest problem in these patients is that of the prevention of irritation of the skin around the ileal stoma. The author believes that the best and most satisfactory treatment of the skin is the application of a dry dusting powder of Fuller's earth (kaolin). The skin should be bathed once or twice daily with soap and warm water and the powder or kaolin freely applied.

Acute or intermittent ileus due to adhesions or volvulus at or near the ileostomy opening brought 4 patients to surgery. A volvulus about the ileum was present in 2 and in 1 patient the ileostomy had to be moved from the right to the left lower quadrant due to two episodes of obstruction from volvulus.

There were striking instances of repeated collapse from sudden salt deprivation due to unexplainable abrupt and profuse diarrhea through the ileal stoma in 3 patients. Once such an attack has occurred patients learn to recognize the prodromal symptoms and can avert an attack with salt tablets or intravenous saline. All patients are encouraged to use an abundant amount of salt in their food in order to maintain a high sodium chloride blood level.

Primary ileosigmoidostomy leaving the colon intact, was performed in 11 cases. One of these patients progressed satisfactorily for a period of 5 years, until she began to have a series of severe symptoms, including diarrhea with blood pus and mucus, and rapid loss of weight. Roentgenograms revealed ulceration of the distal 18 inches of ileum and resection had to be performed.

In 4 of the younger female patients pregnancy occurred and therapeutic abortions were carried out for fear of disturbance in the ileal stoma.

Practically all patients who have been colectomized after ileostomy but who have retained their rectal pouch have a fair amount of discharge through the anal opening two or three times a day. When the discharge is annoying and malodorous, a rectal lavage biweekly has proved helpful.

Careful interrogation into the diet habits of these patients in an attempt to arrive at a standard diet led to no agreement among the patients. Many of them eat practically everything while some avoid certain specific foods which they claim do not agree with them. Of the 50 patients, 40 are at work ranging from manual labor to white collar jobs. Many of the younger patients are able to play golf, baseball and tennis. A few even swim in the ocean.

In the group of 101 patients there were 3 who showed malignant changes originating in a polyp in some part of the colon. These 3 patients are still alive—one, 7 years, one 5 years and the other 3 years after colectomy.

Frequently following the removal of the rectum as the third and final stage in the surgical treatment of this disease the ileostomy takes on in some degree the functions of the rectum. The ileal contents become more solid, the lumen appears to enlarge and the walls thicken. HAROLD LAUTMAN, M.D.

Ehrenpreis, T: Megacolon in the Newborn. *Acta chir scand.* 1946 94 Supp 112.

Since Hirschsprung's demonstration in 1886 of the disease with which his name is synonymous, congenital megacolon has been considered by many investigators, none of whom have satisfactorily elucidated the primary etiology of the condition. Three distinct trends as to the pathogenicity of megacolon have been held: (1) the malformation theory (of Hirschsprung) assumes a congenital anatomical dilatation and hypertrophy of the colon to be present; (2) the obstruction theory contends that the dilatation arises from mechanical obstruction to passage as the result of an abnormally redundant sigmoid which predisposes to valve action kinks or volvulus

and (3) the neurogenic theory which indicts an overly active sympathetic nervous system (or decreased parasympathetic activity) as the causal factor. This last has been held tenable owing to the beneficial results obtained from sympathectomy although experimental evidence is inconclusive.

Working at the Kronprinsessan Lovisas Children's Hospital in Stockholm the author has intensively studied 10 cases of disease of the megacolon beginning at birth. The infants were subjected during the first 10 days to clinical and x-ray examination and were subsequently followed. One hundred normal infants were similarly examined for purposes of comparison. The studies revealed fairly uniform clinical courses and roentgenograms showed the condition to be of early development. Symptoms of obstipation, abdominal distention and vomiting appeared within 7 days after birth. Scout films and contrast enemas showed gaseous distention of the bowel, a marked retention of the enema, and almost no contractile activity of the large bowel in comparison to the normal. The size of the colon was seen to be within normal limits although slightly larger than the average for normal infants. Redundancy of the sigmoid was no greater than in the normal newborn infant in whom such a state was found to be a normal constant physiological phenomenon. No mechanical obstruction was present in any of the cases. Over a period varying from 18 days to 3½ months there was a transition from essentially normal bowel measurements to the typical megacolon picture. A deficiency in the contractile and evacuation power of the colon was evident from the onset.

Megacolon in the beginning consists primarily of an ileuslike state which is identical in appearance to simple meconium retention or to bowel obstruction resulting from atresia or stenosis. From the latter it may be distinguished by contrast enema and from the former by the clinical course in that meconium retention is relieved by evacuation of the bowel whereas the obstipation of megacolon persists over a period of weeks to months until the typical picture of dilation of the colon with a froglike belly is developed.

The author concludes that the theories regarding malformation and obstruction of megacolon are highly questionable. A sympathetic hyperfunction appears to be involved in the cause of megacolon but the nature of the disturbance has not been determined. He therefore defines megacolon disease as a dysfunction of the evacuation of the colon of an as yet unknown origin occurring in the absence of morphological or mechanical causations and giving rise secondarily to a characteristic dilatation of the colon. WAYNE CAMERON, M.D.

Casco, C. M.: A New Technique for Temporary Cecostomy (Nueva técnica para el ceco temporal). *Rev As méd. argent.* 1946 60 3.

The author describes a technique for a hermetic cecostomy whereby the taenia of the cecum is infiltrated with some inert fluid such as water or pro-

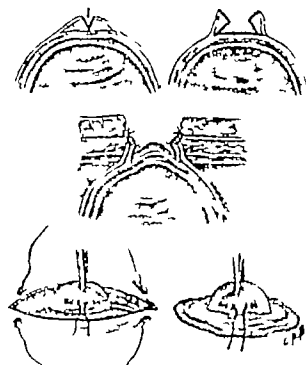


Fig. (Casco)

came in order to form a sizable bleb 6 by 4 cm. The dome of the bleb is then incised and the resultant flaps are sutured to the aponeurosis of the external oblique muscle after iodine is applied to the peritoneal opening and the flaps.

The iodine produces a thick fibrin effusion which insures attachment and seal against subsequent leakage (Fig. 1). The protruding muscularis portion is now pulled upward and a pursestring suture which anchors a Paul tube *in situ* is applied.

The same technique is applicable to colostomies which may be made by utilization of the transverse colon.

STEPHEN A. ZIMAN, M.D.

Joffe H. H., and Wills, A. H.: Normal Appendices in 1,000 Appendectomies. *Minnesota M.* 946 39 1019.

In a review of 1,000 consecutive appendectomies performed by 37 surgeons it was noted that 275 of the appendices removed showed no pathological condition or only obliteration of the lumen without any active inflammatory process.

A study of this group of case records disclosed that a small group of surgeons was responsible for a relatively high percentage of the diagnostic errors. In spite of the pathologist's report of normal appendix, the final clinical diagnosis of the case records was seldom found to be corrected from the original working diagnosis.

The records of the clinical manifestations were quite inadequate for an intelligent summarization,

but it was apparent that obvious signs of disease outside of the appendix were often disregarded.

The authors estimate that normal appendices should constitute not more than from 15 to 20 per cent of the appendices removed where good surgical practice is carried out.

EDWARD W. GORD, M.D.

#### LIVER, GALL BLADDER, PANCREAS, AND SPLEEN

Brunschwig, A., and Morton, D. R.: Resection of Abdominal Carcinomas Involving the Liver and Spleen Secondarily. *Ann. Surg.* 1946, 124 246.

The purpose of this communication is to summarize the experiences gained in a limited series of patients who at celiotomy presented carcinoma primary in an abdominal viscus with direct spread to the liver or with metastases in the liver or spleen, and in whom the primary growths were excised en masse with the spread into the liver; or those in whom the primary growths were excised as well as hepatic or splenic metastases at the same sitting.

In 10 patients with primary malignant neoplasms in various abdominal viscera and with direct spread of one or a few metastases into the liver or spleen the primary growths were excised en masse with the direct extensions in the liver or with resection of the discrete metastases that were visible. The immediate surgical mortality was 10 per cent (1 patient).

The best results were observed when the neoplasms had spread to the liver and discrete metastases were not present. It is suggested that increased palliation might have been achieved in some instances in which metastases were excised, but sufficient time has not elapsed for more definite evaluation of this impression.

JOHN J. MALLOY, M.D.

Savagnone, L., and Citarda, A.: Clinical Contribution to the Study of the Relationship between Biliary Stasis and Hepatic Lesions. (*Contributo clinico allo studio dei rapporti fra stasi biliare e lesioni epatiche*) *Policlinico sez. med.* 944, 55-7.

Two cases are presented in which different etiological factors contributed to a similar clinical picture of severe hepatic insufficiency on a basis of biliary stasis. In the first case a chronic inflammation of the pancreas with subsequent appearance of an adenoma in the cephalic portion gave rise to abundant adhesions around the duodenum, gall bladder and bile ducts and the development of a painless, intense jaundice, a variable low grade hypopyrexia, and the laboratory findings of an obstructive jaundice. In the second case a primary carcinoma of the gall bladder had given rise to metastases to the liver and lungs. In both cases signs of hepatic insufficiency had been superimposed upon those of an extrahepatic obstructive lesion, and ascites formation had led to death in from 6 to 12 months. Autopsy showed a profound disturbance of the lobular architecture and extensive proliferation of connective tissue elements in the first case. In the second case there

was evidence of interstitial hepatitis combined with metastatic nodules.

These cases are offered as evidence that obstruction and biliary stasis even on different bases can produce a similar clinical picture.

EDITH B. FARNSWORTH, M.D.

Mahoney E. B. Cholecystoduodenocolic Membranes. *Surgery* 1946 20 704.

One of the most common anatomic peritoneal variations is the cholecystoduodenocolic fold which is essentially an extension of the normal hepatoduodenal ligament to include the gall bladder second portion of the duodenum and the hepatic flexure of the colon. Mahoney attempted to evaluate the clinical importance of this congenital peritoneal anomaly which occurs in 18 per cent or more of patients but causes symptoms in a very few individuals.

In the past there has been considerable controversy about the etiology of these peritoneal bands. Some investigators thought them to be the result of localized peritonitis which may have started in fetal life while other observers believed that they were the result of excessive abnormal development of normal peritoneal folds. Harvey in 1918 after an exhaustive study concluded that these membranes often developed in fetal life as a result of abnormal growth and that the congenital type could definitely be differentiated from that resulting from inflammatory processes in the upper abdomen.

The congenital peritoneal attachments are most frequently seen about the gall bladder. At the Strong Memorial and Rochester Municipal Hospitals (Rochester, New York) only 18 cases have been found in which the upper abdominal symptoms have been considered to be due to congenital attachments.

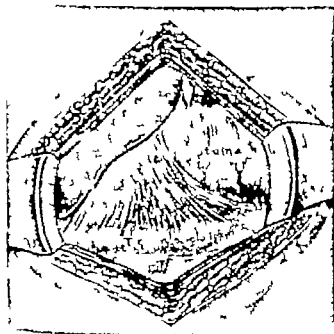


Fig. 1 (Mahoney) Appearance of cholecystoduodenocolic membrane on opening the abdomen.

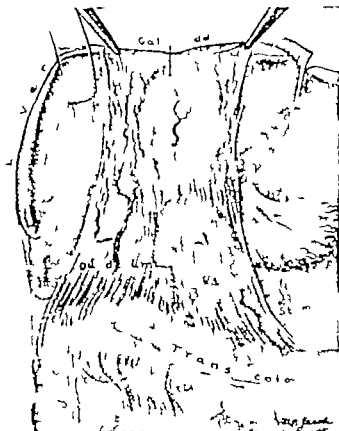


Fig. 2 (Mahoney) Cholecystoduodenocolic membrane after partial mobilization.

Harris, in 1914, was the first observer in this country to call attention to the role of congenital bands in producing abdominal symptoms. All patients had disturbance of digestion characterized by epigastric distress 2 to 3 hours after eating which was usually followed by nausea and emesis with subsequent relief of pain. Tenderness in the epigastrium was present and the gastric analysis showed hyperchlorhydria only 1 of Mahoney's 18 cases had hyperchlorhydria. Homans in 1916 first emphasized the similarity of symptoms caused by these congenital bands to gall bladder disease and/or duodenal ulcer. Taylor and Kantor have described a typical roentgenographic deformity which consists of a high fixation of the duodenum associated with a dilated ptotic stomach and a sharp angulation between the first and second portions of the duodenum; this was not observed consistently in Mahoney's cases.

Of Mahoney's 18 patients 6 had symptoms suggestive of cholecystic disease, 7 had ulcerlike symptoms which also suggested partial duodenal obstruction and 5 had vague upper abdominal symptoms that could be classified neither as ulcerlike or gall bladderlike. A correct preoperative diagnosis of congenital bands was made in 5 cases; in the remainder a diagnosis of chronic cholecystitis was made in 8 cases of duodenal ulcer in 2 and of tumor of the ampulla of Vater, chronic appendicitis and questionable carcinoma of the hepatic flexure of the colon in 1 case each.

The operative procedure employed in this series of 18 cases was cholecystectomy and division of the bands in 8 cases and division of the bands without cholecystectomy in 10 cases. One of the 10 patients also had a Heineke-Mikulicz pyloroplasty because of definite narrowing of the duodenum as a result of the pressure from the band.

The type of congenital bands seen at operation varied considerably. The most commonly encountered type which incidentally is the most extensive type seen is illustrated in Figures 1 and 2. It is attached over the entire gall bladder and spreads out to involve the duodenum, the hepatic flexure and the proximal portion of the transverse colon which may be narrowed by the band.

The operative results were as follows: 13 patients are considered cured, 3 are benefited, and 2 are not benefited. Those patients who had severe pain were benefited by the operation. The patients with equivocal symptom had equivocal results. The patients who were not cured had no other demonstrable organic cause of complaint. R. ARTHUR TOWELL, M.D.

Marble A., and McKittrick, L. S.: Islet Cell Tumor of the Pancreas with Hyperinsulinism. *England J. M.* 1946, 235 637.

Six cases of islet cell tumor of the pancreas with hyperinsulinism were verified at operation are reported. In 5 cases removal of a single adenoma resulted in a relief of symptoms that had persisted from 4 to 7 years before operation. In 1 case death occurred in 7 weeks after operation. This patient was found to have an islet cell carcinoma, with multiple metastases in the liver.

Of the 5 patients with benign adenoma, 3 were females and 2 were males. The ages of the patients at the time of operation ranged from 16 to 49 years and the patients were seen in from 2 to 8 years after the onset of symptoms. In 4 cases the tumor occurred in the head of the pancreas and in 1 in the body of the pancreas. Two of these patients had been operated on previously without the discovery of a tumor.

The patient with carcinoma was a woman 59 years of age at the time of operation with symptoms of 4 years duration. In this case the primary tumor was in the tail of the pancreas.

Microscopic examination of tumor tissue from the 5 patients with adenoma showed the capsule of the tumor to be incomplete in each of 4 cases in which there was enough tissue available for satisfactory examination. In 1 case questionable blood vessel invasion was noted.

In the 4 cases in which assays were carried out the insulin content ranged from 3 to over 100 units per gram of tumor tissue.

The important features in the diagnosis of islet cell tumor are the characteristic symptoms associated with well marked hypoglycemia (blood sugar concentrations usually below 50 mgm. per 100 c.c.) brought on by fasting, increased by physical exertion and relieved by food. The glucose tolerance

test is of aid in diagnosis only if it is carried out in a sufficient length of time—4 to 6 hours—to allow the blood sugar to fall to an abnormally low level.

Because of the danger of damage to the central nervous system by repeated attacks of prolonged hypoglycemia, and because of the possibility of malignant degeneration of a tumor initially benign, early exploratory operation is urged in patients in whom the diagnosis of islet cell tumor with hyperinsulinism has been made. CHASLES BAKER, M.D.

## MISCELLANEOUS

Altmeier W. A.: The Treatment of Penetrating Wounds of the Abdomen in Civilian Practice. *Surg. Clin. N. America*, 1946, 36 1152.

The author reports a series of 161 cases of penetrating wounds of the abdomen treated in the Cincinnati General Hospital, Cincinnati, Ohio, from 1942 to 1946. The over-all mortality rate in this series was 14.3 per cent.

Preoperative preparation consisted of the use of morphine, oxygen, shock position, and the intravenous injection of fluids. He believes that whole blood is far superior to plasma or any other solution in the treatment of shock associated with penetrating wounds of the abdomen. If necessary 2 and even 3 transfusions were carried out at once, at least 1 of which was in an arm vein if bleeding from the venous cava was feared. The systematic administration of 3 gm. of sodium sulfadiazine preoperatively by intravenous injection was routinely carried out.

The operation was performed under a general anesthetic as soon as the general condition of the patient would permit. The arrest of hemorrhage was the first objective. The author stresses the necessity of early suturing of all perforations of the diaphragm in order to minimize pleural contamination and the resultant severe pleural infection. The danger of overlooking tangential wounds at the junction of the mesentery and the small bowel, as well as wounds of the retroperitoneal portions of the colon and duodenum, is emphasized. If resection was necessary an aseptic end-to-end anastomosis was performed. Large bowel lesions were treated similarly; externalization procedures were not carried out. A proximal colostomy was always established in wounds of the rectum. No drainage of the peritoneal cavity was carried out but the retroperitoneal tissues, if involved were always drained. Sulfanilamide was not used locally in the peritoneal cavity; the drug was given parenterally both before and after operation. Penicillin was sometimes used in connection with the sulfa drug. The wounds were closed with through-and-through silver or wire sutures.

The causes of death were hemorrhage in 7 cases, pneumonia in 4 cases, empyema in 4 cases, and peritonitis in only 2 cases (8 per cent of the deaths). By contrast in a series of 104 cases compiled before the advent of chemotherapy peritonitis was the cause of death in 9 cases (31 per cent of the deaths).

J. J. LEEDMAN, JR., M.D.

Bogle J. H.: War Wounds of the Abdomen. A Review of 131 Cases. *Am. J. Surg.* 1946 72 656.

Of the 131 patients with gunshot wounds of the abdomen upon whom Bogle operated 28 died a mortality rate of 21.3 per cent.

Preoperative care consisted in careful inspection of the patient making him dry and warm noting the emergency medical tag for what previous treatment had been ordered appraisal of the patient's wounds, catheterization to rule out injury to the urinary tract and checking of the patient's blood pressure and pulse in order to determine the imminence of shock. Shock treatment was undertaken by a shock team which administered whole blood in amounts up to 5,000 and 6,000 c.c. At the same time, sulfadiazine and penicillin therapy was begun. A Levine tube was inserted into the stomach and Wangenstein suction applied.

As soon as the patient's condition warranted it, anteroposterior and lateral x-rays were taken. In all abdominal wounds, films were taken of the chest as well as of the abdomen and vice versa. The position of the missile or missiles was located and this knowledge in combination with the position of the wounds, gave the surgeon a fairly accurate idea of the path the missile had taken and the organs that were probably injured. It also frequently settled the question of whether or not a thoracoabdominal wound was present.

In the operative treatment gas-oxygen-ether was used in all abdominal cases and was given by the closed system. In cases in which the chest was also involved intratracheal anesthesia was always used and it was also used in many of the purely abdominal cases as well.

Wounds of the back were usually debrided first so that the patient would not have to be turned for this purpose at the end of a long operation. By the same token if the patient was in poor condition after an abdominal operation and it was judged he would not stand further procedures on other multiple injuries such as compound fractures of the extremities, these were put in traction or plaster splints and debrided at a later date.

If a thoracoabdominal wound was present and thoracotomy was necessary this was usually done first and the laparotomy second if the necessary procedures could not be done through the thoracotomy incision.

The type of incision used was based on the position of the wounds and the findings of the roentgen examination.

After sucking and mopping out of the peritoneal cavity, active bleeding was looked for. Then the small intestine was inspected in its entirety and all perforations tagged with clamps. The small intestine was then eviscerated while the other organs within the peritoneal cavity were inspected. This is an important time saving procedure and here again an adequate incision is necessary or the small gut will become markedly congested while it is being held outside.

Injuries of the large bowel may be very deceptive and hard to find and it is absolutely imperative that the operator be sure whether or not there are any perforations in it.

When a penetrating wound of the anterior wall of the stomach is present the gastroduodenal omentum should be incised and the posterior wall inspected. If there is still doubt, an anterior gastrotomy may be done and the missile searched for within the lumen of the stomach.

Injuries of the colon were treated by means of exteriorization in nearly all cases. Small intestinal injuries were repaired if at all possible. If this was not possible resection and usually end-to-end primary anastomosis were done.

Injuries of the infraperitoneal and retroperitoneal portions of the rectum are very serious. The diagnosis may be made by digital examination, proctoscopy or deduced from the course of the missile.

Wounds of the liver had usually stopped bleeding when the abdomen was opened. If bleeding was present it might be necessary to pack the liver.

Lacerations of the duodenum are difficult to repair and are usually associated with other grave injuries. The duodenum must be mobilized adequately to get at least a 2 layer closure and preferably a 3 layer one.

Lacerations of the gall bladder were treated by cholecystectomy as there were other injuries to be cared for and this procedure was simpler and quicker.

Extreme conservatism was used in treating wounds of the kidney. Nephrectomy was done only when the kidney was grossly fragmented or there was continued bleeding from the renal vessels. Extraperitoneal drainage to the kidney area was provided through a flank incision.

Bladder wounds were treated by doing a supra pubic cystostomy and suturing the lacerations.

At the close of abdominal operations when there had been intestinal injuries with contamination 5 gm. of sulfanilamide mixed with 100,000 units of penicillin powder were dusted into the peritoneal cavity and the layers of the abdominal wall. No intraperitoneal drainage was used except in the presence of liver, pancreatic, and duodenal injuries.

All entrance and exit wounds were thoroughly debrided and loosely packed.

Infection was certainly not a factor in the post operative course of the great majority of these patients while under observation in field hospitals.

At the end of the operation the patient was sucked out with an intratracheal catheter if necessary until dry and taken to the postoperative ward. He was not moved from the stretcher. The operative procedure had frequently been long and it was necessary to observe the patient closely in the immediate postoperative period. Oxygen was given frequently usually by nasal catheter. Wangenstein suction was applied. Frequently blood was given. Occasionally a patient would lapse into secondary



shock. Concentrated serum albumin was found to be useful in this emergency, although it was often not available. Patients with chest wounds were put in a sitting-up position when possible.

Parenteral fluids were given a minimum of 3,000 c.c. a day (1,000 c.c. of plasma, 1,000 c.c. of physiological saline solution and 1,000 c.c. of 5 per cent glucose in distilled water) until the patient could take fluids by mouth. Fluids lost by gastric suction were replaced by intravenous saline solution. Whole blood was given when indicated and was very useful for giving a patient a boost several days after the operation.

The time intervals between wound and operation ranged from 2 hours to 4 or 5 days and averaged 2.7 hours.

There were 16 cases in which exploratory laparotomy was performed and in 1 fatal case no visceral lesion was found, a mortality rate of 6.2 per cent. These operations were done in cases in which the presence of a visceral injury could not be ruled out. In some the peritoneum had been penetrated or perforated without injury to a viscus.

The data compiled from this group of cases indicate that the mortality from abdominal wounds in World War II is not greatly influenced by the time lag between injury and operation as has been the case in the past. This is probably due largely to the control of infection by the present methods of chemotherapy. The severity of the injury as represented by the extent and multiplicity of the visceral lesions is the major factor influencing the mortality in this series. The mortality rates here reported are similar to others reported in the recent war and indicate a marked reduction as compared with the mortality rates of previous conflicts.

STEPHEN A. ZISMAN, M.D.

Jones, H. W., Jr. Falor W. H., and Burbank, C. B.: Five Hundred and Twenty Four Abdominal Wounds on the Western Front. *Bull. Johns Hopkins Hosp.* 946 79 233

Despite increasingly lethal weapons in World Wars I and II the mortality in abdominal wounds that reached surgical care has dropped. An analysis of this improvement is important.

Three of 4 casualties that reached definitive surgical care manifested shock as evidenced by the systolic blood pressure. Intravenous blood and plasma were the mainstays in combating shock. At Alamein, it is reported that 16 units of blood and 10 units of plasma per 100 casualties were used. By the time of the Western Front, similar cases received 190 units of blood and 230 units of plasma per 100 casualties. An attempt to standardize the ratio of blood to plasma was made but it was found best to determine the amount of blood needed by the estimated loss, as determined by the hemoglobin and blood count.

Immobilization of the shock cases was rigidly practiced. Clothes were cut off and x rays taken only after revival, and all unnecessary handling was

avoided. To avoid ambulance jostling, definite surgical care was given as far forward as possible; early postoperative evacuation of abdominal wounds was avoided. Oxygen was used but was of little importance. Hot water bottles were helpful only in comfort in the winter months. Surgical problems were disastrous when long major operations were tried on casualties that were not out of shock; but were successfully completed in many cases in which the blood pressure fell to shock levels (80 mm.) after the administration of the anesthetic but before beginning the operation.

Preoperative preparation included, after recovery from shock, passage of a Levin tube with suction, urinalysis, anteroposterior and lateral x-rays of the abdomen. Adequate morphine was given by the intravenous route in shock cases, and operation delayed if morphine had been given subcutaneously during shock until recovery from shock provided evaluation of the patient's reaction to the morphine.

Operation, although near the front, was done with adequate facilities. The duration of operation averaged 1 1/4 hours in 114 cases because of the seriousness of the procedures. Rapid and accurate operating was stressed. More than 90 per cent of the patients were anesthetized with allirox oxide either through an endotracheal tube and the remaining 10 per cent were anesthetized with drop ether or spinal anesthesia.

Seventy five per cent of the incisions were midline or paramedian, 10 per cent midline, 5 per cent subcostal or transverse and 3 per cent miscellaneous. The routine for intra-abdominal exploration was to proceed immediately to the small bowel if the liver and spleen were not grossly hemorrhaging, examine the bowel, and examine the area from the diaphragm valve or ligament of Treitz. Perforations were marked with dry gauze and the Allis clamp and then repaired. The stomach, duodenum, liver and spleen were next examined. The large bowel was examined with the small bowel eviscerated, suspected areas of injury being approached last. Finally the bladder and kidneys were examined.

The use of sulfanilamide and penicillin in the abdomen was abandoned later in the campaign. The peritoneum was closed with continuous suture. The chromic catgut interrupted catgut was used in the fascia and silk in the skin. Army directives required stay sutures. Through and through wire with biter closure also gave good results. Of the 34 cases operated upon, 479 presented intra-abdominal trauma and 45 negative findings, with 1 death in the latter group.

Small bowel injury was the most common abdominal lesion (22%). Bleeding from the small bowel in its mesentery was the most common cause of intra-abdominal hemorrhage. The standard method of treatment was repair of the lacerations and when resection was necessary open end-to-end anastomosis. Ileostomy was never used. The degree of peritoneal contamination in these cases was the most important single factor in the prognosis.

Large bowel injuries were only slightly less common than those of the small bowel. The standard method of treatment was exteriorization without removal fecal diversion. If it was impossible to exteriorize as in the distal sigmoid repair was accomplished by proximal colostomy. The colostomy was preferable through a separate incision but as in exteriorization of the transverse colon, it could be made through the operative wound. Cecal lesions had twice the mortality of other colon wounds. In the latter cases ileotransverse colostomy with exteriorization of the cecum is preferable.

Retroperitoneal hematoma was the third most common finding at celiotomy. Its chief importance is that the preoperative symptoms and findings are indistinguishable from injury to an abdominal viscous. The source of bleeding in the hematoma should not be explored.

The liver was the third most frequently wounded abdominal viscous. Treatment centers about the arrest of the hemorrhage and drainage to provide for the inevitable leakage of bile from the wounded liver. A dry gauze pack usually accomplished both purposes most effectively.

Stomach wounds were usually repaired with care to explore the posterior surface of the stomach by division of the gastrocolic ligament.

Kidney wounds were relatively minor and transperitoneal nephrectomies were necessary in only 43 kidney wounds. Drainage of the perirenal space was adequate for the remaining cases.

Traumatic evisceration was of greatest concern because of loss of tissue but most of the cases were closed with the aid of some ingenuity and healed with surprisingly little real trouble.

Bladder wounds were treated by repair and with suprapubic tube and urethral catheter in 16 cases, and by repair and with urethral catheter alone in 12 cases. The latter did well, while the patients with suprapubic tubes often arrived at the rear echelon in poor condition particularly when a concomitant colostomy existed. It was decided therefore in small bladder wounds away from the neck of the bladder that it is best to close them with a double row of catgut with urethral drainage alone. A Penrose drain in the prevesical space can be used for several days.

Rectal wounds require celiotomy to rule out an intra-abdominal wound and to establish proximal colostomy. The perineal wound must be large enough or be enlarged for adequate drainage. In low rectal wounds the rectum and sphincter may be incised from the injury to the outside. There were 8 deaths in 24 cases, this being the highest mortality of any type of injury in spite of the lowest incidence of complicating visceral lesions.

Spleen injuries occurred in 16 cases 12 required splenectomy and 4 being minor required no treatment.

Great vessel injuries occurred in 7 cases with a mortality of 86 per cent 3 deaths occurred on the operating table. Ligation was attempted in each case with the exception of 1 in which an attempted

suture of the vena cava was made on its being mistaken for the portal vein.

Gall bladder wounds were treated by the use of a drainage tube (3 cases) cholecystectomy (3 cases) and closure of the laceration (1 case). Laceration of a common duct was closed around a catheter (1 case). Drains were used in all cases.

Ureteral wounds (3) were managed by cutaneous ureterostomy by anastomosis and by implantation in the bladder with complete success only in the last case.

Pancreas injuries (3) were treated only by drainage.

Postoperative care was confined to essentials but adequate and standardized to a large degree with complete but brief records of the fluid intake and output penicillin intravenous sulfadiazine gastric suction with frequent check and irrigation during the first 5 hours. The daily fluid given was 2,000 c.c. of isotonic saline solution in glucose 2,000 c.c. of 5 per cent glucose in water and a unit of plasma.

Shock, uremia atelectasis with pneumonia, and peritonitis were the four principal causes of death in decreasing incidence in the order named. The 6 hours from wounding to surgery are no longer considered necessarily the golden period for operative treatment but principal stress is placed upon the shock state. Bronchoscopy was important in the prevention and treatment of atelectasis and massive pulmonary collapse. Judgment in using fluid and electrolytes is important if pulmonary and other edema is to be avoided.

FREDERICK C. HOBEL, M.D.

Crosby R. C. and Cooney E. A.: Surgical Treatment of Ascites. *V England J Med*, 1946 235 581

The authors present a review of the various surgical methods of treating ascites with a detailed description of a method employing a glass button inserted into the abdominal wall which they have used in 7 cases. The authors have added a top plate to the button as used by previous workers in order to prevent the omentum from becoming impacted in the core of the spool and thus blocking the outflow of ascitic fluid.

One great advantage of this therapeutic device is its ease of application. Patients with hepatic cirrhosis do not tolerate major surgery well. Malnutrition susceptibility to shock, and tympanites contribute to the high operative mortality. Wound healing is poor unless vitamin C and a great deal of protein are given. The anesthetic tolerance is low since the damaged liver detoxifies the anesthetic agent poorly yet large amounts of anesthetic are usually required for satisfactory anesthesia in patients with alcoholic liver cirrhosis. For these reasons other major surgical procedures used in the treatment of ascites are limited in their application.

The insertion of the button is a simple procedure which may be done under local anesthesia, although spinal anesthesia was used in these cases. The site selected may be over either the right or left rectus

muscle below the level of the umbilicus. A 6 cm. midrectus incision is made and deepened through the muscle layer to the peritoneum, which is nicked to allow the insertion of a suction tube to remove the ascitic fluid. The opening in the peritoneum is then enlarged to the same length as the skin incision, and the subcutaneous fat layer is freed over an area of about 10 cm. below the lower margin of the wound. After downward retraction of the skin and fat layer and upward retraction of the peritoneum and anterior rectus fascia, a stab wound is made about 4 cm. below the lower margin of the wound, going through the anterior rectus fascia, muscle and peritoneum. The button is inserted through the stab wound and is fixed to the peritoneum by a silk purse-string suture. The rectus fascia is fixed to the button in a similar manner after placing the rectus muscle between the flanges of the button. The main wound is then closed in layers without drainage.

The avoidance of repeated paracenteses is the purpose of the abdominal button. The method has an other advantage in that it returns to the patient his own ascitic fluid with its protein content. The data and results in 6 cases in which the abdominal button was used are tabulated. There were 5 cases of Laennec's cirrhosis and 1 case of chronic constrictive pericarditis. Results were considered good in all cases but one. The button appeared to function in all cases.

JOHN L. LINQUIST, M.D.

Gage, M. and Floyd, J. B., Jr: Unnecessary Abdominal Operations for Pathological Lesions of the Genitourinary Tract. *Surg Clin N America*, 94:6 26 247

The clinical manifestations of lesions in the genitourinary tract often mimic disease of other abdominal organs. The author cites several reports from the literature to confirm this statement and to illustrate that from 25 to 30 per cent of patients with pathological lesions of the kidneys, ureters, or both, have had previous laparotomies for nonexistent lesions of the abdominal viscera.

The chief symptom of both intra-abdominal lesions and urologic diseases is pain. The sympathetic nerve supply to both groups of viscera arises through the celiac ganglion and plexus so that pain from either may be widespread because of the migration of the somatic and sympathetic receptive fibers. Another source of confusion arises from the close association of the parietal peritoneum and the genitourinary tract. Pain is produced by obstruction of any sort in either the ureter or the genitointestinal tract.

Since almost any disease of the genitourinary tract from the kidneys and perirenal tissues to the bladder, prostate and seminal vesicles may simulate other intra-abdominal disease, an accurate differential diagnosis is the first requisite to avoid unnecessary operation. A careful history and physical examination supplemented by selected laboratory procedures are essential for arrival at a correct diagnosis.

The symptoms of acute lesions of the genitourinary tract are characterized by sudden onset. The fever is often higher and the pulse rate lower than in other abdominal lesions. The white blood cell count is higher and more stable in urologic disease. Nausea and vomiting are less common. Muscle spasm is of greater diagnostic importance than is pain or tenderness. If there is obstruction to the ureter the urine may show no abnormalities in the early stages of the illness. Certainly a routine study of the urine is essential in any patient with abdominal pain. Simple x-ray studies may reveal stones in the urologic tract, enlarged kidneys, or changes in the psoas shadow. The excretory pyelogram can often give enough information to eliminate an unnecessary operation. Sometimes cystoscopic examination and retrograde pyelography may be necessary.

The high incidence of unnecessary abdominal operations for unrecognized lesions of the genitourinary tract can be reduced only by constant vigilance and thorough preoperative diagnostic study.

EDWARD W. GORD, M.D.

# GYNECOLOGY

## UTERUS

Augère, G., Labarbe, M. and Colquaud A. The Value of the Operation of Halban in the Treatment of Genital Prolapse with a Dominant Large Cystocele (Sur la valeur de l'opération de Halban dans le traitement des prolapsus génitaux, avec cystocèle dominante) *Bordeaux chir.*, 1945 1 and 2 3

Among the numerous operative measures advocated for the relief of genital prolapse the operation of Halban is beginning to enjoy a certain vogue, especially in Bordeaux.

This technique, devised by Halban in 1919 is specially indicated in prolapse in which a cystocele is of paramount importance particularly in young women.

Indeed, surgery is very limited for prolapse of the bladder. If one accepts the operation of Le Fort (colpodesis) which gives the best results we have only 3 different types of operations (1) anterior myorrhaphy of the levators ani (Delanglade), (2) subvesical interposition of the corpus uteri (Schau a Wertheim) and (3) vesicouterine fixation (of which the operation of Halban constitutes one variety).

Theoretically the anterior myorrhaphy of the levators is an effective operation but experience has proved that most of the time it can not be executed because the gap of these muscles at the level of the pubis is such that they cannot be brought together. Even if one is successful in bringing them together the sutures will not hold but cut through. Finally a successful anterior myorrhaphy makes a posterior myorrhaphy inefficient.

The subvesical interposition of the corpus uteri is an excellent operation. Nevertheless, as stated by Cotte, a major disadvantages are inherent to this technique (1) it can be performed only with a complete prolapse of the uterus and (2) it must be restricted to patients who have already passed the menopause, because pregnancy is difficult and delivery impossible when the uterus is fixed in such a fashion under the pubis.

The simple fixation of the bladder to the uterus without fixation of the uterus under the pubis seems, at first, to be restricted to cases in which the supporting structures of the uterus are intact or can be repaired. The result of this procedure may perhaps, not be as good as that of the subvesical operation on the other hand, it does not interfere with subsequent childbearing because the uterus is in a normal position.

This fastening of the bladder to the uterus can be accomplished through an abdominal or a vaginal approach.

a. The abdominal fixation of the bladder is a modification of the procedure of Werth who used to fasten the uterus to the peritoneum of the bladder

The operation is executed in the following steps opening of the vesicouterine pouch separation of the vaginal wall from the bladder suture of the bladder to the uterus and finally obliteration of the vesicouterine pouch.

The abdominal fixation of the bladder is indicated in cases of cystocele without prolapse of the uterus and when the uterus cannot be exteriorized through the vagina. In these instances vaginal fixation is harder to accomplish.

b Vaginal fixation is, in fact named after Halban, whose technique is reported midline incision on the anterior vaginal wall separation of the vesicouterine pouch from the bladder opening of the corpus uteri fastening of the vesical peritoneum back suturing of the vesicovaginal fascia closure of the vaginal incision and thorough repair of the relaxed pelvic floor which, of course, is a necessary part of the operation.

Amputation of the cervix, accompanied or not by the ligation of the uterine arteries is often a necessary step. The introduction of catheters into the ureters prior to the operation is a great help when the operation is performed through the abdomen.

Nineteen patients were submitted to this operation by the authors with the report of poor results in 12 per cent. Six of the patients were not available for a follow up study.

GERARD GAGNON, M.D.

Colquaud A : Halban's Operation (An Anatomic Study of the Vesicovaginal Fascia (A propos de l'opération de Halban. Etude anatomique du fascia vesico-vaginal) *Bordeaux chir.* 1945 3 and 4 101

In the author's opinion the most interesting stage of the Halban operation is the uterovesical fixation. He does not attach as much importance to reconstruction of the vesicovaginal fascia as does Halban and his disciples. In fact Charrier has never encountered this fascia since employing the Halban operation. On the other hand he did observe a sparse and more or less dense cellular tissue. In order to clear up this confusion between Halban's own account and the operative findings, Charrier requested the present author to make an anatomic study of the region.

The opinions of the writers who agree with Halban as to the existence of a vesicovaginal aponeurosis are cited as Cotte, Koenig and Neel. Among those who do not agree with Halban on this point are Savariaud, Violet, Koenig and Doederlein, Rieffel, Poirier, Testut, Latarget and finally Villemain. Thus, it appears that whereas surgeons generally accept Halban's description of a vesicovaginal partition between the bladder and vagina the anatomists do not recognize such a structure. Other surgeons, such as Savariaud and Charrier seem rather to confirm the findings of the anatomists. Most probably Goff is right in admitting the existence of a thin areola

layer between the anterior vaginal wall and the wall of the bladder and an analogous layer between the posterior wall and the rectum (vaginorectal fascia). These two layers unite on each side of the vagina to form the perivaginal fascia which forms a part of the endopelvic fascia. The character of this fascia renders it impossible to dissect it as a separate layer. It is illuminating that many gynecologists apply the term fascia to the muscular tunic of the vagina because grossly it resembles a heavy layer of aponeurosis.

Thus, the famous vesicovaginal fascia is probably only the peripheral and anterior portion of the vaginal wall.

A careful study of this region was made in 13 patients from 50 to 80 years of age the majority without prolapse the specimens were obtained chiefly from Villemain's laboratory. The bladder, urethra, vagina, and uterus were removed *en bloc* including most frequently the pubis in front and a portion of the rectum behind. It was concluded from these studies that (1) the bladder and vagina can easily be separated from each other especially in older women or those with some degree of cystocele (2) the 2 organs are separated by a very loose cellular tissue (3) this loose cellular tissue becomes slightly condensed on contact with the bladder and vagina (as well as with the rectum) to form a thin layer of areolar type (4) this thin layer is not possessed of any of the characteristics attributed by certain writers to a solid fascia or "vesicovaginal aponeurosis" and (5) what has appeared to some surgeons like a fascia is in the writer's opinion nothing other than a variable portion of the vaginal wall itself in the thickness of which a large number of cleavage lines are to be found. **EMER SCRAMER MOORE.**

Spitt, S. D: Adenomyosis of the Uterus. A Study of 52 Reported Cases and Review of the Literature. *Am. J. Obst.*, 1946, 5: 581.

A series of 52 cases of adenomyosis uteri in which the endometrium was carefully studied is presented. The preponderance of the anovulatory endometrium in this series (72 per cent) seems to indicate a definite association with this condition.

Adenomyosis uteri occurs in from 5 to 10 per cent of all myomatous uteri. The uterine wall is the site of aberrant endometrial tissue in from 15 to 30 per cent of all cases of endometriosis. Adenomyosis uteri is most common in the fifth decade of life as is endometrial hyperplasia.

Metromenorrhagia is the most common complaint, and dysmenorrhea the second most common in patients with adenomyosis uteri.

The sustained interval of nonsecretion of the endometrium is a part of the process leading to actual endometrial hyperplasia and should be classified with it. The early interval endometrium seems to occur in younger women and endometrial hyperplasia in older women, generally. Adenomyosis is associated with anovulatory menstrual cycles in a large percentage of cases, which indicates that either

hyperestrinism or lack of corpus luteum hormone is an important factor in the genesis of adenomyosis uteri. It cannot be said definitely however which one is responsible. The high incidence of fibroids in adenomyosis uteri seems to indicate some relationship. However this association is not frequent enough to make one conclude that one factor is responsible for adenomyosis uteri and uterine fibroids.

Pelvic inflammation and ovarian cysts occur quite frequently in cases of adenomyosis uteri. However, the conclusion that these conditions are factors in the development of adenomyosis uteri does not seem justifiable. **JOHN R. WOLFE, M.D.**

Scheffey, L. C., Thudium, W. J., Farrell, D. M., and Hahn, G. A.: Controversial Factors in the Management of Fundal Carcinoma. *Am. J. Obst.*, 1946 52: 579.

While surgery has, and continues to play the major role in the treatment of fundal carcinoma, the question today is to what extent irradiation therapy can be relied upon as a valuable adjunct. The authors survey 159 cases seen at the Jefferson Medical College Hospital from 1921 through 1945. One hundred and four of these patients are eligible for a 5-year survival study. No patients are unexcised.

Surgery without irradiation has played a negligible role in the authors' management of these cases. Only 8 patients were treated by panhysterectomy with adnexal removal. There are 5 survivors, 62.5 per cent. Since 1940 5 patients were treated in this manner and all have survived (from 2 to 4 years).

Radium alone, by intrauterine application, was used in 31 instances. Among the 21 patients eligible for the 5 year study there were 11 survivors, or 52.4 per cent. Age, obesity and cardiovascular disease, contraindicating surgery were the prime reasons for this type of therapy.

Thirty-seven patients were treated by means of radium plus deep x ray therapy: 36.6 per cent survived. The authors point out that many of the patients in this group had more advanced lesions.

Adequate surgery with some form of irradiation in addition was used in 21 cases. The 5 year survival rate was 37.5 per cent. These patients received either radiation preoperatively or x-rays postoperatively. The treatments were not planned and the time interval between surgery and radiation varied greatly. The adequate recovery in some cases that first appeared hopeless led to the adoption of the planned technique.

The authors' procedure in suspected cases of fundal carcinomas, is to perform a diagnostic curettage. Radium, either 50 or 100 mgm., is placed *in situ* while the curettages are examined by a rapid staining technique which permits a report in 4 hours. If they are malignant, a dosage of from 4,500 to 5,000 mgm. hours is administered. Surgery (panhysterectomy plus adnexal removal) is carried out from 8 to 10 weeks. Among 10 patients so treated prior to 1940, there were 9 survivors (90 per cent). The 1 death occurred 4 years after treatment and was due to cancer. **Dor**

ing the past 5 years, there have been 21 patients treated by this method with 20 survivals (1 to 4 years). The 1 death followed an embolism 2 years after treatment. Although there was no autopsy, no cancer was noted prior to death. Of the uteri removed after the preliminary radiation 54.8 per cent showed residual cancer.

The authors believe that this planned technique of preoperative radiation followed by adequate surgery in from 8 to 10 weeks, will give the best results in fundal carcinoma.

JOHN R. WOOLFF, M.D.

#### ADNEAL AND PERIUTERINE CONDITIONS

Sirtori C. and Bussolati, C.: Anatomical, Histological, and Clinical Observations of Ovarian Tumors (Considerazioni anatomico-istologiche e cliniche sui tumori dell'ovale). *Tumori* Milano 1941 27 308.

The authors made a study of 80 cases of ovarian tumors observed between 1933 and 1940 46 of which were obtained at autopsies and 34 at biopsy. It is their observation that ovarian tumors appear from the 45th to the 65th year of life, being more frequent in women who have suffered a functional derangement of the sexual glands. They find it very difficult to classify ovarian tumors intelligently.

Granulosa cell tumors (17 cases) occur at any age. Such tumors may originate from undifferentiated primitive germinal cords from the primitive cumulus oöphorus from atretic follicles (Müller) or from normal adult follicles (the latter one denied by Meyer). The authors believe that tumors consisting of immature granulosa cells originate either from primitive mesenchymal cells from germinal cords, or from the primary cumulus oöphorus, while the follicular tumors are derived from atretic follicles or mature follicles. Those tumors which have a lutein-like appearance must be considered an evolution of adult granulosa cell tumors. Clinically the tumor causes the appearance of pubic hair in young girls while in older women there is an accentuation of the sexual characteristics (menorrhagia). There is no logical reason to distinguish between granulosa cell tumors and thecomas and it is better to refer to them as mixed tumors. The authors observed only 1 thecoma among the 17 granulosa cell tumors consequently such a tumor is rare. The granulosa cell tumors have a tendency toward malignancy in the adult and a tendency toward luteinization in younger women. Tumors consisting mostly of granulosa cells have few blood vessels while granulosa cell tumors containing many thecal cells have numerous blood vessels.

The Brenner tumor must not be regarded as a special tumor neither is it always benign as those who regard it as oöphoroma or a fibroepithelioma believe. Its occurrence in old women gives it the tendency to be a scirrhous tumor. The authors conclude that the Brenner tumor must be regarded as an epithelioma originating from aberrant epithelial rests in the ovary or in its vicinity that it may pre-



Fig 1



Fig 2



Fig 3

Fig. 1 (Sirtori and Bussolati) granulosa cell type, and thecal cell type of tumor and luteinizing elements next to it. (A, B and C respectively).

Fig. 2. Granulosa tumor follicles, and cells losing the characteristics of the granulosa cell to become cancerous.

Fig. 3. Granulosa cell tumor in the luteinization stage and becoming cancerous. Observe a mixture of granulosa and thecal cell elements undergoing luteal and cancerous changes.

sent cancerous characteristics and that it may have to be considered a special aspect of the common ovarian cancer.

The seminoma of the ovary (disgerminoma) has the identical structure of the testicular seminoma. Histogenetically the tumor may originate from

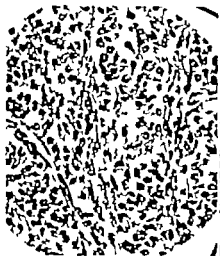


Fig. 4

Fig. 4. An area of fibroma of the ovary which could be considered a thecal tumor.



Fig. 5

Fig. 5. Papillary carcinoma. Brenner tumor



Fig. 6

Fig. 6. Arrhenoblastoma. Special aspect of the seminoma type of tumor with a tendency of the cellular element toward tubular or cordlike architecture.

mesenchymal cells still undifferentiated sexually or it may be considered an error of the primitive elements which may also cause the arrhenoblastomas. This agrees with the histogenetic interpretation of Plate which follows undifferentiated germinal epithelium immature—disgerminoma in males and females less immature—arrhenoblastoma in males and females, and granulosa cell tumor in the female.

The authors discard the idea that the tumor is an epithelioma or sarcoma and regard it as a mesoblastoma. The study of their 3 cases leads them to conclude that such tumors are more frequently found in young women that the tumors are functionless (different from the arrhenoblastomas and granulosa cell tumors which lead to male or female maturity) and that histologically the tumors are in the process of evolution because next to the seminoma are found areas similar to the arrhenoblastoma of the solid homogeneous type.

The arrhenoblastomas, very rare and important tumors, cannot be associated with the property of producing masculinization because some of them do not have this function. The masculinizing tumor is made up of seminiferouslike cords, while the one deprived of such property has a tubular structure, the tubulotesticular adenoma of Pick.

Blasel and Haempel have isolated the substance causing masculinization. Removal of the tumor causes a regression of the masculine characteristics and of menstruation. This was verified in the case of a woman 36 years old who resumed all her feminine characteristics 10 months after the surgical removal of the tumor.

Other tumors e.g. the luteoma and hypernephroma, may cause more or less virilism. The luteoma originates from granulosa or theca cell tumors which have undergone luteinization. Some consider this tumor to be derived from the lutein cells, but the

case of Santi, in a woman in the menopause for 7 years, contradicts this, as the corpus luteum, being a transitory formation is absent after the cessation of menstruation. That hypernephroma of the ovary may cause virilism is still doubted. Mulon considers the corpus luteum as transitory adrenal cortex. The absence of testicular hypernephroma is not sufficient to deny the existence of ovarian hypernephroma due to aberrant adrenal cortex. The authors have not encountered any ovarian hypernephroma.

A fibroma of the ovary may originate from ovarian stroma, from a fibrosed corpus luteum, from interstitial hemorrhage, from the unilateral development of a teratoma, or from interstitial inflammatory exudation.

The authors did not have any cases of mixed tumors of the ovary. They discuss a possible classification of cysts.

They believe that it is almost impossible to classify primary carcinomas of the ovary and conclude by suggesting that all ovarian tumors should be classified according to plans, one to include the histopathologic, histogenetic and clinical criteria and the other to include only the clinical criteria.

JOSSEPH M. A. PARR, M.D.

Halsel, E. V: A Review of 100 Cases of Ovarian Cancer. *Am J Obst.*, 946, 521-535.

While considerable progress has been made in the diagnosis and treatment of uterine malignancies, this cannot be said of ovarian malignancies. With an incidence of 10 per cent of all ovarian neoplasms, and with a mortality rate that has been, and remains, appallingly high ovarian cancer constitutes a major gynecological problem.

The author has analyzed 100 cases of ovarian cancer treated at the Elizabeth Stoll Magee Hospital and the St. Francis Hospital in Pittsburgh, Pennsylv-

vanla, from 1929 to 1943. Thirty five cases could not be traced while the remaining 65 cases were followed from treatment until death or present survival. Four of these patients were negroes. More than half of the patients were past the menopause although 2 were under 20 years of age. 41 per cent were nulliparous.

The insidious onset of symptoms plus the rapid progress of the tumor makes early diagnosis almost impossible. Sixty-eight per cent of the patients were considered incurable when first seen. 3 per cent were examined within 2 months of the onset of symptoms and 18 per cent within 1 month. Abdominal pain, abdominal enlargement, loss of weight and abnormal vaginal bleeding were the most frequent symptoms.

Hessel places ovarian malignancy into four clinical groups as determined at the time of operation. In group I the tumor is completely removable without gross involvement of any other structure. In group II the tumor is completely removable but with some disturbance of other structures such as adhesions. In group III the tumor is only partially removable because of extension to or near by structures which can not be removed and in group IV there is extensive involvement or distant metastases and only a biopsy may be obtained.

The degree of removability determines the survival time. Histological grading is of little value in the prognosis. Postoperative radiation is of value in that it increases the comfort and improves the psychological state of the patient but its curative value is discouragingly low.

Despite the discouraging end results in advanced cases of malignant ovarian disease the author believes that operation is worth while since even simple removal of the primary growth often enables the patient to carry on a life of usefulness in comfort some times for years.

JOHN R. WOLFF M.D.

Romeo, M.: A Study of Pathological Associations between the Internal Genitalia and the Appendix (Contributo allo studio delle associazioni morbose fra genitali interni ed appendice) *Arch. ital.* 1942 6 133

In a previous article the author described 2 cases in which dermoid cysts of the ovary with torsion of the pedicles were associated with chronic appendicitis. He now describes a case in a woman of 27 years in which dermoid cysts of both ovaries with torsion were associated with chronic appendicitis. Histological illustrations of the findings are given.

In connection with these cases he discusses the possible reasons for such a pathological association. It has been claimed by some authorities that there is normally an appendiculo-ovarian ligament through which infections may be carried. Others deny this and claim that the inflammation is carried through adhesions which form between the two organs. A number of other theories are discussed and statistics showing the frequency of this association are presented.

The author concludes that the conditions are different in different cases. In some the infection is transmitted through the lymphatics of the appendiculo-ovarian ligament in some through a newly formed network of lymphatics resulting from adhesions of the inflamed organs sometimes extra peritoneally through the subserous connective tissue and sometimes through the peritoneum.

However while this explains the transmission of inflammatory conditions from the ovary to the appendix, what is to be said of the cases in which a tumor of the ovary is associated with inflammation of the appendix? He believes that in cases in which there are adhesions between the appendix and the tumor the explanation is mechanical. The increased size of the ovary brings about such changes in the anatomical relations of the appendix that the organ becomes a point of least resistance and inflammation readily develops. In the cases in which there are no adhesions and the appendix and the ovary lie at some distance from each other he believes that the association of the two pathological conditions is a mere coincidence.

AUDREY G. MORRAN M.D.

## MISCELLANEOUS

Jacobson C. E. Jr.: Unrecognized Obstruction of the Vesical Neck in Women. *England J. M.* 1946 235 645

Three cases of chronic obstruction of the vesical neck in women were presented in which resection of all or part of the neck was performed with satisfactory relief of the symptoms.

Attention was drawn to the facts that the condition is not infrequent and that dire consequences in the form of dilatation of the upper urinary system may ensue if treatment is not instituted early in the course of the disease.

A search for the presence of early obstruction of the vesical neck in every case of chronic cystitis in women is urged so that this condition may be recognized and adequate treatment instituted.

CHARLES BARON M.D.

Cottalorda, J. and Garvaudan F.: Intraperitoneal Hemorrhages of Genital Origin. Not Including Ectopic Pregnancy (Les hémorragies intrapéritonéales, d'origine génitale en dehors de la grossesse extra-utérine) *Gyn. obs. Par.* 1946 45 150

Intraperitoneal hemorrhages of genital origin of nonovarian source are rare. They include rupture of a vein of a subserous fibroid, strangulation of the pedicle of a pedunculated fibroid or hemorrhage in the course of a chorioepithelioma. Much more frequent than these are hemorrhages of ovarian origin. These may be either from a corpus luteum or from a graafian follicle, or from rupture of an ovarian cyst. The lastly menstrual blood may regurgitate into the peritoneal cavity via the tube. 4 cases of the last type having been observed by the authors. Corpus luteum hemorrhages occur shortly before menstruation. follicle hemorrhages in the middle of the men-



strual interval, while effusions of menstrual blood into the peritoneum naturally coincide with the menstruation.

The symptoms are sudden severe pain irradiating to the anus and lower abdominal region, sometimes accompanied by nausea and vomiting. Systemic signs like shock, weak pulse, and anemia are never observed. In most cases the pains clear up after a few hours. Often, the same kind of attack may be repeated after a 4 weeks interval. As the symptoms are rather dramatic in the beginning, it is often difficult to rule out ectopic pregnancy or torsion of the adnexa, normal or diseased.

If as often occurs surgery is done under the wrong impression of an ectopic pregnancy or torsion of the adnexa, the management should be as conservative as possible. In cases of effusion of menstrual blood, ligation of the tube in hemorrhages of follicles or corpus luteum, suture of the bleeding structure.

In most cases it should be possible to differentiate the ovarian bleedings from ectopic pregnancy without laparotomy. They should be treated by hormonal therapy rather than by surgery.

WERNER M. SOLMITS, M.D.

Costimano, G. N.: Kidney Cysts in the Field of Gynecology (Le cisti renali nel campo ginecologico) *Arch. ital. sci.*, 942, 6 248.

The medical literature reveals many cases in which a diagnosis of gynecological cyst, especially cyst of the ovary has been made when the cyst was really of the kidney. This error may be due to the fact that the kidney is congenitally dystopic or there is an acquired ptosis of the organ, which brings the cyst in close relation to the ovary. This possibility should always be borne in mind by gynecologists in making a diagnosis of cyst of the ovary. They should have an accurate knowledge of the comparative frequency of gynecological and renal cysts and know that it is often impossible to make a differentiation between them from the history and clinical symptoms. Contrary to general belief, such cysts of the kidney often do not cause pain in the kidney region nor abnormalities in the urine. Nor does simple roentgen examination always suffice for differentiation. In all cases of doubt a pyeloureterographic examination should be made.

A case is described in a woman of 64 years in which the attending physician had made a diagnosis of cyst of the ovary. Suspicion was aroused by the fact that the patient had had a history of floating right kidney for some years, and ascending pyelography showed the right kidney to be ptotic and displaced to the left. The rhythm of evacuation of the urine was normal, excluding hydronephrosis, and the tests for hydatid cyst were negative. A diagnosis of solitary serous cyst of the right kidney was made and confirmed on operation.

The author believes that the best operation for such cysts is subtotal resection of the extrarenal part of the cyst and leaving a border to be fixed into the abdominal wound (marsupialization). Some author-

ities hold that this method gives rise to recurrence, but if the inner surface of the cyst is cauterized with gauze soaked in 10 per cent zinc chloride any remaining epithelium is destroyed and recurrence prevented. In exceptional cases in which there is destruction of almost the whole of the kidney parenchyma, nephrectomy is indicated.

ANDREY G. MORSEY, M.D.

Candido, R.: Clinicostatistical Study of 34 Cases of Hydatidiform Mole (Rilevi clinico-statistici su 34 casi di mola vescicolare) *Arch. ital. sci.* 1941, 6 80.

In 56 of 51,534 pregnant women, hydatidiform mole was observed a ratio of 1:385, which is higher than that cited by the majority of authors. Of the 56 patients, 29 were younger and 27 older than 31 years.

The cycle of fecundity can be divided into 3 periods: functional consolidation, stability and functional diminution. Thirty-seven and five-tenths per cent of the author's material was observed in the first period: in women from 15 to 27 years of age, 29 per cent occurred during the second period, in women from 28 to 39 years of age and 34 per cent were found in the third period, in women older than 39 years. Fifteen per cent occurred in primiparae and the greatest frequency of mole was recorded in women having had from 4 to 6 deliveries.

In 21 per cent of the patients the past history revealed certain diseases such as typhoid fever, diphtheria, nephritis, cholecystitis, cardiac insufficiency and pulmonary disease, but inasmuch as in many cases a relatively long period of time elapsed between the disease and the appearance of the mole, the rôle of the preceding illness in the genesis of the mole was rather questionable. In 24 cases in which a Wassermann reaction had been performed, negative results were obtained. In 5 cases the mole became manifest during the second month of amenorrhoea, in 19 during the third month, in 28 during the fourth month, and in 4 during the fifth month.

The anatomopathological study showed that in only 2 cases or 4 per cent of the entire material, the degeneration was partial, while in all of the remaining cases the development of hydatidiform mole was complete.

Fatal hemorrhage occurred in 3 cases, or 6 per cent of the entire material. In 1 case a benign mole and in 2 cases, a destructive mole was present.

Albuminuria was noticed in 15 patients, or 27 per cent. In 9 patients, or 16 per cent, a chorioepithelioma developed. Malignant degeneration of a mole occurs with greatest frequency at the ages between 25 and 30 years.

In 10 cases, or 19 per cent of the author's material, a spontaneous expulsion of the mole took place. In 43 cases, or 91 per cent, a curettage and in 4 cases, or 9 per cent, a hysterectomy was performed.

Endometritis seems to play an important rôle in the pathogenesis of the mole.

JOSEPH K. NARAT, M.D.



# OBSTETRICS

## PREGNANCY AND ITS COMPLICATIONS

Schneider P : Distal Ectopic Pregnancy Implantation of the Ovum in the Cervical Mucosa. *Am. J. Surg.* 1946 72 326.

In the present article, the author quotes the opinions of authorities, attesting to the rarity of true cervical implantation of the ovum. He reports 1 case of this condition.

The author states that there have been only 12 proved cases, and 7 cases in which he believed the condition was clinically possible. There are 11 additional cases in which the placenta involved the corpus, isthmus, and cervix. Finally there are 3 reported cervical abortions.

True or primary cervical implantation is restricted to those cases in which the site of the placenta lies entirely within the cervix. The author defines the cervix as that portion of the uterus which lies between the external and internal os. A complete histological description is made of the three divisions of a pregnant and nonpregnant uterus. The 12 proved cases are described. The chief histological difference between the abnormal and normal implantation is the absence of the intervening decidua. Decidual cells may occur singly and in groups, but these may not be compared with the normal decidua. The decidua basalis limits the destructive action of the villi. However in ectopic pregnancies the villi destroy the underlying structure. This is more pronounced in cervical implantations than in tubal pregnancies or placenta accreta.

The pathological description of cervical implantation is excellent. Clinically the only constant observation was violent hemorrhage that in all cases led to active intervention. In only 2 cases was the correct diagnosis made. The condition has been diagnosed as incomplete abortion, bleeding varicosity chorionepithelioma, and ruptured tubal pregnancy.

Treatment is variable depending upon the amount of bleeding, the location and duration of the implantation. Intracervical packing or some form of surgery was used in nearly all cases. Several late severe secondary hemorrhages occurred.

JAMES F. DOONNELLY M.D.

Armand, M. F. : The Intravenous Administration of Magnesium Sulfate as the Exclusive Treatment for Eclampsia (Traitement exclusif de l'éclampsie par le sulfate de magnésium en voie intraveineuse). *Obst. gyn. int.-amer.* 1946 4 410.

Accepting the assumption of F. C. Irving that eclampsia is not a primary disease of an organ but a state of spasm of its terminal arterioles, the author concludes that the only rational therapy of this condition involves the administration of antispasmodics. Following a review of the literature on the use of

morphine and of magnesium sulfate in the treatment of eclampsia, he discusses the significance of changes in water metabolism in eclampsia, and the effect of water retention in creating spasms of the terminal arterioles. The vascular spasm slows the blood stream, produces edema, increases the viscosity of the blood, and finally causes ischemia of the tubular organs of the vessels involved which explains the clinical picture of pre-eclampsia and eclampsia.

The antispasmodic effect of magnesium sulfate diminishes the nervous irritability and rapidly and definitely diminishes the contractility of the smooth muscles. The blood pressure falls almost immediately and the circulatory equilibrium is restored. Diuresis is augmented. Frequently micturition occurs shortly after the injection and the attack is interrupted. Magnesium sulfate is also said to have an anesthetic effect without reduction of the alkaline reserve of the blood.

Results obtained with the intravenous administration of magnesium sulfate by the author have been so good that he believes this is the specific treatment.

A 50 per cent solution of magnesium sulfate is employed and the dose consists of 5 gm. of magnesium sulfate, or 10 c.c. of a 50 per cent solution. Should the attack recur a new injection of 2.50 gm., or 5 c.c. of the solution, may be given every 4 hours until return to normal. If the patient, although apparently normal, continues to suffer from headache or cramps, or if the blood pressure shows a tendency to rise, a daily injection of 5 gm. should be given.

The total amount of the salt which can be injected without danger depends upon the severity and duration of the attack. In the 22 cases treated by the author the attack was cut short in 3 cases with 2.5 gm. of magnesium sulfate, in 7 with 5 gm., in 1 case with 7.5 gm. In 4 cases with 10 gm., in 3 with 15 gm., and in 1 each with 25, 30, and 50 gm. respectively. As a rule, 5 gm. of the magnesium sulfate, or 10 c.c. of the 50 per cent solution, suffice. Frequently a result may be achieved with less, and rarely is a much larger dose needed. In the presence of recurring attacks and deep coma, one should not hesitate to repeat the injections up to from 30 to 50 gm. If, on the other hand, the patient responds nicely to the first injection further administration is contraindicated since under these circumstances the resulting withdrawal of water from the brain might lead to acute dehydration of the brain and convulsions.

The solution is mixed with an equal portion of blood withdrawn from the vein and the injection should be made very slowly. As a rule, the injection is well tolerated and there is only a slight sensation of warmth. Occasional excitement can be controlled by interrupting the injection for a moment and then continuing it more slowly. The injection is followed by abundant perspiration and, after a quarter or half hour by micturition.

In the present series of cases the blood pressure fell immediately from 3 to 6 cm. Hg. No other treatment is required. Venesection and the use of soda

Nineteen of the 31 cases in the present series were treated exclusively by the intravenous administration of magnesium sulfate with recovery in all and no maternal deaths or complications in all and during pregnancy 4 in labor and 15 in the puerperium. In the 4 patients in labor, delivery was spontaneous. Two patients in labor, delivery was retention and 3 others gave birth to living infants. In the 5 patients seen during pregnancy the pregnancy proceeded normally but only 3 infants survived. The series is too small to permit of definite conclusions, but the results are sufficiently encouraging to warrant further trial of this very simple method of treatment.

Enns Schwartz Moore.  
Hasselund, J., and Hedenstedt, S.: Investigations of the Permeability of the Placenta with the Help of Elliptocytes. *Acta med scand* 1946 Supp. 170, p. 136.

According to the conception generally prevalent the maternal and fetal vascular systems of the placenta are completely detached from one another so that no direct transition of blood from the mother to the fetus, or vice versa, is possible. The authors believe that a leakage can sometimes occur in the placental septum and permit substances which do not permeate under normal conditions to pass over from the maternal vascular system to that of the fetus. This hypothesis may explain some of the complications of pregnancy as in erythroblastosis fetalis. Two investigations on the permeability of the placenta are described.

In the first experiment a transfusion of elliptocytes blood was given to a normal pregnant woman shortly before the onset of labor. No rise in the elliptocytic content of the child's blood was noted after birth. A similar transfusion given to a patient with nephropathy gravidarum resulted in a definitely increased elliptocytic content of the child's blood immediately after birth which gradually decreased in the next few days.

Hasselund, J., and Nylin, G.: Investigations on the Permeability of the Placenta with the Aid of Red Blood Corpuscles Tagged with Radioactive Phosphorus. *Acta med., scand* 1946 Supp. 170, p. 390.

This is a report of the second group of investigations of the permeability of the placenta. Red blood corpuscles from the mother tagged with radioactive phosphorus were reinjected before parturition. In 5 normal patients no labeled blood corpuscles were found to pass through the placenta into the blood of the newborn child. In the sixth patient, whose pregnancy was complicated by asthma, there was a significant increase in the amount of labeled, radioactive red blood corpuscles in the newborn child.

The results of these experiments indicate that under certain conditions maternal red blood cells can pass through the placental membrane into the fetal vascular system.

George Bunick, M.D.  
Lock, F. R. and Myers, R. T.: Endometriosis in Association with Pregnancy. *Am J Obst* 1946 53, 356.

Although the information contained in the medical literature leads one to believe that the combination of pregnancy and endometriosis is a dangerous one, the authors report 2 cases in which patients treated conservatively for endometriosis subsequently conceived and had a normal prenatal course, delivery and puerperium.

Few specific case reports of uncomplicated pregnancies in patients with endometriosis are to be found, but a careful search of the literature reveals that such cases are mentioned casually in articles which deal primarily with the gynecological aspects of endometriosis.

An analysis of 5 of such articles shows that approximately a third of the patients who are treated conservatively can successfully conceive and indicate that the vast majority of such patients have a normal pregnancy. For this reason the desirability of employing procedures which conserve the child bearing function in youthful patients with endometriosis is emphasized.

John R. Wolff, M.D.

## LABOR AND ITS COMPLICATIONS

Martini J. L.: The Demelin Forceps—33 Years of Experience in the Pedro A. Pardo Maternity (El fórceps Demelin 8. Die años de experiencia en la Maternidad "Pedro A. Pardo"). *Obst gín lat amér* 1946 4, 319.

The author describes the experience of 10 years with the use of the Demelin 8 forceps—533 applications from 1935 to 1945. The forceps weigh 650 gm. Its total length is 40 cm. length of the blade 175 mm. length of the handle 225 mm. maximum width of the blade 47 mm. maximum width of the window 147 mm. length of the fenestra expanding in the blade 177 mm. width of the fenestra in the plane 120 mm. width of the cuffs 9 mm. cephalic radius of the articulation when forceps is mounted, 160 mm. The terminal portion of the blades from the window to the beak has the form of a U and the symmetry of the cuffs at this level permits easy determination of the axis of the blade the axis of articulation behind indicated. This feature is not found in the forceps of Tarnier or Levret, in which the cuffs are asymmetric except for a little more pronounced cephalic, pelvic and perineal curvatures. The forceps is almost straight. Demelin gives great importance to the in curving below the extremity of the handle so that the bar of articulation situated in the plane of the

# OBSTETRICS

## PREGNANCY AND ITS COMPLICATIONS

Schnelder, P.: Distal Ectopic Pregnancy. Implantation of the Ovum in the Cervical Mucosa. *Am. J. Surg.* 1946 7 546.

In the present article, the author quotes the opinions of authorities, attesting to the rarity of true cervical implantation of the ovum. He reports 1 case of this condition.

The author states that there have been only 12 proved cases, and 7 cases in which he believed the condition was clinically possible. There are 11 additional cases in which the placenta involved the corpus, isthmus, and cervix. Finally there are 5 reported cervical abortions.

True or primary cervical implantation is restricted to those cases in which the site of the placenta lies entirely within the cervix. The author defines the cervix as that portion of the uterus which lies between the external and internal os. A complete histological description is made of the three divisions of a pregnant and nonpregnant uterus. The 12 proved cases are described. The chief histological difference between the abnormal and normal implantation is the absence of the intervening decidua. Decidual cells may occur singly and in groups, but these may not be compared with the normal decidua. The decidua basalis limits the destructive action of the villi. However in ectopic pregnancies the villi destroy the underlying structure. This is more pronounced in cervical implantations than in tubal pregnancies or placenta accreta.

The pathological description of cervical implantation is excellent. Clinically the only constant observation was violent hemorrhage that in all cases led to active intervention. In only 3 cases was the correct diagnosis made. The condition has been diagnosed as incomplete abortion, bleeding varicose chorionepithelioma, and ruptured tubal pregnancy.

Treatment is variable depending upon the amount of bleeding, the location, and duration of the implantation. Intracervical packing or some form of surgery was used in nearly all cases. Several late severe secondary hemorrhages occurred.

JAMES F. DORRIS, M.D.

Armand, M. F.: The Intravenous Administration of Magnesium Sulfate as the Exclusive Treatment for Eclampsia. (*Traitement exclusif de l'éclampsie par le sulfate de magnésium en voie intraveineuse*). *Obst. gin. int. -mar.* 1946 4 40.

Accepting the assumption of F. C. Irving that eclampsia is not a primary disease of an organ but a state of spasm of its terminal arterioles, the author concludes that the only rational therapy of this condition involves the administration of antispasmodics. Following a review of the literature on the use of

morphine and of magnesium sulfate in the treatment of eclampsia, he discusses the significance of changes in water metabolism in eclampsia, and the effect of water retention in creating spasms of the terminal arterioles. The vascular spasm slows the blood stream, produces edema, increases the viscosity of the blood, and, finally, causes ischemia of the tributary organs of the vessels involved, which explains the clinical picture of pre-eclampsia and eclampsia.

The antispasmodic effect of magnesium sulfate diminishes the nervous irritability and rapidly and definitely diminishes the contractility of the smooth muscles. The blood pressure falls almost immediately and the circulatory equilibrium is restored. Diuresis is augmented. Frequently micturition occurs shortly after the injection and the attack is interrupted. Magnesium sulfate is also said to have an anesthetic effect without reduction of the alkaline reserve of the blood.

Results obtained with the intravenous administration of magnesium sulfate by the author have been so good that he believes this is the specific treatment.

A 50 per cent solution of magnesium sulfate is employed, and the dose consists of 5 gm. of magnesium sulfate, or 10 c.c. of a 50 per cent solution. Should the attack recur a new injection of 2.50 gm. or 5 c.c. of the solution, may be given every 4 hours until return to normal. If the patient, although apparently normal, continues to suffer from headache or cramps, or if the blood pressure shows a tendency to rise, a daily injection of 2.5 gm. should be given.

The total amount of the salt which can be injected without danger depends upon the severity and duration of the attack. In the 21 cases treated by the author the attack was cut short in 3 cases with 2.5 gm. of magnesium sulfate, in 7 with 5 gm., in 1 case with 7.5 gm., in 4 cases with 10 gm., in 3 with 15 gm., and in 1 each with 25, 30, and 50 gm. respectively. As a rule, 5 gm. of the magnesium sulfate, or 10 c.c. of the 50 per cent solution, suffice. Frequently a result may be achieved with less, and rarely is a much larger dose needed. In the presence of recurring attacks and deep coma, one should not hesitate to repeat the injections up to from 3 to 50 gm. If, on the other hand, the patient responds nicely to the first injection further administration is contraindicated, since under these circumstances the result is withdrawal of water from the brain might lead to acute dehydration of the brain and convulsions.

The solution is mixed with an equal portion of blood withdrawn from the vein and the injection should be made very slowly. As a rule the injection is well tolerated and there is only a slight sensation of warmth. Occasional excitement can be controlled by interrupting the injection for a moment and then continuing it more slowly. The injection is followed by abundant perspiration and, after a quarter or half hour by micturition.

In the present series of cases the blood pressure fell immediately from 3 to 6 cm Hg. No other treatment is required. Venesection and the use of sedatives have been abandoned.

Nineteen of the 21 cases in the present series were treated exclusively by the intravenous administration of magnesium sulfate with recovery in all and no maternal deaths or complications. There were 18 primiparas and 3 multiparas. Five women were seen during pregnancy, 4 in labor and 12 in the puerperium. In the 4 patients in labor, delivery was spontaneous. Two patients were admitted with fetal retention and 2 others gave birth to living infants. In the 5 patients seen during pregnancy the pregnancy proceeded normally but only 3 infants survived. The series is too small to permit of definite conclusion, but the results are sufficiently encouraging to warrant further trial of this very simple method of treatment.

EDITH SCHWABER MOORE.

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According to the conception generally prevalent the maternal and fetal vascular systems of the placenta are completely detached from one another so that no direct transition of blood from the mother to the fetus or vice versa, is possible. The authors believe that a leakage can sometimes occur in the placental septum and permit substances which do not permeate under normal conditions to pass over from the maternal vascular system to that of the fetus. This hypothesis may explain some of the complications of pregnancy as in erythroblastosis fetalis. Two investigations on the permeability of the placenta are described.

In the first experiment a transfusion of elliptocytic blood was given to a normal pregnant woman shortly before the onset of labor. No rise in the elliptocytic content of the child's blood was noted after birth. A similar transfusion given to a patient with nephropathy gravidarum resulted in a definitely increased elliptocytic content of the child's blood immediately after birth which gradually decreased in the next few days.

GEORGE BLINICK, M D

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An analysis of 5 of such articles shows that approximately a third of the patients who are treated conservatively can successfully conceive, and indicates that the vast majority of such patients have a normal pregnancy. For this reason the desirability of employing procedures which conserve the child bearing function in youthful patients with endometriosis is emphasized.

JOHN R. WOLFF M.D

## LABOR AND ITS COMPLICATIONS

Martini, J L. The Demelin Forceps 8; Ten Years of Experience in the Pedro A. Pardo Maternity (El fórceps Demelin 8. Diez años de experiencia en la Maternidad "Pedro A. Pardo") *Obst. gin lat* Amer., 1946, 4 339.

The author describes the experience of 10 years with the use of the Demelin 8 forceps—533 applications from 1935 to 1945. The forceps weighs 620 gm. its total length is 40 cm. length of the blade, 175 mm length of the handle, 225 mm. maximum width of the blade 47 mm. maximum width of the window 38 mm. length of the fenestra expanding in the blade 147 mm. length of the fenestra in the plane 120 mm width of the cuffs 9 mm cephalic radius of the curvature, 170 mm., length of the bar of articulation 177 mm. and the distance separating the two screws of articulation when forceps is mounted 160 mm. The terminal portion of the blades from the windows to the beak has the form of a U and the symmetry of the cuffs at this level permits easy determination of the axis of the blade, the axis prolonged behind into the general axis of the instrument once mounted. This feature is not found in the forceps of Fenestrator of the handles make it lighter and straight Demelin gives great importance to the cephalic and perineal curvatures the forceps is almost curving below the extremity of the handle, so that the bar of articulation situated in the plane of the

axis of the blades constitutes one-fifth of the curvature and assures that both blades are in front of the other which impedes tangential escape of the head. The first absolute general principle is to employ the least possible force. Introduction of the blades, articulation, and extraction should be accompanied by the usual precautions as in any other forceps application.

The long blades of the Demelin 8 (from 0.185 to 0.15 m. instead of 0.05 m.) act like a kind traction that attenuates considerably the bumps and rubbings by the incidence of very oblique pull on the resistant walls of the pelvic cavity whereas shorter blades accentuate the contacts between the pelvic walls and the presentation by reason that the angle of incidence (of the blades to the fetal part) approximates much more the straight short arm of the lever. The almost straight blades of the Demelin 8 adapt perfectly with the presentation and the soft parts herniating by the windows. This ample cephalo-instrumental contact permits a secure hold which is impossible if the blades only depend on their beaks like in the divergent forceps.

In the last 10 years, there were 17 008 deliveries with 533 Demelin 8 forceps applications, 88.55 per cent (472 cases) in primiparas 8.06 per cent (43 cases) in secundiparas and 3.39 per cent (18 cases) in multiparas 34.98 per cent of the patients were below 30 years of age while 40.02 per cent were above that age.

The causes for intervention were fetal suffering in 60.03 per cent of the cases prolonged expulsive period in 40.52 per cent failure of rotation in 39.83 per cent dystocia of contraction in 33.62 per cent perversion of rotation in 3.17 per cent maternal exhaustion in 2.43 per cent, eclampsia in 2.25 per cent, prophylaxis in 2.06 per cent, amniotic infection in 1.68 per cent, relative narrow pelvis in 0.56 per cent vaginal diaphragm in 0.56 per cent, polypiform edema

of Rouvier in 0.37 per cent, and excessive fetal volume in 0.18 per cent.

There were 76 episiotomies, 14.07 per cent of the total interventions. There was only 1 face presentation the rest were all vertex presentations. The 3 maternal deaths are not accounted for by the forceps hence the maternal mortality may be said to be nil. With respect to the maternal morbidity it occurred as follows: In first degree perineal lacerations, 18.33 per cent or 98 cases in second degree, 4.69 per cent or 25 cases in third degree, 0.93 per cent or 5 cases; in vaginal mucosa lacerations, 1.50 per cent or 8 cases in vulvar mucosa lacerations, 0.18 per cent or 1 case in cervical laceration, 0.18 per cent or 1 case, in shock 0.56 per cent or 3 cases in vulvovaginal thrombus, 0.18 per cent or 1 case in febrile puerperium, 6.19 per cent or 33 cases and in afebrile puerperium, 2.43 per cent or 13 cases. In the 533 interventions death occurred 36 times or in 6.75 per cent. Applications in the superior strait give a mortality of 33.33 per cent in the inferior strait, one of 6.13 per cent and in the excavation, one of 5.03 per cent. As to the fetal morbidity only benign lesions were observed, generally ecchymosis of the cheeks and scalp, never serious traumatism as caving in or fractures of the parietals, nor ocular lesions, or facial paralysis. In conclusion, the Demelin 8 is a convergent forceps almost straight, with double posterior articulation, with traction passing by the center of mobility of the head, realizing a solid and symmetrical application, respecting the spontaneous mobility of the head, scarcely traumatizing, and requiring less force for extraction in comparison with other types of forceps. Its maternal mortality is nil, the low traumatic maternal morbidity consisting mostly of benign lesions of the perineum its maternal infectious morbidity is also low its fetal mortality is 6.75 per cent and its fetal morbidity is practically nil.

A. B. VICINO, M.D.

# GENITOURINARY SURGERY

## ADRENAL, KIDNEY AND URETER

Broster L. R. and Gardiner Hill II: Addison's Disease Successfully Treated by a Graft *Brit M J*, 1946 2: 570.

Broster and Gardiner Hill describe the case of a young woman in whom a diagnosis of Addison's disease was made 9 months previously on the basis of the clinical and biochemical findings. An adrenal gland from a patient with the adrenogenital syndrome was grafted and as a result the symptoms and signs of Addison's disease disappeared. Tests by means of the withdrawal of sodium chloride showed that her blood sodium no longer was below normal and at the last test, 14 months after operation no substitution therapy with sodium chloride was required.

The tumor of the gland was from a 21 year old woman who had hirsuties, adrenal virilism, hallucinations, and depressions and who excreted 295 mgm. of ketosteroid daily. The left adrenal gland was used. It was hypertrophied to 2 to 3 times its normal size. Its large unbranched vein was cut long. The vein was perfused with heparin solution and the graft was placed in normal saline solution and the

In the recipient an incision was made along the outer border of the left rectus muscle. The rectus was retracted medially. The deep epigastric artery and vein were exposed and cut medially. The wound was bathed in heparin solution, and the artery and vein were separately piloted into the adrenal vein and anchored. The recipient menstruated unexpectedly on the second day after the operation.

During subsequent examinations the graft was palpable and tender, especially before and during a period. The patient's blood pressure rose to normal or even hypertensive levels, the pigmentation disappeared almost completely, and the sodium chloride level did not diminish even when substitution therapy was omitted. The authors believe that the cortical deficiency was corrected by the graft and that they maintain that a cure was obtained 14 months after operation.

DAVID ROSENBLUM, M D

Fine, J. Frank, H. A. and Seligman, A. M.: The Treatment of Acute Renal Failure by Peritoneal Irrigation. *Ann Surg*, 1946, 124: 857

The authors believe that certain types of acute renal failure need not be fatal if the period necessary for repair can be provided by utilizing an extrarenal pathway as a temporary substitute for the normal excretory function of the kidney. The peritoneal membrane has long been recognized to be an excellent dialyzing membrane readily permeable to water and crystalloids. Peritoneal irrigation makes use of this dialyzing capacity for the removal of diffusible substances from the plasma and ultimately from the extracellular fluid.

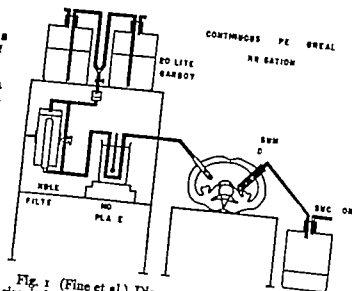


Fig. 1 (Fine et al.) Diagrammatic representation of the circuit for continuous peritoneal irrigation. (Courtesy of J B Lippincott Co.)

It has been determined in the dog that adequately conducted peritoneal irrigation would provide as much as from 40 to 75 per cent of the normal renal function.

The authors describe in detail their method, and the peritoneal irrigation apparatus employed (Fig 1). The irrigating fluid is a modified Tyrode's solution to which is added the sodium salt of heparin, penicillin and sodium sulfadiazine. Heparin is used to prevent the formation of fibrin and intestinal adhesions. Penicillin and sulfadiazine are employed as a prophylaxis against infection. The sodium sulfadiazine should be omitted if renal sensitivity to sulfonamides is present or suspected. Protein is not employed because edema of the peritoneal membranes does not occur as a result of irrigation. When fourth reported case, gelatin is employed because the large amounts of protein required make the use of preferable. The gelatin solution should be adjusted to a pH of 7.5 with concentrated sodium hydroxide.

The flow of fluid is illustrated in Figure 1. Under local infiltration anesthesia the inflow and outflow tubes are inserted into the peritoneal cavity through a small incision in each flank. The stainless steel sump drain is directed into the cul-de-sac of Douglas for drainage. This type of drain obviates the plugging of the tubes as long as fluid is kept running in.

Collateral therapy is necessary for maintaining nutrition and water soluble vitamin requirements, for correcting anemia, acidosis, hypoproteinemia, and for the management of concomitant disease. The authors admit and stress that this interesting therapeutic method is still in the experimental phase. They have to date established (1) that properly per



formed peritoneal irrigation can eliminate all clinical and chemical evidence of uremia. (2) that significant clinical improvement may occur in from 36 to 48 hours. (3) that the total time required will vary with the duration and severity of the uremic state, the degree of saturation of the tissues with the retained products, the degree of dehydration or edema, the nutritional state, the food intake, the rate of protein catabolism, the presence of concomitant disease, and the rate of efficiency of the peritoneal irrigation. (4) that irrigation does not exert a deleterious effect on the peritoneal structures, and (5) that the efficiency of irrigation so far as blood urea clearance is concerned does not diminish with time and exceeds the minimal degree of renal excretory function (10 to 15 per cent) necessary to avoid the reaccumulation of nonprotein nitrogen of urea.

The time necessary for repair of the kidney injury and recovery of sufficient kidney function cannot be forecast; this will vary from one type of injury to another and from case to case with the same type of injury. Lesions that are capable of repair in the course of a few weeks should respond to this form of therapy because it probably can be maintained safely that long. To date this form of therapy had been maintained for 12 days.

The chief hazard is the possibility of the development of peritonitis. This danger has been minimized by the introduction of a bacterial filter on the inlet side of the irrigating system, with chemotherapy and with careful quarantine of the abdominal wounds and tubes by proper dressings. The peritoneal drainage fluid has yielded the following bacteria: the *Escherichia coli* in 2 cases without significant clinical effects, and the *Escherichia coli*, *Clostridium welchii*, *Staphylococcus albus*, and enterococci without peritonitis in 1 case, as evidenced at autopsy. The inflow and outflow tubes should be so placed that dislodgment necessitating subsequent replacement should not occur. It is highly important to observe the fluid and electrolyte balance.

Pulmonary edema occurred in 75 per cent of the cases because of the intravenous administration of fluid in excess of tissue requirements for fluid in anuria and because of the presence of acidosis. The fluid requirement during anuria consists only of the amount of the water lost by evaporation which is about 1,000 c.c. daily unless fever, diarrhea, vomiting or sweating are also present. Intravenous fluid is necessary as a vehicle for glucose and amino acids. Glucose in amounts of from 100 to 200 gm. daily will satisfy the caloric needs and will prevent acidosis as the peritoneal irrigating fluid contains 2 per cent dextrose solution.

Unfortunately the proper time for peritoneal irrigation has not yet been established because it is impossible to determine the precise existence of irreversible damage. It should be begun after the onset of full blown uremia, and discontinued following the return of sufficient renal function to prevent azotemia and to sustain a normal fluid and electrolyte balance.

In the discussion of this paper before the American Surgical Association, E. D. CROMBIE related his experience with renal shutdown following severe trauma on the battlefields which was resistant to all known forms of therapy. He expressed a hope that peritoneal irrigation as described by the authors will prove successful in combating renal shutdown following severe trauma. A. B. MCGRAW reported a successful outcome in a child with nephrosis treated by peritoneal irrigation. A. O. WITKOWSKI believed that the authors had established a point of departure in the therapy of anuria and uremia which will apply to surgical and medical problems, and hence the constitutes a real advance.

J. E. RHOADS and R. COPE discussed the method of external dialysis. FINE conceded that this method may prove satisfactory but objected to external dialysis because it imposes an arteriovenous anastomosis on an already seriously ill patient. He again stressed the point that peritoneal irrigation is still in the experimental stage and that it is not yet considered a satisfactory clinical method.

ROBERT TRULL, M.D.

Alcorta L. F., Dente, J., and Sandro, R. E.: *Renal Tuberculosis in a 6 Year Old Girl* (Tuberculosis renal en una niña de 6 años). *Rev. argent. med.* 1944, 3: 294.

A case of renal tuberculosis in a 6 year old girl is reported by the author because tuberculosis of the kidneys is rare at that age. According to the statistics, children younger than 10 years form only 0.4 per cent of the entire material operated on for tuberculosis of the kidneys.

The patient was admitted with complaints of polyuria and nocturia of 1 year's duration. There were no pains in the lumbar or bladder region and palpation of the kidneys did not provoke any painful sensations. A flat picture of the abdomen showed an abnormally large shadow of the right kidney while an excretory urogram furnished the typical picture of right pyelonephrosis. Roentgenograms of the chest revealed calcified residues of a primary infection. The urine was turbid and gave an alkaline reaction. The sediment contained numerous leucocytes. The bacteriologic examination established the diagnosis of tuberculosis.

The involved kidney was removed and the histological diagnosis of the specimen was found to be follicular and caseous tuberculosis. The patient made an uneventful recovery.

JOSÉPH K. KADAT, M.D.

Voltschavskii, A. B.: *A New Method of Suturing the Renal Pelvis in Pyelotomies*. *Frankfurter Zeits.* 1945, No. 5, 347.

After the kidney has been exposed, the pelvis is incised, and the stone removed in the usual manner, the edges of the incision are seized by Pen or Kocher forceps, one on each margin, and brought together so as to approximate the two wound borders at this point. A fine catgut suture is then compe-

lated over the ends of the two forceps and tied so as to produce a perfect approximation of the mucosal edges. A varying number of these ligature sutures (1 to 3) corresponding to the length of the incision may be applied. Care is taken to grasp only the outer layers of the incision and avoid the mucosa. However in difficult conditions such as pyelotomies *in situ* the entire thickness of the wound edge with perhaps some of the mucosal surface of the renal pelvis cavity may be included. A row of sutures burying this first row may be applied to the surrounding fatty tissues.

The author employed this method in 10 pyelotomies and found that the wound healed uniformly in from 2 to 3 weeks. He claims the following advantages for his method.

The suture by ligation removes the danger of hemorrhage in pyelotomies and the possibility of injury to the renal blood vessels which pass close by. Technically the method is much easier than the usual manner of suturing the incision in the kidney pelvis. As the cavity of the kidney pelvis is not penetrated by the suture material, the danger of foreign body irritation from penetrating suture material with recurrence of the stone is removed. The rapid healing of the perfectly approximated wound edges forestalls invasion by infectious processes of the incised kidney pelvis.

JOHN W. BRENNAN, M.D.

Dees, J. E.: The Use of a Fibrinogen Coagulum in Pyelolithotomy. *J. Urol.*, Balt. 1946 56 371

If a soft calculus in the renal pelvis is fragmented during its removal, or if a small stone is unsuspected or is not located and left behind a recurrence of calculus disease is almost certain to follow. In many cases the x ray shadow of a small stone is obscured by the opacity cast by a larger stone in the kidney. The interior of the kidney pelvis cannot be visualized through a pyelotomy incision and a search for the stone must be made blindly with appropriate forceps or by digital palpation. In such a search the kidney may be traumatized considerably. A small free stone may move from one calyx to another blood clot may cover a small stone so that crepitus cannot be elicited. Radiolucent stones and minute calculi may fail to show in the roentgenogram. Neither is irrigation of the renal pelvis and the use of routine x-rays of the kidney on the operating table in allible.

The authors have developed the following technique for pyelolithotomy.

At open operation solutions of human fibrinogen and thrombin are simultaneously injected into the renal pelvis filling it completely. A firm tenacious coagulum results which forms a perfect mold of the cavity of the pelvis regardless of its configuration. The coagulum is removed through the usual pyelotomy incision after coagulation and all free stones are incorporated within the clot. Coagula formed by the action of thrombin on human fibrinogen solu-

tions fulfill most closely the theoretical requirements (1) the substance should be fluid so that it can be injected into the renal pelvis (2) it should coagulate uniformly completely and rapidly (3) the coagulum should be malleable and elastic enough to permit withdrawal of the mold of each calyx through its narrower infundibulum and to permit removal of the entire clot through a short renal pelvis incision (5) it should be noninjurious to the kidney (6) the coagulum should dissolve or disintegrate spontaneously if a particle is left and (7) the coagulable substance should be unaffected by small amounts of urine or blood. Two per cent clotting globulin produces coagulation of the fibrinogen solution in 30 to 20 times as great as that of human blood clot. The coagulum is disintegrated by urine in 6 to 24 hours.

Coagulum pyelolithotomy permits removal of all free pelvic stones avoids fragmentation of calculi minimizes kidney trauma and avoids the necessity of complete surgical mobilization of the kidney but it cannot be expected to remove a calyceal calculus larger than that of its infundibulum, or one which is imbedded or adherent to the renal pelvis wall. When severe infection is present and the urine is mucoid, preventing complete dissemination of the injected fluid throughout the pelvis and around each calculus aerosol O.T. (0.1 per cent) is used to irrigate the renal pelvis first as a wetting agent which permits better distribution of the solution.

After surgical exposure of the kidney pelvis and upper ureter (1) the lumen of the ureteropelvic junction is gently occluded with a suitable instrument or tape (2) a 4 mm. incision is made in the renal pelvis (3) a 12 F. rubber catheter with two eyes is introduced into the pelvis until the second eye lies just within the pelvis it must fit snugly one end being clamped if necessary and urine is aspirated from the pelvis (4) the pelvis is aspirated distending it with normal saline solution (5) the pelvis is lavaged with 0.1 per cent aerosol solution in amounts not exceeding two-thirds of the capacity if considerable infection is present (6) the pelvis is lavaged with fibrinogen solution and is aspirated (7) fibrinogen solution in the amount of 90 per cent of the predetermined pelvic capacity is injected into the pelvis (8) simultaneously by means of a small syringe and needle an assistant injects one tenth the amount of the pelvic capacity of 2 per cent clotting globulin through the wall of the urethral catheter into its lumen so that the two materials are intimately mixed as they enter the renal pelvis, (9) 4 minutes are allowed to elapse (10) the urethral catheter is removed and the small pyelotomy incision is enlarged and the coagulum is slowly but firmly withdrawn. The pyelotomy incision is closed completely.

The authors had perfect results in 28 cases and partially satisfactory results in 6 cases. The treatment failed in 2 cases. Illustrations showing the gross appearance of the clot are presented.

DAVID ROSENBLUM, M.D.

Howard, F. S.: Instrumental Perforation of the Ureter. *J. Urol. Balt.*, 1946 56 319.

Eight cases of proved instrumental perforation of the ureter are reported. The condition is probably more common than the small number of proved cases reported might indicate.

When the rent in the ureter is small and there is no ureteral obstruction below it, there is ordinarily no untoward reaction to the injury, and the patient readily recovers without surgery. However a very serious state of affairs may be reached if there are complicating urological conditions or if the opening in the ureter is large enough to allow extravasation to continue in large amounts. Perforations by large instruments are more apt to be serious than those produced by small ones.

In itself instrumental perforation of the ureter calls for observation rather than immediate surgery. The time for drainage is determined by surgical judgment based upon the individual findings in each case. Most patients who are going on to recovery without surgical intervention are either well or nearly well 24 hours after the injury.

JOHN A. LOWE, M.D.

#### BLADDER, URETHRA, AND PENIS

MacLean, J. T. and Gerrie, J. W.: Repair of War Wounds of the Bulbos and Membranous Urethra with Split Thickness Skin Grafts and Penicillin. *J. Urol. Balt.*, 1946 56 485.

The ideal time to repair injuries of the urethra is immediately after shock has been controlled. It is then possible to do an end-to-end anastomosis, even when there is considerable loss of tissue.

In injuries of the bulbous and membranous urethra free grafts are more practical than local flaps (Thiersch Duplay) or tubed pedicles (Gillies Davies). McIndoe, in 1937 described an improvement of this technique in which he used specially designed trochars and tubes for the insertion of the graft after a preliminary correction of the chordee. He maintained the urethra in a distended position for a period of 6 months by using indwelling gum elastic dilators. Humby in 1941 described a technique for the cure of hypospadias, in which a full thickness skin graft was built up around a catheter glued to it, and buried in the septum between the corpora cavernosa by splitting the penis longitudinally.

In the cases presented it was decided to use a combination of these latter two techniques with certain modifications.

The operative procedure is given as follows:

1. Suprapubic cystostomy. The urinary stream should be diverted by suprapubic cystostomy.

2. Exposure of the area of defect. The patient is placed in the perineal position on the table.

The anterior urethra is thoroughly irrigated with protargol 1/4 of 1 per cent, and a 22 F sound is passed to the point where it meets obstruction. Another sound is passed into the suprapubic opening through

the internal sphincter and along the posterior urethra until it meets obstruction.

An inverted perineal incision is then made, and the ischioanal space on each side is opened by blunt dissection. The median raphe is divided and the rectourethralis muscle is exposed and divided, which exposes the urethra, where the ends of the 2 sounds can readily be palpated.

An incision is made over the point of each sound, and the scar tissue between is excised.

A 24 F Foley bag catheter is then passed through the external urinary meatus, grasped as it appears in the perineal incision, and threaded on into the posterior urethra. The balloon on the catheter is distended and the catheter is withdrawn until the balloon meets the bladder neck. The exposed catheter in the perineal wound is the area of the catheter to be covered by skin graft.

3. Preparation of the urethral graft. A split thickness graft of the desired size, from 15/1000 to 18/1000 of an inch thick is cut with a Padgett dermatome from the inner aspect of the upper arm. The exposed portion of the catheter in the perineal wound is drawn further into the wound by decompressing the balloon, and the skin is placed around the catheter to form a tube. It is held in place by a few mattress sutures of 0000 plain catgut.

4. Implantation. The perineal portion of the catheter with the attached graft is then replaced, and the ends of the graft are carefully threaded into the exposed urethra at the proximal and distal ends, so that some of the graft overlaps normal urethra at each end. The seam of the tube graft should be anteriorly. No attempt is made to obtain accurate end-to-end anastomosis as any surplus portion of the graft that does not take will slough out. The catheter with its covering partial thickness graft is now in the exact position desired. The balloon on the catheter is distended with water and tied to prevent the catheter from slipping out. The urethra must be kept distended with a catheter for at least 10 weeks after the operation, then dilated at weekly intervals.

5. Closure of the perineal wound. The soft tissues are closed over the graft with a few mattress sutures of 0000 plain catgut on an atraumatic needle. A medium sized Penrose drain with a wick is inserted and brought out through the angle of the perineal wound. The wound is then closed with a subcuticular continuous running suture of No. 1 or 2 catgut.

The 36 F suprapubic Malecot catheter is reinserted in the suprapubic wound.

6. Modification of the grafting technique. In the second case, the tube graft was built up on an intra-tracheal inflation cuff which was pulled on over the Foley bag catheter. By inflating the cuff slightly it was possible to build this portion of the urethra much larger than the normal caliber which allowed in advance for shrinkage as the healing and the surrounding fibrosis became complete.

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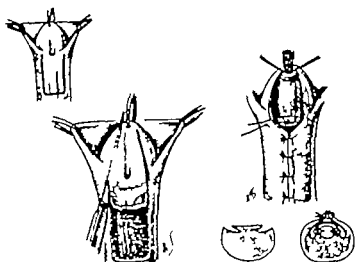
urethra could be carried out, if desired, without disturbance of the graft. **JOHN A. LOFF M.D.**

**Leveuf, J:** The Treatment of Hypospadias (Le traitement de l'hypospadias) *J Chir. Par.*, 1946 61 90.

Preliminary operations for the correction of a curvature or torsion of the penis may be performed on boys at the age of 3 or 4 years but a reconstruction of the urethra should not be attempted before the genital organs attain sufficient dimensions. In other words not the age of the child but the development of his genital organs is the determining factor. Usually this operation can be performed at the age of 8 years. However the operation may have to be postponed in a child with adiposogenital dystrophy. In such cases a preliminary treatment with thyroid pituitary or/and testicular extracts is indicated.

For correction of a curvature of the penis the author recommends Ombredanne's technique. It should be remembered that fibrous bands responsible for the curvature are found not only in the median but also in the lateral portions of the organ. The hemorrhage is never of any importance. After the operation the author applies extension to the penis (10 to 25 gm) until cicatrization is complete.

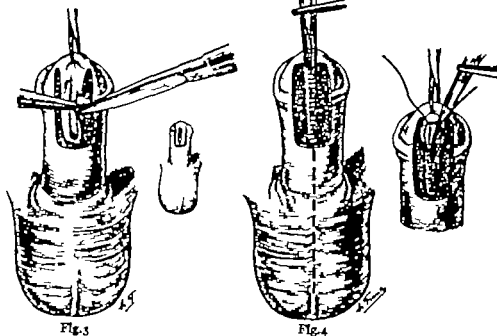
The torsion observed by the author was approximately 90 degrees and in each instance to the left. For its correction he recommends a vertical incision on the right side of the root of the penis extending from above the pubic bone down to the middle portion of the scrotum. After dissection of the cavernous bodies from the pubis to the perineum a correction of the position is obtained by re-torsion and is main-



**Fig. 1 and 2 (Leveuf)** Modified Mathieu's technique. The cross sections show the glans before and after the operation.

tained by a series of sutures with a nonabsorbable material which is carried to the suprapubic fibrous tissue. The pyramidal muscle on the right side may be turned downward and attached to the cavernous bodies, but as a rule this is not necessary.

As to the reconstruction of the urethra, it is extremely important that the cutaneous flap contains no hair follicles as otherwise calcareous deposits may form. The lower surface of the penis serves the purpose very well. The diameter of the reconstructed urethra should be sufficient to permit normal micturition. To diminish the chance of a fistula formation the knots of the sutures should be placed within



**Fig. 3** Treatment of hypospadias of the penis. Dissection of flap. Insert, Direction of incision.

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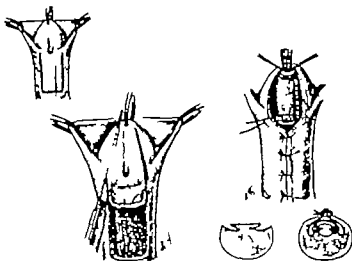
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JOHN A. LOHR, M.D.

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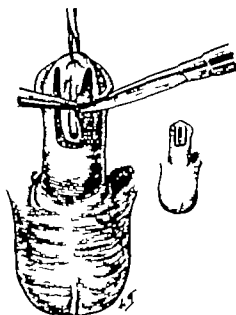


Fig. 3

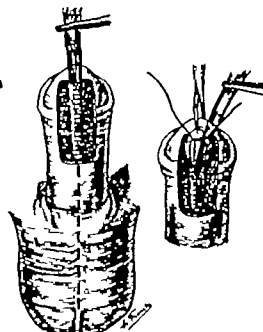


Fig. 4

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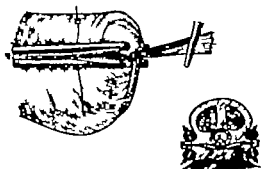


Fig. 5 (Leveuf) Treatment of hypospadias of the penis. Attachment of the penis to the scrotum. Insert, Plan of operation.

the urethra. Finally, the suture lines of the urethra and the flap should be separated one from another by as much cellular tissue as possible. If this is done and one of the sutures of the urethra gives the resulting fistula closes spontaneously.

For the treatment of hypospadias of the glans or one located at the junction of the glans and the prepuce the author recommends a modified Mathieu's technique (Figs. 1 and 2).

Figures 3, 4 and 5 show the method of treatment of hypospadias of the penis employed by the author.

In hypospadias at the junction of the penis and the scrotum two stages are required for reconstruction of the urethra. First a urethral canal which leads from the scrotal meatus to the lower portion of the penis is constructed. Six months later the same procedure is employed as in hypospadias of the penis.

JOSEPH K. NARAT, M.D.

Lenowitz, H., and Graham, A. P.: Carcinoma of the Penis. *J. Urol. Balt.*, 946 56 458.

Carcinoma of the penis may begin as a relatively benign warty excrescence which at a certain stage undergoes malignant degeneration as a small neoplastic growth which after a variable period of time fissures and ulcerates, or as a scaly seborrheic or psoriasis-like patch which may not ulcerate or show its true neoplastic nature for many months or years. The differential diagnosis includes chancre, chancroid, tuberculosis, balanitis, herpes progenitalis, gummatous ulceration, granuloma inguinale and psoriasis.

From 1931 through 1944 the Tumor Clinic of the Veterans Administration Hospital at Hines, Illinois treated 13,490 white and 982 colored patients for all types of cancer. Of these, 100 white patients and 39 negro patients were admitted for carcinoma of the penis, an incidence of 0.66 per cent for both groups. Negro patients constituted 28 per cent of the patients with carcinoma of the penis. Of all the colored patients admitted for carcinoma of all types 3.791 per cent had carcinoma of the penis, whereas only 0.741 per cent of the white patients were admitted for this condition.

An average of 21 months had elapsed after the onset of the penile lesion before these patients ar-

rived at Hines. Previous treatment had included circumcision, local and insufficient excision of the tumor, local antiseptics or arsenicals, and insufficient radium or x-ray therapy. Two patients had undergone emasculation and total amputation of the penis with bilateral groin dissection.

Carcinoma of the penis is rare among males. It has been circumcised at birth. None of this group of 139 patients had been circumcised in infancy. It was noted that the incidence of venereal diseases had been higher in this group than in the general population but it is difficult to attribute etiological significance to this finding. The marital status was not found to be a causative factor. Irritation, trauma, injury and chronic inflammation seemed to have a definite etiological bearing. In both white and negro patients, the highest incidence occurred between the ages of 45 and 49.

The papillary type of tumor predominated over the infiltrating type in this series. The sites of origin were found to be (1) the prepuce and frenum, (2) the glans, and (3) the coronal sulcus. Metastatic spread is by way of the penile lymphatics which, with those of the scrotum, lower abdomen, and thighs, are part of one system draining into the inguinal and femoral lymph nodes. In this series, 54 patients had no involvement of the lymph nodes, 37 had bilateral involvement, while 11 had unilateral lymph node involvement. Inguinal node metastases appeared to depend primarily upon the degree of malignancy of the primary lesion and not upon the duration or the extent of involvement of the penis by the carcinoma.

There are no symptoms pathognomonic of cancer of the penis. The disease is treated by radiotherapy or surgery or a combination of these methods. A lesion 2 cm. or less and not involving Beck's fascia is treated entirely by radiation. Radiotherapy is also indicated for preoperative irradiation preliminary to surgical intervention and for palliation. Preoperative irradiation is not given to metastatic inguinal nodes because it is ineffective in clinically arresting the disease. Postoperative irradiation of the groins is effective in decreasing the incidence of recurrence and for palliation.

Adequate preoperative and postoperative care is essential. Spinal anesthesia, combined in some instances with sodium pentothal given intravenously was the anesthetic of choice in this series. Simple or partial amputation was performed on 45 patients, with bilateral groin dissection either at the same time or at a later date, according to the general physical condition of the patient. Total or complete amputation was performed on 10 patients who had extensive involvement of the penis but no involvement of the regional lymphatics. The urethra was brought out through the perineal body in preference to leaving it in the upper portion of the scrotum. Partial amputation with bilateral groin dissection was performed on 6 patients. Total amputation with bilateral groin dissection was performed in 13 cases in which the entire organ as well as the regional lymphatics were extensively involved. Emasc-

culation with bilateral groin dissection was performed on 8 patients.

Irradiation alone was given to 53 patients and of these 62 per cent are alive. Major surgical procedures were performed on 82 patients and of these 42 per cent are alive.

A plea is made for early biopsy of all suspicious penile lesions

CLARENCE V. HODGINS, M.D.

## GENITAL ORGANS

Pearse, R. and Meyer E. G.: Cancer of the Prostate. *Canad. M. Ass. J.*, 1946 55 441

Cancer of the prostate ranks third in frequency being surpassed only by cutaneous and gastrointestinal carcinomas. Malignancy usually arises in the posterior lobe of the prostate gland far away from the urethra hence the lack of early symptoms but this anatomic position makes it susceptible to early detection by digital palpation through the rectum (Fig. 1)

A small hard prostatic nodule with ill defined margins felt digitally on rectal examination should arouse grave suspicion. Such a nodule may be an early carcinoma and should be differentiated from a fibrous nodule resulting from chronic prostatitis or prostatic calculi. The patient should be observed for a while during which time the serum acid and alkaline phosphatase is estimated. In case of doubt the patient should be hospitalized and prepared as for a perineal prostatectomy. The prostate gland is exposed by the perineal route the nodule excised and biopsy performed. If cancer cells are found a radical prostatovesiculectomy is performed.

When cancer is coexistent with adenomyoma the problem of diagnosis becomes more difficult. It should be remembered that the cancer is not situated in the adenomyoma but in the thinned out prostate which forms the so-called false capsule of the larger benign tumor and will not be removed by suprapubic enucleation which is commonly but erroneously called prostatectomy (Fig. 2). Such cases should be treated by radical perineal operation as these patients have good prospects of cure.

The majority of patients present themselves for treatment late in the course of the disease when they experience symptoms of urinary obstruction or metastases, or both. There is no known cure for such a patient. However strikingly beneficial results follow bilateral orchiectomy performed on patients with urinary obstruction and pain from metastatic foci. The pain disappears in from 24 to 36 hours and the patient may void more freely within a week. Roentgenograms of osseous metastases will show a return to more normal bone structure in 2 to 3 months. The serum acid phosphatase, which is usually elevated drops toward a normal level and the alkaline phosphatase shows an initial further rise and then a slower recession. Many cases, however require transurethral resection in spite of orchiectomy. The same chain of events may occur when similar patients are treated with estrogens. The results of orch-



Fig. 1



Fig. 2

Fig. 1 (Pearse and Meyer) Diagram showing site of early cancer adjacent to rectum remote from urethra.

Fig. 2 Diagram showing adenomyoma (A) nodule of cancer in thinned out prostate gland (C) and line of cleavage followed by the finger when suprapubic enucleation is done (B)

ectomy and/or estrogen therapy are not lasting relapses may occur.

It is not known why relapse occurs. It is postulated that since androgens are produced in the testes and adrenal glands the adrenals acquire a compensatory androgen activity following orchiectomy and thereby reactivate the cancer. The combined treatment by orchiectomy and with estrogen does not achieve better results than either type alone.

Estrogen therapy renders the patient less miserable and apparently prolongs life. This is considered the best palliative treatment. Whether orchiectomy is to be preferred to estrogen therapy is a matter of further research. In performing an orchiectomy it is necessary only to remove the bodies of both testes and replace the cords and epididymes in the scrotum. The epididymes are saved because they are not concerned in the production of androgens. Also the presence of something in the scrotum pleases the patients. In 3 or 4 months the epididymes atrophy but by that time the patient is already reconciled and psychologically adjusted.

Orchiectomy can be done through a small (1 inch) incision over each external inguinal ring.

ROBERT TURELL, M.D.

Blasini A.: Two Cases of Seminoma in the Inverted Testicle (Due casi di seminoma in testicolo invertito). *Arch. Ital. urol.*, 1943 50 236

The author reports 2 cases of seminoma of the testis with inversion. He precedes the report with a discussion of primary tumors of the testicle in which he observes that such tumors (1) are rare and (2) may be classified as epithelial tumors, connective tissue tumors, mixed tumors, and teratomas.

The seminomas he continues are to be found in the testis and in the ovary may be small in size not to exceed 100 gm., or they may weigh up to 500 gm. The cut surface of the smaller ones shows a neoplastic mass subdivided in lobules by connective tissue and in the large ones the cut surface may be studded with areas of hemorrhage and necrosis. The tunica albuginea is usually smooth in both and if invaded by the neoplasm it will ulcerate and cause a fungating neoplasm. A hydrocele is always present.



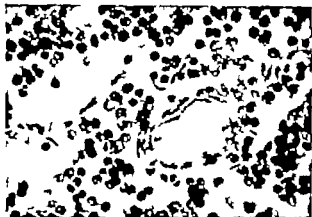


Fig. (Blasini) Seminoma of the testis. Intimate contact of the neoplastic elements with the dilated capillaries.



Fig. 2. Microscopic view of seminoma with low power.

A detailed histological description of the tumor follows. The neoplastic mass has fine fibrillary septa surrounding the individual cells, and a more abundant connective tissue stroma which causes distinct lobulation and tubular forms with transition of one into the other. The cells themselves may be round or polygonal. The cytoplasm is scanty. The nuclei may be round or oval and the mitotic figures numerous. A silver impregnating stain reveals a fine fibrillary stroma, part of a more massive one which makes the scaffold for the cell nests. Areas of hemorrhage, necrosis, and lymphocytic infiltration are present. The neoplastic tissue invades, compresses, and destroys the parenchyma of the testis.

Because some of the cells resemble spermatocytes, the tumor is classified as carcinoma by some and because of the presence of fine fibrillary network it is considered sarcoma by others. The presence of this fibrillary scaffold which embraces practically every cell has been clearly and irrevocably demonstrated by Cozzarelli and Perrera with the Bielschowski Weigert stain. This is in contradiction to some authors who would ascribe the presence of this fibrillary network due to stains.

LaManna has proved without doubt the presence of these fibrillae surrounding the acini and the individual cells, and therefore concludes that seminomas must be considered sarcomas. He also cites the radiosensitivity of the tumors which is similar to that of sarcomas, as stated by Porchownick, Auburg, and Mexasakawa. A discussion as to the origin of such tumors (seminoma) is then given. Most authors ascribe its origin to a proliferative perversion of the different elements which constitute the testis. Etiologically trauma is given as a first cause, and LaManna ascribes the origin of the tumor to repeated surgical interventions for hernia and hydrocele. Ectopia and hypoplasia make the tumor more common on the right side. It usually occurs before the twentieth year of age.

The tumor is of slow growth, decreases sexual potency, causes a feeling of heaviness in the erect

position but no constitutional disturbances. The growth of the tumor may displace the root of the penis. The testis is hard, smooth, mobile, and slightly painful. The epididymis is usually normal, but indurated at times. The cord is normal and the hydrocele usually contains blood tinged fluid. The inguinal lymph glands are invaded on both sides, become adherent to the skin early and soon the iliac, retrocolic, and lumboaortic nodes are invaded. In the diagnosis, x-ray study is of importance as it may reveal metastases or a modification of the normal contour of the involved organs proximal to the suspected growth.

The Ashheim Zondeck test is always positive in malignant tumors of the genitalia and becomes negative after the removal of the tumor. The test is positive in the presence of metastases. A thorough examination of the fluid withdrawn from the hydrocele must be made.

The prognosis is poor. A seminoma of the testis not removed is always fatal, therefore early diagnosis and early surgical removal are necessary. Removal of the testicle must include removal of the cord and the lymphatic glands up to the renal pedicle. (According to Chevassu: from the nodes around the renal pedicle the drainage is toward the mediastinum, root of the lungs, and suprarenal gland.) Metastases occur at an early age and have been found in the mediastinum, lungs, and vertebral column.

Occasionally x-ray therapy before and after surgery may be helpful, but it is to be remembered that the tumor is exquisitely malignant, and that it is refractive to surgical as well as roentgenological treatment.

The author reports 2 cases of seminoma with the didymis-epididymus apparatus in anterior inversion. He states that the inversion may be anterior, vertical, horizontal, or lateral, and concludes that the anomalous orientation of the gland along with trauma may be the cause of the neoplasm.

JOSEPH M. A. PARR, M.D.

## MISCELLANEOUS

Robinson, J. N., Colp, O. S., Suby, H. I., Reiser, C. W., and Mullenix, R. B.: Injuries to the Genitourinary Tract in the European Theater of Operation. *J. Urol.*, Balt. 1946 56 498.

Cross section groups of patients with injuries to the urinary tract have been studied in as much detail as the available records permit.

High explosive shell fragments were the most common missiles encountered in 100 cases of ruptured urethra the anterior urethra was injured most frequently, and the bulbous segment was the most common site of the injury. It is apparent that the treatment of choice is (a) early restoration of urethral continuity and (b) adequate urinary drainage. Very small defects may be managed satisfactorily in a variety of ways, but in the authors' cases, larger injuries did best when treated with suprapubic cystostomy, a splinting urethral catheter and some type of surgical approximation of the damaged tissue. No deaths occurred in this group and 52 per cent of the patients resumed duty in the European theater of operation.

Of 100 perforating wounds of the bladder 50 were extraperitoneal defects, 30 were located intraperitoneally and 20 had both extra and intraperitoneal involvement. Shell fragments and bullets were responsible for most of these. Seventy-one per cent also had injuries to other systems, usually perforation of the intestines or fracture of the pelvis. All were treated eventually by suprapubic cystostomy. In 81 cases which were recognized promptly the average time between injury and operation was 9.3 hours. Drainage of the peritoneal cavity was unnecessary and repair of the bladder defect seemed to hasten recovery but was not essential. Treatment by indwelling urethral catheter alone proved unsatisfactory. Two deaths occurred in this entire group. One patient whose condition was not diagnosed and treated until after evacuation developed peritonitis the other died of pneumonia. Eighty per cent recovered promptly while still in the ETO. Early cystostomy proved to be the most important single factor in the treatment of these patients.

Twenty-five wounds of the ureter were studied. The lower third was injured most frequently and complete division was more common than partial severance. Only 2 patients failed to have injury to other organs usually the intestinal tract. Only one fourth of the patients were diagnosed at the initial operation. Early diagnosis is imperative and may be possible only after pyelography. Proper treatment depends upon whether the defect is partial or complete. In partial rupture, although the anatomical closure of the ureteral tear is desirable extraperitoneal drainage and/or indwelling ureteral catheters often are adequate. In cases of complete division however end-to-end anastomosis over a splinting catheter with diversion of the urine is the operation of choice. One death occurred in this group of 25 patients and this was due to peritonitis following

unsuccessful repair of an associated intestinal injury. Nephrectomy should be confined to cases with massive loss of ureteral tissue and to complete fail ure after more conservative surgery.

Twenty five blast syndrome kidneys recovered without surgical intervention despite secondary hemorrhages in 2 cases. Only 2 patients failed to resume duty in the theater and these were evacuated to the United States with thrombophlebitis and lung abscess, respectively. The urinary tracts were normal.

Seventy five gunshot or shell fragment wounds of the kidney were studied. Seventy per cent also had wounds of other important structures, with the chest predominating. Sixteen had nephrectomy at the original operation and 8 required nephrectomy after evacuation to the rear. The remaining 51 had only conservative surgery. Two patients died 1 from peritonitis due to necrosis of the colon and the other from secondary hemorrhage following nephrectomy. Seventy five per cent of the patients returned to duty in the ETO. Only when there is uncontrollable hemorrhage, evidence of increasing urinary extravasation, massive destruction or extensive infarction of the kidney is surgical intervention indicated. Operative treatment usually can be conservative with foreign body removal, suture or packing of the kidney and perirenal drainage as the operation of choice. Occasionally it will be obvious that nephrectomy is necessary.

Sulfonamides and penicillin were used almost routinely in all of these injuries to the urinary tract. They seemed to prolong the safe interval prior to initial treatment and lessen postoperative complications. Transfusions of plasma and whole blood were employed frequently and undoubtedly influenced the clinical courses and end results.

JOHN A. LOFF, M.D.

Hanley, H. G. The Female Urethra and Its Relation to Upper Urinary Tract Infections. *Proc. R. Soc. M. Lond.* 1946 39 747

Hanley reports a study of 433 women in an attempt to demonstrate the close relationship between urethral inflammation and upper urinary tract infection in women of the childbearing age. In addition to a general and gynecological examination a full urological examination was made in every case.

Over half of the women attending the author's clinic have symptoms directly referable to the urethra, such as frequency, urgency, and dysuria. He contends that true cystitis is a relatively rare condition compared with the urethrotigonitis which really causes these symptoms. A nonpurulent urethritis associated with normal urine is the underlying disease. The trigone is frequently affected also. The onset is generally acute, there may be acute exacerbations, and the condition may progress to a typical pyelitis.

Fifty four per cent of the women in this pyelitis group had a history of preceding urethrotigonitis. In acute urethrotigonitis the onset is sudden, severe urgency and dysuria are present and only a few

drops of urine are passed at a time. Terminal hematuria is common. Occasionally dysuria without frequency is observed. There are marked constitutional effects. Usually the symptoms subside in a week. During the acute stage the urine may contain pus, red cells, and the *Bacillus coli* but the urine quickly clears. Inflammation of the trigone and urethra is present cystoscopically.

A high proportion of cases settle down into a state of chronic urethral irritability punctuated by acute exacerbations for months or years. Morning frequency and dysuria are present, associated with urgency. Incomplete bladder emptying, suprapubic pressure and terminal hematuria. There frequently is referred pain to the loin, groin, thigh, and suprapubic region probably caused by an associated ureteritis. In some cases the histories went back from 8 to 10 years.

Only 3 per cent of the group gave a history of previous abortion. Normal childbirth did not seem to be important etiologically. There was a surprisingly low incidence of accompanying pelvic disease other than cervical erosion. The urine is usually crystal clear. The urethral orifice is frequently edematous and hyperemic. Narrowing of the urethral lumen was one of the commonest findings. Cystoscopy demonstrated a normal pink yellow mucosa, but a localized trigonitis, always accompanied by a similar or worse degree of pathology in the urethra, was present. At the margin of the internal urethral orifice are evident edematous, translucent, pedunculated or sessile polyps and large congested vessels. These are best seen with a foreoblique telescope or a urethroscope. The polyps appear singly or in clusters, usually between 10 and 2 o'clock, and may be

solid, pedunculated, translucent, or in rigid hillocks. These hyperplastic changes are found so often in association with the symptoms of frequency and dysuria that there can be little doubt that they are part of the syndrome.

Because of the argument that these urethral findings are so common as to be of no significance, a control series of 70 women of the same age group who had never at any time complained of abnormalities of micturition was examined. Urethral polyps and hillocks were present in only 5 of the 70 controls, but all of these 5 had had abortions or salpingitis. These figures suggest that urethral polyps are not in a previously uninfected urethra. As to the mode of infection, the first symptoms date from the time of marriage in so many cases that there is no doubt that the sexual organs are closely bound up with the etiology of the condition.

In 80 per cent of the women the first onset of urethral symptoms developed within 3 months of marriage. Not only defecation but coitus after a prolonged interval may precipitate an attack. In the majority of cases the primary acute infection is a direct ascending infection from the vulva.

The author believes that the evidence in favor of a blood-borne infection in pyelitis is not convincing and he considers ascending infection up the periureteral areolar sheath an important consideration. In periureteritis there is dull, almost continuous pain in one or both iliac fossae and groins, mild spasms of colic which are made worse or better by the onset of menstruation. The passage of a ureteral catheter may produce a dramatic cure, and frequently mere urethral dilatation suffices.

DAVID ROBERTSON, M.D.

# SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

## CONDITIONS OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Murray R. C., Kirkpatrick, H. J. R., and Forral, E.: A Case of Albright's Syndrome (Osteitis Fibrosa Disseminata) *Brit. J. Surg.* 1946, 34: 48

Albright's syndrome is characterized by unilateral multiple cystic bone lesions, by brown nonelevated pigmented areas of the skin which tend to be on the same side as the bone lesions by endocrine dysfunction associated with precocious puberty and by the beginning of the disease in the early years of life.

Generalized osteitis fibrosa cystica (von Recklinghausen's disease) is very similar to Albright's disease and is caused by an excessive secretion of parathyroid hormone usually associated with adenoma of the parathyroid glands. In Recklinghausen's disease generalized osteoporosis with foci of osteitis fibrosa is the predominant finding. There is also a high serum calcium and plasma phosphatase a low plasma inorganic phosphorus, and an excessive excretion of calcium by the kidneys.

In Albright's disease generalized osteoporosis is absent. The bone lesions are spotty and there is normal bone between the lesions. The plasma calcium and plasma inorganic phosphorus usually are normal. Blood phosphatase is elevated only in advanced cases. The urinary output of calcium is not increased. In female patients there is precocious puberty and early union of the epiphyses.

Some cases exhibit only one or two of the principal three symptoms of Albright's disease. Very often the disease occurs in a mild form without any extra-skeletal symptoms. The bone lesions are regularly but not exclusively found in Albright's disease.

At the site of the bone lesions the cortex is extremely narrowed and the normal structure of the

bone is replaced by irregular unperfectly calcified osteoid tissue. The outer surface of the cortex is covered by a layer of fibrous tissue. The Haversian canals are widened because of increased osteoblast-osteoclast activity. The deeper portions of the bone are replaced by a matrix consisting of closely packed spindle shaped cells, small foci of osteoid tissue giant cells and irregular trabeculae. In some areas depending on the activity of the process some more mature fibroblasts are seen. There are many thin walled vessels and there is evidence of recent hemorrhages.

A detailed account is given of a patient 25 years old who was afflicted with Albright's disease. The childbirth was uneventful and the child appeared normal except for a large birthmark. The parents' sisters and brothers showed no evidence of any deformity. At the age of 4 the child was noticed to be knock-kneed. At the age of 9 medical aid was sought because of deformity of the lower extremities. The upper ends of the tibiae were enlarged and nodular. A wedge osteotomy of the left tibia and fibula was performed and healed normally. A year later the child sustained a fracture of the femur which healed satisfactorily. This patient was seen again at the age of 22. The deformities of the lower extremities were described as grotesque by the examining physician (Figs. 1 and 2). There was some clubbing of the left ring and middle fingers. A very large area of brown pigmented skin covering the left side of the body was also noticed. The heart was enlarged. The electrocardiogram showed inversion of the P<sub>4</sub> and a slight tendency toward right axis deviation. No abnormality of the reproductive system was noticed. Roentgenograms of the entire skeleton revealed lesions in many areas of the bones of the legs, pelvis, spine, ribs, and upper extremities.



Figs. 1 and 2 (Murray et al) Photographs showing the condition of the lower limbs on admission.

The laboratory findings were normal except that the serum phosphatase showed 80 King Armstrong units and there was a trace of Bence Jones proteose in the urine on 7 occasions.

The patient had four osteotomies on the tibiae and fibulae, and both femora. The object was to bring the legs in general alignment with the hips. Two years after treatment was initiated he was able to walk with seat-bearing corset-topped calipers.

Treatment of the general condition with the object of restoring the bone to normal is usually not successful. X-ray therapy of the bone lesions and the pituitary gland did not prove successful. Helfet reported considerable success in treating generalized fibrocystic disease of bone, unassociated with parathyroid adenoma, with aluminum acetate or gluconate with the object of precipitating part of the phosphate in the bowels to prevent its absorption. Activity of the parathyroid gland is stimulated by the blood phosphates.

Various theories were cited to explain the etiology of Albright's disease. Albright advanced the theory that the symptoms are based on embryological defects. Lichtenstein and Jaffe believe that the disease has its origin in the perverted activity of the bone-forming mesenchyme. Steinberg and Joseph believe that the cause lies in faulty development. Others suggest that the disease is the result of endocrine disturbances. Burrows attributes changes of the blood vessel walls to be responsible for the localization of the foci in the bones, skin and parathyroid glands.

GEORGE I. REES, M.D.

Caffey J: Infantile Cortical Hyperostoses. *J Pediat.*, S. Louis, 1946 29 541

The author reports 10 cases of cortical thickening of the skeletal system in children. His first case was observed in 1938. Three similar cases were encountered in 1939, 1940, 1944 respectively. The present communication pertains to a detailed study of 6 additional cases which the author has studied in collaboration with other clinicians.



Fig. (Caffey) Top, Lamellated thickening of the cortex of the right ulna. Left lower, Symmetrical cortical thickenings in the second, third, fourth, and fifth metatarsals of both feet. The first metatarsals, in contrast, are not involved. The phalanges were normal.

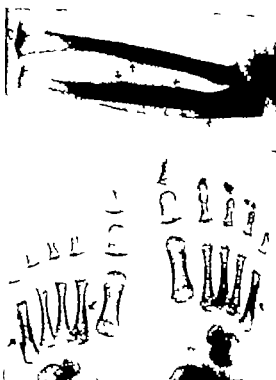


Fig. 2 (Caffey) Top, Long, thick hyperostosis in the right radius. The ulnar side of the radius is also slightly thickened. Bottom, Symmetrical hyperostoses in the fifth metatarsal. There is also some cortical thickening on the medial side of the second left metatarsal.

All of the patients exhibited the following triad: (1) tender swelling deep in the soft tissues, (2) cortical thickenings in the skeleton, and (3) onset during the first 3 months of life. There was a distinct uniformity of cortical hyperplasia under a proliferant ing periosteum. Bony predilection is unpredictable. Infantile cortical hyperostoses were demonstrable roentgenologically in the mandible, clavicles, scapulae, ribs, skull and the tubular bones of the extremities. Soft tissue swellings were deep, firm, non-fluctuant, noninflammatory and not particularly superimposed upon the bony hyperplasia in all instances.

Other less uniform manifestations were fever, pleurisy, anemia, and an increased sedimentation rate. After a variable period of weeks, and in some cases months, all patients recovered without any residual morbidity. Prolonged clinical investigation has not elicited the causative agency of this unusual entity. It is further noted that this disorder is a self-limited disease for which there appears to be no specific treatment. Eight of the 10 patients, whose onset of the disease flourished at or under the age of 6 months, exhibited facial swellings. All except 1 disclosed mandibular hyperostoses. Cortical thickening of the metatarsal bones was noted in the older group of patients. Pain was also felt by this group, particularly at the onset and therefore they refused



Fig. 3 (Caffey) Progressive changes in the left tibia and fibula from the third to the fourteenth week after onset. a, Three weeks after onset the medial side of the tibia is covered with a faint, short, thin strip of water density (arrows) b Five weeks after onset the tibia and fibula are surrounded by long, thick, sclerotic envelopes of calcium density c, Eight weeks after onset the cortical thickenings have increased in depth and density The medial surface of the hyperostosis is now rough. d Fourteen weeks after onset the hyperostoses are shrunken in comparison with earlier findings. The absence of metaphyseal and epiphyseal changes suggestive of scurvy at all stages is noteworthy There is a striking absence of transverse lines in these last films.

to walk. It is Caffey's opinion that walking and weight bearing may yield traumatic possibilities to the pathogenesis of infantile cortical hyperostoses.

Repeated x-ray examination of the susceptible bones may avert confusing the bone thickening with parotitis neoplasm and osteomyelitis of the mandible. The painful pseudoparalysis of the extremities may be confused with scurvy Fever painful extremities, and hyperirritability may be masquerading poliomyelitis. Anemia, fever and bone pain may simulate infantile leucemia, rheumatoid arthritis, and rheumatic fever The components of the syndrome common to all patients are deep swellings of the soft tissues and cortical hyperostoses in the neighboring bones.

SAMUEL L. GOVERNALE, M.D

Stack, J. K. and Hunt, W. S.: Radiohumeral Synovitis. *Q Bull Northwest. Univ. M School* 1946 20 394.

The term 'tennis elbow' as used to diagnose pain and disability in the posterolateral aspect of the elbow is incorrect. It fails to differentiate extra- and intra-articular lesions of the radiohumeral joint. Disorders of the radiohumeral joint usually come under observation in from 1 week to 6 years after the onset they are caused by a trivial injury or by

an unusual exertion The symptoms are tenderness and pain in the posterolateral aspect of the elbow, and often a grinding sensation on pronation and supination of the forearm. Very often there is radiation of pain along the extensor surface of the forearm. There is weakness in the grip to the extent that the patients inadvertently drop objects and many patients are unable to perform the finer movements of the hand i.e. buttoning of the collar but ton, knitting etc.

Examination usually reveals tenderness over the posterolateral aspect of the elbow The patient is able to lift heavy objects when the forearm is kept in supination but is unable to perform the same task if the arm is pronated Often a grating sensation is palpable or even audible in the area of the radiohumeral joint on pronation and supination of the forearm. Rarely a slight fullness is found over the lateral aspect of the radiohumeral joint.

There are several pathological entities which may be responsible for these symptoms. The most common lesion is an incomplete tear of the origin of the common extensor muscles, associated with underlying periostitis. Sometimes the periostitis reaches proportions to be discovered only on x ray examination and it is then diagnosed as epicondylitis ('epicondylalgia' by the older writers)

The existence of a radiohumeral bursa is questioned by many workers. Some authors have found bursitis to be the etiological factor in these conditions (as demonstrated in dissected cadavers). In some cases a pea-sized mass of granular, areolar tissue and fat is found to lie deep in the conjoined tendon and externally but exactly over the capsule of the radiohumeral joint. Curetting away of this so-called bursal mass relieves the symptoms.

The intra-articular lesion might be caused by repeated pinching of the redundant synovial membrane followed by hyperemia and subsequent thickening and villous formation. Another intra-articular lesion may be caused by fraying of the orbicular ligament or the coronary ligament.

Most of the complaints will clear up without treatment of any kind if the particular movement causing the pain is avoided. One author reported that the condition may exist for a period of 30 years.

Conservative treatment consisting of sling immobilization, heat in the form of packs or diathermy or plaster immobilization is recommended. The majority of patients will get well. Patients who do not recover after a reasonable period of time are suspected of having intra-articular lesions, and surgery is recommended. The surgical incision is the same as that used for the approach to the head of the radius. The radiohumeral joint is incised and the offending tissue is removed. Four patients in whom conservative treatment failed were operated on by the author. GEOFFREY I. REINA, M.D.

**Sutro C. J.:** Para Articular Ossification of the Soft Parts of the Ankle; Complication of the Sprain with or without Fracture of the Shaft of the Ipsilateral Fibula. *Arch. Surg.* 1946, 53, 44

A thin plaque of increased density in the region of the inferior transverse or posterior ligaments of the ankle was noted in 3 of 43 sprained ankles reported in this article. The 3 patients had unusually long convalescences, suffering recurrent pain and swelling for the duration of the follow up period (4 to 7 months) while the other 42 patients recovered in from 4 to 6 weeks. In 3 other patients who sought treatment for recurrent pain and swelling of an ankle which had been sprained 2 to 3 years previously similar densities were noted in the roentgenograms. The densities were also noted in 2 patients who had sustained fractures of the shaft of the fibula as well as a sprain of the ankle and in whom the recovery from the sprain was prolonged and more troublesome than the fracture.

The author believes that the density is due to ossification and not calcification of the connective tissue. The bone is not new periosteal bone. The basis for the recurrent swelling of the ankle may be due to inflammation or irritation of the synovial surfaces by the ossification of the para-articular tissues.

The treatment given all the patients with this complication of ankle sprain consisted of assignment to duties not requiring excessive walking, the application of elastic supports to the ankle and repeated

courses of hydrotherapy. This resulted in permanent resolution of the swelling and pain, but did not cause the disappearance of the densities in the soft parts. No surgical correction was attempted.

The author believes that this condition is similar to the ossification of the tibial collateral ligament of the knee. NEWTON C. MANN, M.D.

**Agati, D.:** Circumscribed Osteochondritis of the Astragalus (Osteochondritis circumscripta astragali). *Radiol. med.*, Milano, 1945, 31, 102

The author cites 2 personal cases of osteochondritis dissecans (circumscribed osteochondritis) of the astragalus and 13 other cases found in the literature.

He finds that males and persons in the younger age group from 20 to 30 years, are affected more often than females and those of other ages, and further that in older groups arthritic characteristics may mask the initial osteochondritic focus. He finds that there is also a preferential site for the lesion in the astragalus just as there is in the knee elbow and hip and that this is usually the medial side of the trochlea of the astragalus (11 cases of 13). As in the other locations he feels that the cause is due to predisposing anatomic and functional factors and conditions of trophic unsteadiness from a vascular deficit. In the astragalus the greater weight comes to bear heavily on the trochlea of the talus is an important factor.

Agati found that in the majority of cases the occasional trauma which determined a recrudescence of the syndrome and which consequently brought the patient to roentgenological examination was of minor importance, and that the disturbance even though slight antedated the trauma. The trauma, therefore, more than the direct causal agent of the disease seems to be the aggravating factor and the revealer of a latent pathological state. Therefore, he believes that there can be silent lesions of osteochondritis that are never diagnosed.

From the clinical point of view he notes that this lesion has a variable course—it is possible for it to end in a spontaneous and complete cure or remain itself unmodified for months or years. The subjective symptoms are usually limited to moderate local pain which is often interpreted as dependent on arthritic factors or ascertained roentgenologically in other cases. The swelling is not constant and appears usually after the revealing trauma of the disease—usually in part or all around the ankle so that one suspects a sprain or tries to exclude a fracture.

The x-ray findings are comparable to those observed in other articular sites. The author describes these findings and cites an example in which the osteochondritic mass seemed to be mobilized free in the joint but at operation was found not to be free, therefore he gives a warning regarding operative interference.

Regarding therapy he offers a word of caution—keeping all the evidence in mind. Therapy may be surgical when locking phenomenon or limitation of

joint movement are found—one must be certain of the existence of an endoarterial mobile mass. Therapy may be conservative (rest immobilization physical therapy) when a joint mouse cannot be recognized even after pneumarthrography. Regarding the astragalus there has not been observed a mobilization of the isolated piece therefore the conservative method is the best treatment. The author describes the roentgenological differential diagnosis and concludes by saying that up to now osteochondritic lesions of the astragalus have been found on the trochlea.

G ALBIN LIVA, M D

## SURGERY OF THE BONES, JOINTS MUSCLES, TENDONS, ETC

Morris, H. D.: Tenon and Mortise Grafts for Bridging Metacarpal Defects Due to Gunshot Wounds. *Surgery* 1946 20 364.

A method for bridging defects in the metacarpal bones due to gunshot injuries is presented. The method is applicable when damage to the nerves and tendons is minimal and when loss of substance and continuity of the bone results in deformity and disability.

The procedure is to resect the distal and proximal fragments until a transverse cortical surface can be obtained. The fragments are then reamed out and a cortical tibial bone graft of sufficient length and a tendon 1.5 cm. long on either end is then used to bridge the gap. The graft can be more easily placed if a slot is cut in the distal fragment and the tendon held in place with a wire loop. If necessary the graft may be seated into one of the distal carpal bones. Immobilization is maintained for 8 weeks after which time union will be complete.

VERNON C. TURNER, M D

Tavernier, L.: The Treatment of Chronic Congenital Dislocation of the Hip (Le traitement des luxations congénitales invétérées de la hanche). *Rev orthop* Par., 1946, 32 109.

A considerable number of congenital dislocations of the hip still fail to get orthopedic treatment in infancy. The majority of these patients come to the orthopedic surgeon at a time when arthritis of the hip has made their condition intolerable.

Many surgeons have developed a definite technique in the treatment of these conditions and adhere to it. Most French surgeons are satisfied with palliative surgery i.e. subtrochanteric osteotomy. Other surgeons perform reconstruction operations. The author adapts the procedure to each individual case.

The author has done most of the operations recommended during the last 20 years. In the last few years an "enervation" operation of the hip joint was done associated with other procedures or alone in cases in which pain and not lameness was the outstanding complaint. On consolidation of the experiences thus gained a certain procedure was developed

which proved to be very satisfactory in the treatment of congenital dislocation of the hip and the following operations were completely abandoned: resection of the femoral head, arthrodesis of the hip and the operation of Zahradnick. The following operative procedures: reconstructive arthroplasty, "shelf" operations, subtrochanteric osteotomy and enervation of the hip deserve further discussion. Nové Jossérand has resected the femoral head in old patients who had intolerable pain. The author did this procedure once and found that it relieved the pain a great deal but resulted in a very unstable hip in fact the hip was much worse than prior to the operation. This procedure should be done only in cases in which there is a decalcified head which has resisted all attempts at reduction. A secondary stabilizing operation is necessary i.e. a shelf operation or subtrochanteric osteotomy. In this group only 1 arthrodesis of the hip was done in an old patient who had an old painful unilateral dislocation with good result. There were unusual circumstances in this case because ordinarily one tries to obtain a better result than a fused hip. However this operation should be kept in mind as a reliable procedure which can be used if other procedures fail.

The Zahradnick operation (open reduction, shelf operation and shortening of the femur) was done in a few patients. With the exception of a few good results most of them were unsatisfactory and after a patient died due to shock at operation this procedure was completely abandoned.

Arthroplastic operations of the hip joint are sound but have the disadvantage of being difficult and major operations. The difficulty lies in the reduction of a fixed head due to periparticular adhesions and in the reduction of the femur after the operation. It consists in forceful traction of the leg with the use of the Kirschner wire 2 weeks prior to the operation. The resection of the upper end of the femur at the operation, resection of the capsule, reshaping of the femoral head to fit the new acetabulum above the old one at a level where the head can be reduced and maintained comfortably and interposition of fascia lata. The result was very good in 3 cases. The hip was stable and motion was satisfactory. The shortening was negligible. In 7 cases the result was good. There was a solid hip with diminished motion. One of these cases terminated in an ankylosis with good function. One patient had an excellent joint post-operatively as far as stability and flexibility were concerned but there was considerable pain. A second enervation operation on the hip joint alleviated the pain completely. Two patients had fair results. The hip was solid and not painful but there was a considerable limp. Two patients had poor results. The hips became dislocated as soon as they were taken out of plaster and reoperation was necessary. Subtrochanteric osteotomy was done in both cases. In 1 muscular atrophy remained considerable in spite of a flexible hip joint and the patient's activity was restricted to walking in his home with canes.



Generally these results can be classified as satisfactory as far as reallocation is concerned but they are disappointing as far as muscular atrophy is concerned. Even in the results classified as good weakness of the gluteal muscles persisted which caused the patient to limp and to have a tired feeling after walking. It was interesting to find that patients with an ankylosed hip were more satisfied than the ones who underwent arthroplasty and that they walked and danced without a limp. It is the danger of insufficient muscles which makes it difficult to recommend the arthroplasty more often.

It is much more difficult to draw definite conclusions as to the value of shelf operations. This procedure has been the main operation for old dislocation of the hip for the past 20 years. Although no one else uses shelf operations in high posterior dislocation of the hip the author has used it in cases of this type with good results. The classical indication for the shelf operation is the locked anterior dislocation and subluxations which are very rare. In these cases the operation offers a mechanically sound solution and forms a solid roof over the "locked femoral head." In supra-acetabular dislocation, however satisfactory stability is present as a rule and there is only a negligible amount of lameness. It is pain that sends the patient to the orthopedic surgeon. The pain is similar to pain in deforming arthritis and does not resemble pain due to ligamentous strain observed in young patients.

The supra-acetabular dislocations are well tolerated until puberty at which time pain appears after prolonged walking and disappears after moderate rest. There is no limitation of motion except the limitation caused by pain due to ligamentous strain. In these cases a shelf operation is very successful as the pain and limp disappear. The postoperative course might be complicated by a peculiar arthritis which is transient and does not impair the final good result. It is very unusual for arthritis to occur if the shelf is constructed at a level which does not require the head to be lowered too far. One is justified in assuming that deformity and deforming arthritis will not occur in cases in which the head lies under a shelf under nearly normal mechanical conditions but would occur if not treated. On the other hand, if a patient with a supra-acetabular dislocation has reached the age of 35 or more without any serious complaints and then develops pain while at rest, limitation of movement and abnormal posture shelf operation is not the rational procedure. In this series shelf operations were done in these cases. Some have helped the patient but only for 1 or 2 years. This is not surprising if one realizes that this operation does not change anything but the mechanical action of the hip. Many patients did not get any benefit at all from the operation and in many the condition was actually worse after the operation. The newly constructed shelf blocked the deformed head limiting its movement even more and thus limiting movement in the hip joint without relieving the pain. One can readily see why the shelf operation is con-

traindicated in these cases and why arthroplasty or "enervation" would be the better operation.

The shelf operation was performed on female patients between 20 and 30 years old with much success. The best results were observed in some patients only after the lapse of 1 or 2 years of persistent pain. This time was necessary to permit the head to adjust itself to the shelf. Before it can be judged that the operative procedure will eventually be successful it is important to study the shape of the head very carefully. In 2 cases there was a sharp angle at the top of the head where it rested against the ilium. This deformity was responsible for a poor result and always is a contraindication to the shelf operation. One readily sees that the shelf operation is limited to old dislocations of the anterior type in patients not older than 30 years.

Subtrochanteric osteotomy is the treatment most frequently used for old dislocation of the hip in France. It is a simple operation. It is done with a double angulation: one in the frontal plane to correct the adduction deformity—by stretching the muscles extending from the pelvis to the trochanter and putting pelvic support—and one in the anteroposterior plane to correct the pelvic tilt and to compensate in advance for the balance of the pelvis and the head. It is a very good palliative operation which improves stability and abolishes pain in the hip. It is frequently the only operation that can be employed in severe deformities due to high posterior dislocation of the hip. The results, although satisfactory are inconsistent. Sometimes there is considerable increase of movement, sometimes not sufficient relief of the pain in the hip joint.

The results are much more favorable in unilateral dislocations in which a better balance of the pelvis can be achieved by forceful abduction of the femoral fragment which also will minimize the shortening of the leg and in which limitation of motion is not too disabling. Ten operations were done in this series; the results were very good in 8 cases, and fair in 2. In bilateral dislocations the results are less favorable. Better results were obtained in cases in which osteotomy was done on one side and a shelf operation or arthroplasty on the other (15 good results and 3 fair). The results in only 3 cases of bilateral dislocation were classified as good postoperatively. 14 they were classified as poor because of persistent limp, stiffness of the hip, faulty gait, and persistent pain. The results on more recently operated patients confirmed these findings. Pain persisted in 4 of 9 operative patients.

Röntgenograms showing the anatomical results do not explain the persistence of pain. Osteotomies which appear roentgenographically correct often are associated with persistent pain while other osteotomies anatomically less satisfactory, are clinically very satisfactory. In spite of this rather paradoxical fact, which is true for pain only and definitely does not apply to movement technique of the procedure is very important. It is important in every case to determine accurately the location of the osteotomy

and the angle in the frontal and anteroposterior planes. The Mommson technique is the best from this point of view. The projecting portion of the upper fragment maintains the position securely at a chosen degree of angulation until the wound is closed and the plaster is applied. In the determination of the angle of abduction in the frontal plane one should consider that a wider angle gives a better result since it helps to maintain the balance of the pelvis. This, of course is possible only in unilateral dislocation of the hip. In bilateral dislocation two operations are performed, the second after a sufficiently spaced interval following the first operation. It is surprising to notice how satisfactory the result is following the first procedure and how little benefit is derived from the second operation.

From the orthopedic point of view enervation is entirely inadequate. The fact however, that patients consult the surgeon late because of pain and only secondarily because of lameness made the author treat these patients by enervation. This operation was done on 19 patients. At the same time 15 patients who had bony operations were observed for the same period of time as control cases.

The history of these 19 patients was surprisingly similar. They were able to get along fairly well for a number of years the lameness not being extensive in fact, they were able to walk more than 10 kilometers daily. One day pain occurred first after long walks then after shorter ones, and finally there was pain even at rest and especially at night. At the same time limitation of motion in the hip made itself noticeable there was abnormal posture and at the end of 2 or 3 years the patient became disabled. These complications usually appeared between the ages of 30 and 35. In a small group of individuals, deforming arthritis appeared sooner at the age of 25 or later at the age of 45. In most of them the enervation operation was followed by absence of pain. Faulty posture due to contractures or spasm of the muscles disappeared motion was improved and the patients were again able to walk as far as they could prior to the occurrence of pain. In 9 cases very good results were obtained in 8 the results were fair and in 2 there was no improvement. The 9 results were classified as very good because the pain and lameness had completely disappeared and the ability to walk had greatly improved. The patients with fair results had less pain, the pain occurred after long walks, or the pain had stopped in certain regions and occurred in others. The last case in this group was one of the first operated on and only the branches of the obturator nerve were cut. Some pain persisted but finally stopped after section of the posterior branches of the sciatic nerve.

Section of the obturator branches alone was done in the first 7 patients operated upon with good results in 1 case fair results in 6 cases and pain persisted in the posterior regions in 3 cases. These patients were advised to have the operation completed by having the nerve to the quadratus femoris muscle sectioned. The last 12 patients were subjected to

total enervation. Eight patients had a very good result, 2 a fair result, and 2 had poor results. In comparing the older with the more recent cases one readily sees the advantage of total enervation over simple obturator enervation.

The 2 failures following the enervation operation in chronic congenital dislocation were just as puzzling as the failures of the enervation operation in deforming arthritis which occur much more frequently. Five patients in the series had bilateral dislocations and were subjected to bilateral enervation operations. There was a total of 24 operations with 2 failures, or 8 per cent. In these 2 failures the pain seemed at first to have stopped only to recur in one case after a few weeks and in the other after 7 months. Since total enervation was done the once suggested theory of an abnormal articular branch is eliminated but the reason why this operation failed in 2 cases is not explained.

The control group of 15 patients observed during the same period of time had osseous and articular operations only. Three patients in this group underwent an enervation operation with good results in 2 and improvement in the condition in 1 patient.

The favorable results indicate how valuable the enervation operation is in the treatment of chronic congenital dislocation of the hip either alone or in association with any other basic operation on the hip.

There are 3 main considerations in determining the indication for one of the many types of operations in congenital dislocation of the hip: the type of the dislocation whether there is unilateral or bilateral dislocation and the age of the patient. In young patients after puberty and until from 25 to 30 years of age the following reconstructive operations are indicated—the shelf operation for anterior dislocation and arthroplasty for the posterior form. In these cases the indication is precise since function is the most important factor. Sometimes these young patients tolerate the dislocation well and are without appreciable lameness yet they desire to know what can be done for them. The answer is that operation at this time might prevent complications at a later time or the operation might not be of any benefit at all. If there is a supra-acetabular dislocation it is always better to do a shelf operation because it is less unlikely to fail than an arthroplasty. In case of unilateral dislocation an arthroplasty should be tried if the patient desires it, because if stiffness occurs, an arthrodesis can be done secondarily without handicapping the patient too much. In bilateral dislocation a shelf operation is done on the lower hip and if the operation is successful an arthroplasty is attempted on the other side. The decision is much more difficult in cases of posterior dislocation of the hip.

In cases of high posterior dislocation which cannot be lowered by heavy skeletal traction sufficiently to allow arthroplasty, the subtrochanteric osteotomy will give good results in unilateral cases. The bilateral dislocations require further considerations if one side responds to traction better than the other an arthroplasty can be done if an osteotomy is done on

the other side. If both sides are high the lordosis is severe and adduction deformity is considerable, a bilateral osteotomy should be done. If pain is the main complaint and the patient is prepared to accept the lameness, the enervation operation is indicated even in the young patient.

In the older patient these conditions present themselves in an entirely different light. If he seeks advice in a late stage he usually has no severe lameness but the pain in the hip has become intolerable. The enervation operation has all the advantages of a simple operation with the possibility of abolishing pain and putting the patient back to a stage before the pain had limited his gait and posture and before the appearance of the deforming arthritis.

The enervation operation is for the time being a valuable, palliative efficacious, and minor procedure in the treatment of chronic congenital dislocation of the hip either alone or in combination with other osseous procedures. GROWER I. RITTS, M.D.

### FRACTURES AND DISLOCATIONS

Speed, K.: Subtrochanteric Osteotomy for Ununited Fracture of the Neck of the Femur. *Ann Surg* 1946, 24 576.

The author reviews briefly the mechanics the pathologic changes, the technique after treatment and results of subtrochanteric osteotomy. Before determining the advisability of subtrochanteric osteotomy the following requirements must be met:

1. All tractions or splints and fixations (including internal fixation) must be removed.

2. Open ulcers, or decubitus ulcers near the fracture area must be healed.

3. Roentgenological examination of both hips in a posteroanterior plane and a lateral view of the fractured hip must be obtained to determine (a) the amount of absorption of the neck, (b) the presence or absence of infection or sequestra or ankylosed joint (c) the rotation of the head fragment, and (d) the viability of the head as determined by its relative density.

If these factors are unfavorable, and if the head of the femur is completely necrotic, one of several reconstruction operations on the hip may be the best procedure especially in patients under 60 years of age. If these conditions are found to be favorable the patient's general condition (unless obviously moribund) his fear of follow-up care his age and even his weight may be discounted.

Preliminary traction on the leg by means of a sturdy steel pin inserted through the calcaneus may be helpful in marked overriding of the fractured neck. At operation manipulation on a fracture table is performed to put the fragments of the ununited neck in apposition and to hold them thus with slight abduction of the legs. The reduction at the neck of the femur is checked by roentgenograms in two axes.

Following operation a plaster-of-Paris cast is applied. Eight weeks of immobilization suffices for union.

Of 10 patients operated upon, whose ages ranged from 63 to 72 years, 1 fatality is reported.

EMIL C. ROBERTS, M.D.

### ORTHOPEDECS IN GENERAL

Coppo, M., and Calamario, S.: The Effect of Innervation on the Mineral Composition of Bone. New Experimental Research (*Sull'Influenza dell'innervazione sulla composizione minerale delle ossa. Nuove ricerche sperimentali*). *Sperimentale*, 1942 96 503.

Coppo has for some time been studying the factors that bring about mobilization of the minerals in the bones so that they are available for use elsewhere in the body. Leriche and Polizard asserted that decalcification of bone is dependent on a disturbance of the normal relationship between the composition of the blood, the activity of the circulation, the condition of the connective tissues determined by the internal secretion, and the mechanical effects of pressure. They leave entirely out of account any effect of innervation on the composition of bone, although a considerable amount of research has been done pertaining to such an effect. The question is not entirely settled however and there are still authorities who deny it. The various conclusions of a number of authorities are given.

For the purpose of further study of this factor the authors operated on 20 rabbits, removing a section of the sciatic nerve near its origin, and in some cases also a section of the crural nerve. The animals were divided into two groups of 10 each, those of one group being killed from 11 to 21 days after the operation and the others from 24 to 75 days after it. The normal composition of the mineral ash of the bones was determined and compared with that of the animals in the two groups. Tables are given showing the details of the results and the comparative content of ash, calcium, and phosphorus in the groups. The determinations were made on the tibia of the denervated side. It was found that in the group killed after from 11 to 21 days there was a marked decrease in ash, calcium, and phosphorus, but this decrease had been compensated for in the animals killed after from 24 to 75 days.

These experiments show conclusively that innervation has an effect on the mineral composition of bone, but there are some points still unexplained, such as the great variation in the amount of decrease of the minerals in the animals of the first group and the reasons for the compensation in the second group. AUBREY G. MORRIS, M.D.

Sorrel, E., and Longuet, Y. J.: The Anterior Transbrachial Route in Surgical Repair of Supracondylar Fractures of the Humerus in Children (La voie transbrachiale antérieure dans le traitement des fractures supra-condyliennes de l'humerus chez l'enfant). *Rev orthop* Par 1945, 31 7.

By the term anterior transbrachial route is meant a surgical approach to the inferior extremity

of the humerus which extends across the brachialis muscle, this muscle having usually been cut transversally at the time of a supracondylar fracture of the humerus.

It seems paradoxical to repair a fracture of the elbow by the anterior transbrachial approach. The elbow is covered anteriorly by the thickest portion of the brachialis and biceps muscles and the radial and median nerves as well as the humeral artery and veins pass in the same area from the upper arm into the forearm.

The posterior approach with sectioning of the olecranon is excellent in adults. In children, however it is of questionable value. A number of workers state that usually severe stiffness and, in some cases ankylosis of the elbow joint follow. The soft tissues anterior to the elbow joint are frequently lacerated by the anteriorly projecting fragment of the diaphysis. If the posterior soft tissues are cut a considerable amount of trauma is added. Furthermore the posterior portion of the periosteum is cut which eliminates an important barrier protecting the soft tissues from the formation of osteitis ossificans. There is also the danger of injury to the epiphysis. When the posterior approach is used the small periarticular vessels are cut. This loss of collateral circulation is liable to have serious sequelae if because of pressure of the diaphyseal fragment the humeral artery becomes thrombosed.

The posterolateral approach is to be preferred and is superior to the posterior route. The object is not to go through the supinator muscle which gives little exposure and is liable to cause partial paralysis of the radial nerve. The incision is carried posteriorly to the supinator which is detached from its insertion along the lateral aspect of the humerus. Leveuf and Godard state that this approach is the best for open reduction of supracondylar fractures in children. There are two reasons why the authors discarded this approach: (a) the muscular dissection is considerable, which leads to the formation of osteitis ossificans, and (b) it does not expose sufficiently the injured structures which lie anteriorly to the elbow joint which makes repair of these structures nearly impossible.

Most supracondylar fractures can be reduced by the closed method. There are three principal reasons which make open reduction a necessity in these cases: (1) failure of the closed method of reduction (2) in injuries to the artery, veins, and nerves and (3) compound supracondylar fractures.

The usual position of the diaphyseal fragment is familiar to most orthopedic surgeons. The fragment is displaced anteriorly, has a sharp irregular fork-shaped edge, and usually has two sharp projections on its lateral and medial borders. The fragment usually lacerates the muscles and extends to, and sometimes pierces the skin.

In a small number of cases the skin is perforated by the diaphyseal fragment. The site of the perforation is nearly always the same: the anterior aspect of the elbow just superior to the crease. Compound

fracture in itself constitutes an indication for surgical treatment. Muscular interposition nearly always explains the failure of closed reduction. The anterior muscle group in most cases is pierced by the distal end of the diaphyseal fragment. The lateral and medial edges have diverging edges which causes them to pierce the muscular tissue. In these cases manual reduction even with the help of Kirschner wire traction is futile. The upper fragment impinges also on the vessels and the nerves which pass in front of the elbow joint. These structures are compressed between the end of the upper fragment and the coronoid process. The compression usually causes paralysis of the nerves and obstruction of the humeral vessels with subsequent Volkmann's contracture. The first signs of impending danger are diminished radial pulse, swelling, cyanosis or discoloration of the hand and diminished function of the fingers.

If reduction is accomplished within the first hours after the accident most of the complications due to the compression of the nerves and vessels can be averted. A general anesthetic, traction by Kirschner wire and x ray control are necessary for closed reduction of a severe supracondylar fracture of the humerus. If 24 to 48 hours have passed before reduction can be accomplished the changes caused by the damaged nerves and vessels usually are permanent. There is no agreement as to whether or not open reduction always is necessary in these cases. Boehler states that closed reduction is the treatment of choice and open reduction is not indicated at the beginning of the treatment. Others think that immediate open reduction is absolutely necessary. It is the authors' policy to do an open reduction if there are vascular injuries. In case of nerve injury no immediate operative intervention is necessary because neurolysis or delayed nerve suture gives satisfactory results. If the postreduction roentgenograms are unsatisfactory, open reduction is indicated in every case. In case of injury to both nerves and vessels immediate surgical intervention is necessary.

Since 1936 the authors have been trying to find a way to reduce the fracture and to repair the injured vessels and nerves through one and the same incision. The anterior transbrachial approach was worked out and used since that time in about 10 cases. The study of these cases has enabled the authors to form an opinion as to the proper indications, contraindications and technique of this approach.

There are four indications for the anterior transbrachial approach: (1) supracondylar fractures of the humerus (articular fractures i.e., intercondylar and transcondylar fractures are excluded because this particular approach does not furnish adequate exposure) (2) supracondylar fractures of the "extension" type only in which the upper fragment lies in front of the elbow joint (3) cases in which the anterior displacement of the diaphyseal fragment is considerable and (4) recent fractures only. In old cases one could use this approach to do an arteriectomy, sympathectomy, neurolysis or nerve suture. One must not use this approach however to excise

usually with a rapid onset of paralysis, any form of therapy is useless.

Included in the present article is a discussion on the neurological complications of spinal tuberculo. The surgical management of spinal tuberculo at different levels is discussed.

Spontaneous atlantoaxial subluxation is illustrated by the report of a case history. The treatment consisted of Blackburn skull traction with a pull of 9 to 13 pounds while the patient lay in a posterior plaster shell. Within a period of 10 days, reduction was complete and an occipitatlantoaxial fusion was accomplished with a split rib graft.

Two 4½ year old girls with cervicothoracic Pott's disease came under observation. Both patients were treated with skull traction and a posterior and anterior shell. A special device to prevent drop foot is described in detail.

Conservative treatment is recommended routinely for thoracic Pott's disease. In cases in which neurological deterioration continues in spite of adequate immobilization the anterior decompression procedure, as described by Mr. Dott, is employed. This procedure was used in a group of 13 patients between the ages of 6 and 65 years. Through a curved skin incision from midline to midline of the back the trapezius and latissimus dorsi muscles are reflected laterally and the longitudinal posterior muscles medially. Three or more ribs are then resected. The intercostal nerves are followed to locate pedicles and the dura. The pedicles are then removed to expose the anteriorly located abscesses. The diseased vertebrae are excavated to eliminate any pressure on the thecal layers. The abscess is evacuated and sequestra and displaced intervertebral discs when found are removed. At the termination of the operation normal pulsation of the dural sac and relaxation of the intercostal nerves are noticed. A gibbus usually facilitates exposure of the diseased area considerably. Skull traction is applied as a preliminary step and the operation is done in an anterior plaster shell.

In every one of the 13 patients operated on, a mechanical factor was responsible for compression of the spinal cord.

It is important to realize that normal spinal fluid manometer readings and a low protein content do not necessarily rule out compression of the cord.

Three of the 13 patients died—2 of uremia in 4 to 5 days after the operation and 1 patient from an unrelieved compression of the cord. There was no evidence of dissemination of infection following operation.

In the closing remarks of the authors, 3 cases are briefly cited. In one case stereoscopic views of an apparently quiescent juvenile kyphosis revealed calcification of a paravertebral abscess. In the other case that of a 9 year old patient a secondary focus (tuberculoma) was discovered in the cerebellum. Finally it is pointed out that symptoms simulating ruptured intervertebral disc may very well be due to a tuberculous process in the same area.

GEORGE L. REIN, M.D.

Cleveland, M: Orthopedic Surgery in the European Theater of Operations. *Ann. Surg.* 1946, 124: 188.

The writer assumed the duties of Senior Consultant in Orthopedic Surgery in the European Theater about 3 weeks before D Day (following a year's duty at the Station Hospital at Fort Jackson and 9 months duty as Orthopedic Consultant for the Fourth Service Command).

The earlier battle casualties with compound fractures and amputations were observed and it was apparent to all the surgeons that there was room for improvement in the care of battle casualties with wounds involving the bones and joints.

Prior to D Day the increasing personnel of the Army in the United Kingdom and the Air Force sustained many injuries of varying severity. During the period of Army training the Medical Corps had its training program. The Chief Surgeon and his staff issued a Manual of Therapy for the ETO in May of 1944. This was supplemented from time to time by circular letters as experience was gained.

The earliest hospitals to arrive in the Theater were well staffed, each one of them having from 5 to 50 officers trained in bone and joint surgery. There were eventually 160 hospitals with the trained personnel spread thinly among them. The amazing fact remains that so much creditable surgery was done with so little relatively well trained personnel.

An interesting and significant study was made among Air Force casualties. Three parallel groups of wounds were treated as follows: (1) by adequate débridement and immediate primary closure; (2) by adequate débridement, immediate primary closure and the use of sulfonamides; and (3) by adequate débridement, immediate primary closure, and the use of penicillin. There was no essential difference in the healing in these three groups, which indicated that surgical treatment was of paramount importance. However the immediate primary closure of wounds in Air Force personnel would have been jolly if attempted on infantrymen wounded under different conditions.

The fixed hospitals, from the standpoint of the orthopedic surgeon, offered greater opportunity for long time contact with bone and joint casualties than did service in the continental hospitals which evacuated compound fractures and amputees at the earliest possible moment. Air evacuation was started within the first week of the invasion and finally the great bulk of the patients were transported by the means.

The first aid care of the wounded with bone and joint casualties rested with the medical enlisted men. Compound fractures of the femur, tibia, and fibula were immediately placed in a half-ring Thomas splint. For compound fractures of the foot and ankle the well padded wire ladder splint was used. Upper extremity compound fractures were placed in slings or swaths.

At the battalion level, plasma was available and whole blood was administered at the clearing station.

The bone and joint casualties for the most part were considered transportable and were sent to evacuation hospitals where adequate and thorough débridement of damaged and necrotic muscle, fascia, and skin was carried out. All possible skin and all bone fragments were preserved. These compound fractures were dressed with fine-mesh plain gauze laid over or into the wound. "Packing" with vaselined gauze prevents drainage of blood and exudate, and invites infection. Penicillin was administered and circular plaster of Paris splints of varying types for each of the long bones involved were applied. All of these circular splints must be split to the skin and slightly spread to allow for swelling in transit.

Definitive surgical treatment began at the fixed hospitals in the Zone of Communications. Delayed primary closure of these wounds was the outstanding improvement in the care of these casualties. Delayed primary closure was attempted in 2,393 patients by suture in 2,087 by skin graft in 236 and by combination of suture and skin graft in 70. Skin grafting was done by means of split-thickness free grafts and by pedicled grafts when loss of bone and soft tissue was considerable. Ninety three per cent of the patients upon whom closures were attempted left the hospitals with their wounds healed. Delayed primary closure of these compound fractures can be successfully accomplished in almost 3 of 4 cases. Long bone fractures were treated with skeletal traction usually with Kirschner wire. Of 3,190 compound fractures, 68.6 per cent were satisfactorily united, 13.3 per cent were united in malposition and 18 per cent were ununited.

The only amputation allowed in the Theater was of the circular type which is considered an emergency measure only and received later revision at the Amputation Center.

The wounded hand was considered chiefly from the standpoint of its soft parts. A pressure dressing with the hand and fingers in functional position was recommended with elevation of the part and early closure of the wound by suture or skin graft.

The proper treatment of wounds involving joints was based on sound surgical principles and a high percentage of joint wounds were salvaged with useful motion.

The divided or potentially divided major peripheral nerve should be given precedence over the compound fracture. Patients with this condition were transferred immediately to a neurosurgical center where the wound was closed by delayed primary suture or skin graft. The fracture being placed in balanced suspension. Three weeks after wound healing the nerve was explored and sutured if found divided. If it was necessary in order to get the nerve ends together the bone was shortened up to 2.5 cm.

The writer concludes his report with a comparison of the medical care of the wounded in World War I with that in World War II. The general level of care of bone and joint casualties was vastly improved there was a more complete and general understanding of resuscitation, evacuation was more rapidly accomplished, overseas hospitals were better equipped and the incidence of infection was lower because of better surgery in the forward areas or the use of sulfonamides and penicillin.

RUDOLPH S. REICH, M.D.

# SURGERY OF THE BLOOD AND LYMPH SYSTEMS

## BLOOD VESSELS

Magendie, J. and Tingaud, R.: Pseudembolic Phlebitis—Grégoire's Blue Phlebitis (Phlébite à forme pseudembolique—phlébite bleue de Grégoire) *Bordeaux chl* 1915 3 and 4

Following a brief review of the literature on the interrelations between arterial and venous inflammations, the authors present in detail a case of the peculiar condition known as blue phlebitis, or pseudembolic phlebitis, first described by Grégoire in 1918. The patient was a woman of 36 years with hepatic disease and a complicating pyosalpinx on the left side. The pus contained numerous aerobic and anaerobic organisms and had extended from the pelvis into the iliac fossa and left lumbosacral region passing through the iliac veins. The patient was suddenly seized with a violent pain in the calf of her left leg with marked changes in her general condition. Simultaneously she developed edema, cyanosis, chilling and complete disappearance of the femoral pulsations on the same side with slight diminution of the oscillations on the opposite side. Following infiltration of the sympathetic nerve the pulsations reappeared for a few minutes but then disappeared again. The patient collapsed and died.

Autopsy revealed a flat empty artery, with slight periarteritis but no endarteritis. The phlebotic veins were distended by a jellylike friable blood clot.

Seventeen similar cases from the literature are tabulated with data concerning the functional signs at the onset of the condition, physical signs, arterial signs, condition of the opposite side, the end result and verification of the vein and artery.

Grégoire's blue phlebitis or pseudembolic phlebitis is characterized by a violent sudden onset including severe pain and circulatory collapse. The chief symptoms are cyanosis, edema, chilling and hypæsthesia, and abolition of the arterial pulsations. The two functional signs at the onset are common arterial and venous manifestations. The severe pain and collapse may be caused by sudden arterial obliteration, or massive and rapid venous thrombosis. Attention has been drawn repeatedly to the possibility of error in diagnosis between blue phlebitis and arterial embolism of the extremities.

Among the physical signs, only one is of venous origin, namely the edema. Two are of manifest arterial origin, namely the chilling with hypæsthesia and the abolition of the pulsations. The fourth symptom, cyanosis or acrocyanosis, was considered up to the time of Grégoire to be of venous origin, but he attributed it to arterial causes, and later findings have confirmed his theory.

The initial pain is usually violent and sudden. It is generally located in the calf of the leg, sometimes involving the whole limb to the root of the thigh in the groin.

In rare cases there is no pain as, for instance, in Bergeret's case, in which the syndrome appeared progressively in a greatly debilitated patient. In Grégoire's case there was a simple swelling and a sensation of heaviness. These exceptions only help to prove the rule of sudden extremely painful onset.

A change in the general condition with circulatory collapse is mentioned in the majority of reports. Some patients have pale faces with anxiety, a sensation of impending death and a small rapid pulse. This picture may be related to the extent of the thrombosis. The phenomenon of intravenous coagulation probably occurs suddenly with the brutality of a physicochemical reaction. The sudden obstruction leads to coagulation of the blood with resulting cardiac collapse, as brutal as in massive pulmonary embolism. In the present case the veins at the root of the lower extremity were distended with blood of the consistency of currant jelly and homogeneous throughout the entire region of the leg and pelvis. These cases of massive coagulation evidently carry a desperate prognosis, for although certain drugs may prevent coagulation once it has begun no means of checking it is known.

The dramatic onset may be due to generalized spasm, having its point of departure in a relatively minimal thrombosis, the resolution of which may result in instant relief. It is unwise, therefore, to base the prognosis on the intensity and apparent severity of the initial violent circulatory collapse. In many cases the absence of pulsation is due to spasm without thrombosis as evidenced by recovery even though temporary following intervention on the sympathetic system. The cause of the spasm may persist in spite of the treatment. The maximum reflex action probably springs from the perivascular sympathetic nerve irritated by the sudden distention and inflammation of the venous walls in cases of massive thrombosis. One may thus, have to deal with a functional reflex, a sort of autodefense. Sudden distention of the venous system diminishes the supply of blood to the arteries. The enormous, fusiform, moniliform dilatation of the vein, and marked perivascular inflammation encountered at operation, and seen at autopsy indicate the intensity of this spasmodic reflex. In cases involving a whole limb it would be most difficult to cut the path of the vasomotor reflex. Here an operation as high as possible on the sympathetic nerve would be indicated, but it seems problematic whether the state of collapse in such patients would permit resection of the lumbar sympathetic. The authors were greatly deceived by the transitory effect of infiltration of the lumbar sympathetic in the present case.

The prognosis in blue phlebitis is poor even though the spasmodic element is indicated by intermittent arterial obliteration. Some cases go on to complete recovery while others go on to an ordinary

phlebitis with final cure. However the outcome is unfavorable in the majority of cases. Many cases will require amputation for gangrene and numerous fatal cases have been reported.

Besides this blue phlebitis due to arterial spasm complicating a phlebitis, of which the present case is an example there is phlebitis of similar aspect due to the more common association of arteritis and chronic phlebitis. In this case the symptoms are progressive and the striking initial functional or general symptoms are lacking. Although this type of phlebitis is a blue phlebitis it cannot be classified as a pseudembolic phlebitis and its diagnosis is of much less significance. Between these two types, the pure spasmodic and chronic organic arteritis, all transitions are possible with the association of a spasmodic element and a more or less marked endarteritic lesion. Nevertheless the pseudembolic type due to spasm remains the most curious and interesting of these arteriovenous inter reactions.

EDITH SCHAMCHER MOORE.

Shumacker H B., Jr. Incisions in Surgery of Aneurysms. *Ann. Surg.* 1946 124 586

In the surgical treatment of aneurysms it is important to use an incision which permits of easy and complete access to the vessels involved. The incision should be so placed that, by lengthening it the vessels distal and proximal to the site of suspected pathology are accessible without difficulty.

The author describes this general problem and particularly that of exploration in the popliteal fossa and in the antecubital space. In his experience it is rarely if ever necessary to use incisions other than those which are sound from a plastic standpoint. A number of specific problems are discussed and methods which have proved satisfactory are described.

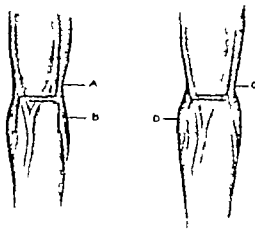


Fig. 3. Incisions used in exposure of brachial vessels in antecubital fossa. a, Usual incision for exposure of brachial vessels in antecubital space. b, Incision used when lesion is suspected in proximal portion of ulnar vessels. c, Incision used when brachial vessels are involved just proximal to antecubital crease. d, Incision used for exploration of distal end of brachial or proximal end of radial vessels. (Courtesy of J. B. Lippincott Co.)

If the circulation is adequate for surgery of the aneurysm, the distal flap will have an adequate blood supply. EMIL C. ROBINOWITZ, M.D.

Potts, W. J., Smith S., and Gibson S.: Anastomosis of the Aorta to the Pulmonary Artery. *J. Am. M. Ass.*, 1946 132 627

Following the lead of Blalock and Taussig who in 1945 introduced arterial anastomosis of the subclavian or unominate artery to either the right or left pulmonary artery for the relief of anoxemia due to pulmonary stenosis or pulmonary atresia the

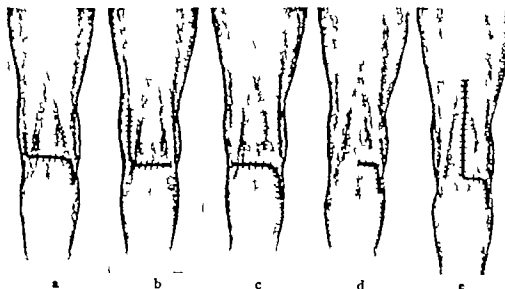


Fig. 1 (Schumacker). Skin incisions used in exploring popliteal vessels. a, Incision used when the lesion exists in the popliteal vessels in the midpopliteal space. b, Incision used when lesion is higher in the popliteal fossa. c and d, Incisions used for exploring distal popliteal vessels. e, Modified incision useful when associated nerve lesion requires exploration.





terized by a tendency to bleed in the presence of normal platelets a normal coagulation time and an increased bleeding time. The recognition of a typical case of pseudohemophilia is not difficult. Either sex affected. The patient complains of excessive bleeding over a long period of years often since childhood. Positive family history is frequently obtained. Physical examination is usually negative. Ecchymoses are common but petechiae are rare. The tendency to bleed is accompanied by an increased bleeding time an essentially normal coagulation time a normal number of platelets and a normal clot retraction.

The etiology and pathogenesis of pseudohemophilia are not known. Three groups of factors are known to be concerned in the hemorrhagic disorders plasma factors platelet factors, and vascular factors. Each of these has been studied in cases of pseudohemophilia. Most data tend to classify pseudohemophilia as a disorder of the vascular apparatus.

The conclusions are as follows:

Eleven cases of a hemorrhagic diathesis are presented characterized by increased bleeding time in the presence of a normal coagulation time normal blood platelet count, and normal clot retraction. An analysis of 63 similar cases in the literature is presented. These cases which have been designated as pseudohemophilia probably represent a particular disorder of the capillaries, in which capillary retractility following trauma may be inherently defective. The differential diagnosis of these cases from other types of hemorrhagic disease and the necessity for their recognition particularly from the prophylactic standpoint, are stressed. Except for easily accessible local bleeding therapy is at present ineffectual.

HERBERT F. THURSTON, M.D.

Perkins, W. Pseudohemophilia; Case Study  
*Blood J. Hemat.*, 1946 1: 497

The author presents a case of a hereditary hemorrhagic disease primarily because the family history offers an unusually good opportunity to trace the genealogical background in this particular instance. The only persistent abnormality found has been prolongation of the bleeding time. Such a condition which is often hereditary and is characterized by a prolonged bleeding time in the presence of normal platelets has been previously described and referred to as pseudohemophilia, or hereditary hemorrhagic thrombasthenia.

The present case of hereditary pseudohemophilia in a 20 year old white American born male was transmitted by and occurred only in the male line. The occurrence of the condition in the male offspring of the patient's father and of the latter's second wife irrefutably proves this point.

In addition to the case history the blood findings also are presented in detail. The degree of prolongation of the bleeding time varied from day to day and was occasionally normal. Except for transient hypocalcemia with tetany no defect in the blood elements nor in clot formation was noted. There

appears to be a failure of normal capillary constriction following trauma. The author notes that this conclusion confirms the original observations of Macfarlane. Whether or not this physiological defect is entirely responsible for the prolonged bleeding time is not proved but is under further investigation.

HERBERT F. THURSTON, M.D.

Hill, J. M., and Haberman, S. Demonstration of Rh Antibodies in the Newborn and Further Evidence of the Pathogenesis of Erythroblastosis. *J. Lab. Clin. M.*, 1946 31: 1053

It is generally accepted that hemolytic disease of the newborn or erythroblastosis with a few possible exceptions, is caused by the production of Rh antibodies in Rh-negative mothers bearing Rh positive children. Although the evidence for each step in the pathogenesis of the disease is not complete the sequence of events may be outlined as follows: (1) the Rh antigen in the fetal erythrocytes is inherited from the father; (2) it gains access to the mother's circulation; (3) it evokes a maternal response of Rh antibodies; (4) these antibodies, in turn, pass across the placenta into the fetal circulation or, after birth, are absorbed from the mother's milk; (5) they are adsorbed upon the infant's red cells and (6) this results in their destruction which produces anemia and jaundice. Further reactions on the part of the tissues of the newborn such as myeloid hyperplasia, ectopic hematopoiesis, and edema, then follow according to the severity of the disease.

The authors are concerned principally with the demonstration of evidence for events 4, 5, and 6 in the pathogenesis as outlined. This consists of the identification of Rh antibodies in the fetal serum, their specific adsorption on the cells of the newborn and the hemolytic destruction of Rh positive human erythrocytes in vitro. The demonstration of Rh antibodies in the infant has been difficult and uncertain. The elution technique has demonstrated the presence of adsorbed anti-Rh agglutinins. This is done by removing the agglutinins from the red cells into saline solution by brief subjection to a temperature of 56° C. The authors have employed this method routinely in all cases of hemolytic disease of the newborn since their first report. Positive tests have been found in only 3 of 10 cases of erythroblastosis. The presence of antibodies adsorbed on the Rh-positive erythrocytes of the infant has never been demonstrated except when they were also present freely in the infant's serum and in the serum of the mother. The use of the blocking test slightly increases the number of positive demonstrations of fetal antibodies.

A new approach to this problem of detecting fetal antibodies is the use of antihuman globulin serum. The action is to develop an observable agglutination in which the specifically adsorbed antibodies are not able to agglutinate by themselves (blocking or incomplete antibodies). The authors have called this the developing test. They have employed this developing serum both in a test for weak antibodies in



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A new approach to this problem of detecting fetal antibodies is the use of antihuman globulin serum. The action is to develop an observable agglutination in which the specifically adsorbed antibodies are unable to agglutinate by themselves (blocking complete antibodies). The authors have employed the developing test. They have employed the developing serum both in a test for weak anti-

the serum of mothers and in a diagnostic test for hemolytic disease of the newborn

The methods used were as follows

1 Testing of the serum of mother and infant when isoimmunization was suspected by the test tube method of Levine and Stetson

2 Wiener's method was used to detect the incomplete blocking antibody described by Race and Wiener

3 The elution technique of Landsteiner and Miller was used routinely to attempt to demonstrate adsorbed Rh agglutinins on the cells of the blood in all cases of hemolytic disease of the newborn and on the erythrocytes of all babies whose mothers showed a positive test for Rh antibodies

4 If no clumping was seen in the agglutination test a blocking test was done with a drop of anti Rh serum and the lack of agglutination indicated the presence of blocking or incomplete agglutinins

5 For the purpose of detecting weak Rh agglutinins, incomplete antibodies or immune globulin an antihuman globulin serum was used a positive developing test indicating specifically adsorbed immune globulin was shown by definite clumping of the red cells

6 As a possible diagnostic test for erythroblastosis the developing serum was used to demonstrate the presence of antibodies specifically adsorbed on red cells in vivo

7 The demonstration of hemolytic activity of Rh serum in vitro

Ten cases were investigated. The erythroblastosis was listed as severe in 5 cases moderately severe in 2, moderate in 1 case mild in 1 and subclinical in 1. The outcome was listed as recovery in 5 cases, kernicterus in 1 case, stillborn in 1 partial recovery in 2 cases, and macerated fetus in 1 case. The treatment consisted of early transfusion in 3 cases, delayed transfusions in 3 and no transfusion in 2.

Since the developing test applied to erythrocytes of the newborn showed promise of being diagnostic for erythroblastosis, its specificity was investigated by performing routine developing tests on the erythrocytes of all cord bloods. A total of 365 developing tests on cord cells were done. Four of these did not show clinical erythroblastosis, but a background and history compatible with a subclinical isoimmunization was observed in the 4 cases. In this series developing tests were obtained on both sera and cells of 5 stillborn infants clinically not erythroblastotic. In addition there was 1 hydropic stillborn from which neither serum nor erythrocytes could be obtained. Clinical icterus was found in 4 infants negative to the developing test each of whom had the same Rh type as the mother. These were considered to be examples of physiological jaundice.

The successful removal of Rh antibodies from cord erythrocytes by elution in 3 cases of erythroblastosis is significant chiefly as a demonstration of the actual sensitization of the infant's cells preliminary to their destruction and as an opportunity to prove the specificity of this reaction by further reabsorption of the

eluted antibodies on known Rh-positive red cells. This reabsorption may be indicated by agglutination or the blocking or developing tests may be required, according to the type of antibody involved. The proof that the eluted material consisted of specific Rh antibodies of the same type found in the mother's serum indicates their origin in the mother as well as their transport across the placenta from the maternal circulation into that of the fetus. The specific nature of the union of the antibody to the Rh antigen of the erythrocyte is strongly suggestive of the destructive role this antibody must play in sensitizing the red cells for their hemolysis in vivo (so characteristic of erythrocytes in vitro) by the Rh antibody is significantly demonstrated by the greater liberation of hemoglobin as compared to controls. The earlier experiments seem to give evidence that these antibodies can act as hemolysins as well as agglutinins in vitro. In comparing the relatively weak hemolysis seen in vitro with the severe hemolysis common in vivo it should be noted that in the latter cases red cell destruction may be greatly enhanced by the action of the spleen in its role of phagocytosing the slightly damaged corpuscles. Finally the titer of 1:3,000 effective in the test tube is sometimes exceeded in the mother's serum, particularly if the developing test is used to demonstrate the titer of the anti Rh immune globulin.

The elution technique in conjunction with the demonstration of hemolysis in vitro, presents additional evidence of the sequence of events in the pathogenesis of erythroblastosis. It seems to offer little as a test to identify antibodies in the infant's blood. Only in those cases that showed antibodies in the serum of the mother were the elution tests on fetal cells positive. In this series of cases it was further demonstrated that positive elution tests to demonstrate antibodies adsorbed on fetal cells were found only in those cases in which the cord serum as well as the maternal serum contained demonstrable Rh antibodies.

Since adopting the use of antihuman globulin serum as a developing test in suspected Rh isoimmunizations, the authors have been able to confirm the advantages of this serum in respect to its sensitivity to incomplete antibodies and to prove its usefulness in demonstrating Rh antibodies in the serum of mother and infant when other tests failed. Of even greater interest is the fact that the developing test not only detects incomplete or blocking antibodies but also detects specific Rh antibodies not demonstrable with agglutinating or blocking tests. The developing test also shows agglutination when agglutinating Rh antibodies are present, but the clumping reaction is much stronger than that of the agglutinating antibodies alone. In the author's cases it was found that the developing titer equaled, or far exceeded, the agglutination or blocking titers. There were 2 instances of developing titers in mother or baby which were much higher than agglutinating or blocking titers and even examples of positive tests when the other 2 tests were negative. This evident

difference between the 3 tests indicates that the basic character of Rh antibodies must be different. In the case of the agglutinin which saturates the hapten and produces the visible reaction of clumping the classical antibody is seen. In the case of the blocking reaction an antibody is present which is capable of specific hapten saturation without the production of clumping. However in the case of the immune globulin, demonstrable by the developing serum the antibodies apparently are capable of specific adsorption without saturation of the available haptens and without the production of agglutination. The unique feature of this developing reaction in not saturating the available haptens is further demonstrated by the fact that after Rh-positive cells are subjected to the immune globulin no interference is found with the agglutinability of these cells with known Rh typing serum. They have designated this third type as developing antibodies. This developing antibody is of great clinical importance since it has been observed that clinical erythroblastosis may occur in the Rh-positive mother in whom no antibodies were evident. It has been noted that the observed titers of maternal antibodies have shown little or no correlation with the severity of the disease in the infant. This is because the immune substances were previously hidden to the ordinary agglutinating test. This was demonstrated in some of the cases of the authors.

The application of the developing test to the erythrocytes of the newborn shows promise of a specific test for erythroblastosis. This test may satisfy the requirements of sensitivity and specificity to fill this role. The developing test as applied to washed infant's cells is not necessarily specific for Rh antibodies but presumably would detect any specifically adsorbed antibodies.

The specificity of the developing test is supported by the negative reactions obtained in stillborn infants and cases of jaundice of the newborn in which no evidence of erythroblastosis could be found.

Analysis of the reported cases of hemolytic disease of the newborn brings out a therapeutic consideration. First, the use of early and adequate transfusion of Rh negative blood through the cord route in severe cases is urgently recommended. Second the infant should not be put on the breast if any Rh antibodies can be demonstrated even if no clinical erythroblastosis is apparent. The developing test on infant erythrocytes probably will be sufficiently sensitive to determine this question for Rh positive babies of Rh negative mothers.

LEROY J. KLEINSASSER M.D.

Lozner E. L., Lemish S., Campbell A. S., and Newhouser L. R.: Preservation of Normal Human Plasma in the Liquid State. Clinical Chemical, and Physicochemical Studies during 3 Years of Storage at Room Temperature. *Blood J. Hemat.*, 1946 1: 459.

Liquid plasma is the popular form for the preservation of plasma because of its simplicity economy

and immediate availability, and despite the fact that it provides a good bacteriological culture medium even when containing bacteriostatic agents in clinically nontoxic concentrations. That plasma may be preserved in the liquid state for many months and be administered with clinical safety has been demonstrated by many investigators but the necessity for meticulous asepsis is imperative.

Previous articles concerning this study of plasma preserved in liquid state at room temperature for 3 years stated that when liquid plasma was properly prepared it may be administered to patients with safety and benefit despite the inactivation within 6 months of certain labile constituents and a slow increase in the nonprotein nitrogen and alpha amino nitrogen content, i.e. free amino acids in blood filtrates as determined by the ninhydrin-carbon dioxide method).

This communication has as its purpose the reporting of electrophoretic, osmometric, and viscosimetric studies on plasma stored in the liquid state for 3 years and to summarize the clinical and chemical observations to date. Thus practically the work would form a reasonable basis for the determination of the expiration date of plasma preserved in the liquid state.

The authors present their results as the chemical electrophoretic, osmometric, and viscosimetric findings. Chemically it was found that there was a notable increase in the alpha amino nitrogen concentration during the first 3 years of storage the non protein nitrogen concentration increased steadily for the entire period. Osmotically the stored plasma was slightly but significantly more effective than fresh plasma. Three year old plasma was slightly more viscous than fresh plasma but the difference was of no practical significance. Electrophoretic patterns showed that after 3 years of storage there was a large increase in components with the mobilities of alpha globulin and albumin at the expense of all the gamma globulin, all the fibrinogen and all of the beta globulin.

The results of questionnaires concerning some 3,384 administrations of plasma more than a year old, and a comparison of these results with those of dried plasma indicated that stored plasma was as therapeutically effective as fresh plasma and with considerably less reaction rate. However stored plasma should never be used for its immune properties or to supply blood coagulation factors in patients with a hemorrhagic diathesis. Also overenthusiastic use of stored plasma by simple dilution might result in a fall of the patient's globulin and prothrombin.

Thus liquid plasma stored for periods up to 3 years appeared to be an adequate therapeutic agent to supply colloid of human origin. Except for the fact that stored plasma is relatively isotonic, whereas human serum albumin as supplied is hypertonic, the two agents are similar in their clinical indications and precautions. Both are preserved in the liquid state at room temperature neither supplies much except a human colloid and neither should be used excessively.

The blood drawing and plasma preparation should be done with "closed systems" and meticulously aseptic and scrupulous bacteriological control throughout as liquid plasma even when containing bacteriostatic agents, may permit bacterial growth contaminants during preparation may multiply to dangerous proportions during preservation for even short periods.

EDWARD H. CAMP, M.D.

#### LYMPH GLANDS AND LYMPHATIC VESSELS

Tice G. M.: Lymphoepithelioma. *Radiology* 1946  
47: 116

In the present article, the development of our knowledge of tumors of the pharynx and nasopharynx is reviewed and the author has shown that lymphoepithelioma of this area has gradually come to be considered as a clinical entity the importance of which lies mainly in the fact that these tumors are quite radiosensitive and amenable to irradiation if recognized early.

The early symptoms which were listed by previous observers are (a) pain in the eye with or without diplopia, (b) pain in the ear resembling an acute infection or mastoiditis, (c) trigeminal neuralgia, (d) ptosis of an eyelid and (e) enlargement of the cervical lymph nodes.

Irradiation is believed to be the only method of treatment. For tumors in the tonsillar area, the author prefers roentgen to radium treatment (300 roentgens intraorally every other day with 50 roentgens to the adjacent cervical area on alternate days, a total skin dose of 3,000 roentgens and a total intraoral dose of 2,000 to 3,000 roentgens). For tumors in the posterior nasopharynx, 1,300 to 1,500 mgm. hours of radium are given, with intensive roentgen irradiation of the cervical lymph nodes.

Early recognition of the condition and intensive early treatment offer the only hope for cure. Distant metastases are not amenable to cure, and even symptomatic relief obtained by irradiation, is not as great as that obtained in similar metastases from cancer of the breast.

A series of 12 cases are reported. Six of the patients have died; the average length of their survival being 2½ years from the beginning of symptoms. The corresponding time of survival of the 6 patients who were alive at the time of the author's report was 2 years.

Whether transitional-cell carcinoma undifferentiated-cell carcinoma, and lymphoepithelioma are essentially the same has not been determined, but therapeutically this is of academic interest only.

HENRY L. LANK, M.D.

# SURGICAL TECHNIQUE

## OPERATIVE SURGERY AND TECHNIQUE POSTOPERATIVE TREATMENT

Rubin, L. R.: Repair of Avulsion Wounds of the Hands and Feet by the Flap Graft Technique. *Am J Surg* 1946, 72: 373

The treatment of avulsion wounds of the hands and feet in a general hospital functioning in the Mediterranean theater of operations during World War II presented definite problems which necessitated a closure technique providing a thick fatty skin cover within the shortest period of time. All of these wounds were either penetrating or perforating tendons, nerves, and bones were exposed. In most cases the bones were fractured and often fragments were missing. While many of the cases were clinically clean immediately after débridement at evacuation hospitals all were contaminated and many were infected by the time the general hospital was reached. Unless covered with a skin layer early exposed tendons and bones soon became necrotic. To prevent further loss of the deep tissue structures, and to provide for the earliest functional results all techniques of skin grafting were investigated.

The free grafts Thiersch split skin, and full thickness grafts would not take over the deep structures mentioned. A fat-containing pedicle type of graft was consequently indicated which would (1) cover exposed bone, tendon, or deep irregular muscle defects, (2) not adhere to the underlying structures, and (3) not contract excessively.

Three such types of tissue covering were available—the contiguous skin flap, the tube and the flap grafts. The contiguous skin flap or the utilization of the tissue adjacent to the wound was limited because of the relative immobility and inelasticity of the tissues of the hands and feet due to the paucity of subcutaneous fat. This was especially true for large wounds.

The tube graft was an ideal technique for covering but required at least three and more often additional operations to cover a defect. To decrease the number of the operations required the flap graft was reinvestigated and used instead of the tube graft.

Wounds of the hands and feet presented defects which could be brought to the donor sites with relative ease which obviated the necessity for tubing. An ideal situation was thus present for the use of the flap graft.

The usual donor site for hand defects was the abdomen. Practically all flaps were cut with the pedicle facing posteriorly or diagonally superiorly so as to allow the lower thoracic and posterior lumbar vertebral vessels to enter the flap. On occasion when indicated the flap base was directed superiorly or inferiorly with the source of blood supply coming from either the thoracoepigastric vessels or the su-

perforal iliacs coming up to anastomose with them. The flaps were thick and included all layers of skin and fat down to Scarpa's fascia. The size of the flap varied considerably the author did not exceed the rule of length no more than three times the width but always tried to get the widest pedicle possible.

A loose pedicle was important to avoid pull on the graft when the hand was placed on the abdomen. The part sutured to the defect was placed with normal skin tension.

The anterior lateral and medial aspects of the thigh were chosen as the best donor sites for the foot defects. In most cases the base of the flap was placed in the superior direction. However in cases in which the defect was on the lateral aspect of the foot or ankle a retrograde flap was raised the blood supply coming from the rich plexus of vessels about the knee.

In search for a more comfortable donor site the lower leg was considered but found unsuitable for several reasons. The subcutaneous tissue contained little fat, a limited blood supply and lacked contour for large defects. Another disadvantage was the lack of silent areas on the leg.

When there was doubt as to the circulation of the flap either because of the position or the size a delayed technique was used. The ideal technique called for two delays. All flaps raised were of a single pedicle type.

Only frankly necrotic tendon and bone were surgically removed before a flap was placed over the defect. Infected tendons were not debrided. All granulation and early scar tissue were removed, making sure there would be no barrier for new blood vessel penetration. Fresh skin edges were cut and then slightly undermined to facilitate suturing to the flap. Since many wounds were of the bursting as well as the lacerating type the size of the defect could often be decreased by undermining the adjacent skin edges, sliding or rotating that tissue, and then suturing. Not only did this decrease the size of the flap to be raised but also it gave a regular edge to the wound. In some of the large defects of the feet it was thought advisable to decrease the size of the defect because of the difficulty in obtaining sufficient flap from the thigh. A combined flap and split skin graft technique was used.

There can be little doubt as to the necessity of grafting exposed tendons and nerves with a fatty cover. Since past experiences have shown that such uncovered deep structures became necrotic, covered early flaps were attempted even when they were infected.

Forty nine cases of flap graft closures were performed for deep wounds of the hands and feet, with good functional results. The very early coverage of exposed infected tendon and bone is advocated by the use of this technique. The flap graft technique



is quick and sure of take in the covering of wounds of the hands and feet with a fat containing skin cover. The principles of multiple blood transfusions and penicillin therapy are believed to be important adjuncts in the take of grafts. Early physical therapy for optimal function is a full time job for a trained nurse or an assistant who understands the problems.

JOHN L. KIRKPATRICK, M.D.

**Odenat and Monssingeon: Gas Embolism of the Brain. The Good Effect of the Intravenous Injection of Novocain (Embolie gazeuse du cerveau. Reueuse action de la novocalinisation intraveineuse) *Mém Acad sci Par* 1946, 72 355**

A woman of 47 years was operated on for calculous cholecystitis. Ten days after the operation at about 10 30 o'clock in the evening an exploratory pleural puncture was made on account of a postoperative pleural syndrome. The puncture was made with a very fine needle and did not yield any fluid but a few minutes later the patient coughed up foamy blood. After a few seconds she lost consciousness and the pulse could not be felt. Her eyes were half open and showed horizontal nystagmus to the left. There was conjugate deviation of the head and eyes to the left. The limbs were flaccid and fell heavily; there was epileptoid tremor of both feet and a bilateral Babinski sign. At about 11 o'clock an intravenous injection of 20 c.c. of 1 per cent novocain was given. Recovery was remarkably rapid. Motion and sensation were quickly restored and after about 5 minutes the Babinski sign disappeared. At 12 30 o'clock the patient was in good condition and remained so. It seems certain that this was a case of gas embolism of the brain.

In spite of the severity of the attack, improvement had begun even before the novocain was administered and it is probable that the patient would have recovered without the injection. However, it is worth while to study such cases carefully to determine the indications and mode of action of the drugs used and the finer mechanism which produces the accidents. The differences between the findings in animal experiments and in this clinical case are discussed, and it is suggested that possibly the vasodilatation brought about by the novocain opened up new vascular networks that had previously been closed, such as the pial network and the deep subcortical capillary network.

In the discussion ISLÉN described 3 cases of surgical embolism in which the intravenous injection of 20 c.c. of 1 per cent novocain gave extraordinarily rapid and favorable results.

AUDREY G. MORGAN, M.D.

**Leriche, R.: The Prognosis and Treatment of Large Emboli of the Pulmonary Artery (Prognostic et traitement des grandes embolies de l'artère pulmonaire) *Lyon chir* 1946 41 357**

Death from pulmonary embolism occurs suddenly. The period permitted for the observation of symptoms is brief and accurate diagnosis is correspond-

ingly difficult. Diagnosis is usually based on a history of an operation from 6 to 10 days earlier, a sudden collapse, pain, anxious expression, air hunger, dyspnea followed by cyanosis, and an irreversible fall of the blood pressure.

The most accurate means for localizing the site of embolus is to eliminate the vegetative elements by sympathetic block. This procedure clarifies the clinical picture by leaving only the effects of the mechanical block in the pulmonary circulation. Reflex phenomena may be only supplementary or they may be a major portion of the illness.

The treatment of pulmonary embolism involves first a suppression of sympathetic vasoconstrictor effect and then re-establishment of permeability of the artery. Stellate ganglion block may modify the circulatory obstruction to such a point that it remains compatible with life, also, it may indicate the need for embolectomy. If the patient's condition improves after stellate block the embolus probably has obstructed a secondary branch of the pulmonary artery rather than the main trunk. If improvement is only momentary a major trunk probably is obliterated and immediate embolectomy is necessary. The intravenous injection of 10 c.c. of 1 per cent novocaine may accomplish the same purpose and is easier to perform. However removal of the sympathetic effect produces no improvement for 2 of every 3 patients. In these one must assume that the obstruction is of the main pulmonary artery and its two branches and that operation is mandatory.

Embolectomy is a major operation requiring trained and skilled personnel with proper instruments, sterile and available for immediate use. Sixty per cent of the patients with pulmonary emboli die within 15 minutes. Others may have clots lodged in lobar branches from which they cannot be removed. Still others who may survive surgical removal of a clot may sustain a fatal recurrence.

If the operation is undertaken the author prefers a T-shaped incision with a horizontal limb 10 cm. in length over the second rib or second interspace. The vertical limb is placed 1 cm. to the left of and parallel to the left border of the sternum from the sternoclavicular articulation to the fourth costal cartilage. The second and third ribs are cut 7 or 8 cm. from the sternum and disarticulated. The pleura is retracted and the internal mammary vessels are ligated if necessary. The pericardium is opened at the level of the third cartilage and the aorta and pulmonary artery are identified. This important step requires skill and a knowledge of anatomy. A rubber tube is passed around the two vessels to serve as a tractor and to control circulation through the vessels. Interruption of the circulation must be brief. It is hazardous to exceed the 45 second period advocated by Trendelenburg. While the assistant holds the rubber tourniquet and obstructs the circulation the operator incises the pulmonary artery. Preliminary aspiration of the vessel may obviate confusion with the aorta. The incision in the pulmonary artery should be placed at the level of the



skin wound should be enlarged preferably in the length of the limb the deep fascial envelope freely opened, and the removal of tissue should be directed especially to damaged, soiled and devitalized muscle. Skin need be only sparingly removed. After excision the wound is left open or it is lightly filled with paraffin vaseline is sometimes applied on gauze, and an external protective dressing is applied. Insufflation of sulfonamides is not so largely used as formerly. Giving the selected sulfonamide by mouth and penicillin by intramuscular injection is the method of choice in the administration of these drugs. The initial surgical treatment of wounds still calls for observance of the fundamental principles. The excised wound should be left open and should not be closed earlier than the fourth or fifth day after excision. With the combined use of penicillin and sulfonamides closure may be accomplished earlier—in from 2 to 3 weeks—than with the use of sulfonamides alone.

Pyrexia was noted in some cases in which penicillin had been administered by continuous drip and was observed occasionally when penicillin was given intermittently.

The results were studied in 706 wounds in which the dressing had not been disturbed from the time the patient left the casualty clearing station until his arrival at the base hospital.

The incidence of infections in these wound was as follows:

Forty-nine per cent of wound which had been operated upon without the application of any bacteriostatic agent were infected. 43 per cent of wounds operated upon with the application of sulfanilamide powder were infected and 25 per cent of wounds operated upon with the application of penicillin sulfathiazole powder were infected.

The author states that immobilization of the injured part is essential for comfort of the patient and the healing of wounds. This principle applies not only to fractures but also to joint injuries and severe flesh wounds. The use of a complete nonpadded plaster cast however is dangerous if left unopened and the risk is greatest in closed or simple fractures. The swelling of a limb with intact skin and fascial envelope may produce great tension within the cast and lead to serious damage to the tissues. More emphasis is now placed on adequate and sufficiently maintained immobilization of fractures, and less emphasis is being placed on the early movement of joints.

A lowered mortality from burns has been achieved by replacing fluid loss and by the use of pressure bandages applied over copious dressings. It is now appreciated that the great reduction in the exposed skin surface in extensive burns, in which a large proportion of the body surface is swathed in bulky dressings, may lead to interference with the normal heat regulating mechanism of the body especially under tropical conditions. Excellent results have been obtained by nursing burned patients in air conditioned rooms.

JERRY L. LUNDQUIST M.D.

## ANTISEPTIC SURGERY TREATMENT OF WOUNDS AND INFECTIONS

Tabanelli M: Frostbites Sustained in War (Cau-  
gabement di guerra). Arch. Ital. Chir. 1943, 48  
111

Of the various methods of treatment of frostbites, namely immersion of the affected extremity in hot normal saline solution diathermy x-ray irradiation, periarterial sympathectomy and a block of the perivascular sympathetic plexus, the author prefers the last one. From 10 to 20 cc. of the customary concentration of novocain solution or one of its derivatives, are injected in the axillary region or in Scarp's triangle respectively. In order to anesthetize the sympathetic plexus of the corresponding arteries.

A few minutes after the injection one can observe a local capillary vasodilatation alleviation or complete cessation of pain, increase of the normal temperature and disappearance of the cyanosis.

Local anesthetic block consisting of the injection of novocain without adrenalin into tissues surrounding the affected area is supposed to produce similar results.

In first degree frostbites the author obtained excellent results with anesthetic block of the perivascular sympathetic nerves. From 1 to 3 injections given at daily intervals were required to produce the desired results.

In second degree frostbites the injection of novocain into the axillary region or the femoral canal may be supplemented by an injection of from 10 to 20 cc. of novocain into the region of the second lumbar sympathetic ganglion. After the treatment a sensation of heat in the affected area is noticed by the patient. Vasodilatation is followed by relief of the pain and the oscillometric index demonstrates an improvement in the condition. From 1 to 3 injections at 1 day intervals are usually required to obtain relief. In 5 of 56 cases of second degree frostbite, the anesthetic block of the perivascular sympathetic nerves was supplemented by an infiltration of the second lumbar sympathetic ganglion. The results of this method were very satisfactory.

In third degree frostbites surgical procedures had to be employed. Amputation or exarticulation of the hand was done in 4 cases, while similar procedures on the feet were employed in 104 cases. Among 165 similar procedures performed on the tarsal and metatarsal bones, Lindfranc's exarticulation was done 50 times and Chopart's method was employed in 10 instances. Streptocoll was applied locally in every case.

Tubular pedicles used in skin transplantation gave good results in 85 per cent of the cases. In 56.6 per cent of the cases in which transplantation of derma and epidermis according to the Davis method was employed perfect results were obtained in 50 per cent the results were partially successful and in the remaining 16.6 per cent failures were recorded.

In 56 cases a tendon transplantation was required to correct the varus position of the foot. The lower end of the tendon of the anterior tibial muscle above

or together with the tendon of the extensor digitorum longus muscle was attached to the niche created in the cuboid bone. This operation was required to correct the deformity following the Lisfranc operation.

JOSEPH K. NARAT, M.D.

Watson E. F. Hoge, W. G. and Koch S. L.: Burns in Children. *Q Bull Northwest Univ M School* 1946 10: 286.

The authors discuss the methods of therapy and the results of their endeavors in 266 patients admitted to the Burn Project at the Cook County Hospital. Their discussion is divided into two parts: one regarding local treatment and the other systemic therapy. Local treatment consisted of surgical cleansing under aseptic conditions, with white soap and soft cotton followed by dressing with a nonadherent fine mesh gauze which was covered by compression dressings. Petrolatum bentonite carbowax containing 10 per cent activated zinc peroxide, and penicillin were used to impregnate the gauze. The authors believe that the best results followed the use of either the penicillin gauze or the zinc peroxide carbowax gauze. Primary change of dressings was delayed for from 10 to 12 days if possible. Indications for earlier dressings were extensive saturation of the dressings or prolonged high fever. To secure clean granulating wounds for early grafting the authors found daily dressings saturated in Dakin's solution the most efficacious.

In the general treatment of the patients sedation was given to half. This consisted in either morphine or the barbiturates. Plasma and oxygen were given to all who had over 5 per cent of the body burned. Fluids by mouth were given as soon as tolerated and augmented by vitamins and a skimmed milk mixture to maintain protein balance. Salt solution and sodium bicarbonate were given by mouth.

Seventeen or 6.4 per cent of the patients died. There were no recoveries among the patients who had over 50 per cent of the body surface burned. All but 2 deaths occurred within 34 hours of admission. The authors both begin and conclude with the admonition that burns are an important problem, and that their care can be undertaken only in a hospital. The best first aid is to wrap the child in a clean sheet and to bring it to a hospital for care.

WILLIAM C. BECK, M.D.

Gardner C. E.: Air Force Battle Casualties. An Experience with Acute Injuries of 839 Battle Casualties from the Eighth Air Force. *Arch Surg* 1946 53: 387.

Air force crews in combat are subject to injury not only from enemy gunfire but also from the effects of cold or anoxia at high altitudes from burns or injury from crash landings or parachute jumps or from a haphazard assortment of accidents within a plane in flight the commonest of which is being caught in a revolving gun turret. Of the 839 patients whose cases constitute the basis of this report 645 had battle wounds from missiles 140 had battle injuries from

plane crashes 26 had battle injuries from parachute jumps and 28 had injuries from plane accidents.

Of the 645 patients injured by missiles 69 per cent were wounded in the extremities 20 per cent in the head and neck and 11 per cent in the trunk. Of the wounds of the extremities fractures occurred in 25 per cent, neural injuries in 8 per cent and major arterial injuries in 5.5 per cent. There was a low incidence of penetrating thoracic and abdominal wounds as compared with wounds of ground forces in the field because of the effectiveness of body armor worn by crews of heavy bombers in combat.

Treatment was begun by the crew in the plane before it landed after which the wounded man was seen by his flight surgeon and taken from the plane to the medical station on the field. Here first aid measures begun on the plane were checked and continued and plasma was given if necessary. Patients were then transferred to the hospital where they were received in the shock ward for resuscitation study and preparation for operation. Shock was treated with transfusions of whole blood. Reactions to transfusions had to be guarded against. Hemolytic reactions are more prone to follow large multiple or repeated transfusions. Alkalinization of the urine was carried out in an endeavor to prevent the renal damage resulting from hemoglobinemia and hemoglobinuria.

Wounds of the soft parts were treated by excising all devitalized tissue, removing foreign bodies irrigating with isotonic solution of sodium chloride dusting lightly with sulfanilamide powder in most cases inserting loosely a gauze strip covered with petrolatum to the depth of the wound, and applying a voluminous dressing snugly. No harm resulted from the local use of sulfanilamide in wounds left open for later secondary suture. Healing of the wounds in which sulfanilamide was not used was not essentially different from healing of sulfanilamide treated wounds. Sulfadiazine was given routinely by mouth until after secondary closure of the wound had been carried out. Penicillin was given to patients with major wounds. Pentothal sodium was the anesthetic used in most cases.

Wounds of the scalp face and all serous cavities were closed after excision. All others were left open and not dressed until 5 days later when the patient was returned to the operating room and secondary closure was done. For associated wounds of the skeletal system requiring traction skeletal traction was used. Where traction was not necessary well padded plaster casts were applied. Internal or external skeletal fixation was not used. First dressings were done in the operating room 5 days after débridement at which time the wounds were closed if possible by suture or skin graft.

Wounds penetrating the skull or brain were treated by scalp débridement, removal of loose fragments of skull enlargement of the skull defect removal of traumatized brain by suction with special care to remove indriven bone fragments and pains taking hemostasis, with the use of muscle packs or



a good skin covering at the earliest moment rather than to allow them to granulate and develop extensive contractures or to allow healed scarred epithelium which is tense and thin to become excoriated with secondary ulceration.

Contracture of the hand due to various etiology—lacerations, penetrating objects, shrapnel and bullet wounds, in which soft tissue is the primary tissue injured and in which heavy scar develops with healing—may be superficial and involve only the skin and subcutaneous tissue of the hand or it may extend deeper and involve all the soft structures underlying it including the tendons, joints and nerves. Usually the condition is not relieved permanently by conservative treatment and surgery is ultimately required.

Many of the patients, fortunately, have only one or two digits or merely parts of digits traumatically amputated, and a useful hand can be obtained with the remaining digits if the amputation stumps are covered satisfactorily. Usually the skin over the stumps is thin and atrophic, or painful neuromas are present which prevent even light pressure on these areas. Frequently because of pain a patient will not use the other remaining functioning digits of his hand with resulting joint stiffness which further increases his disability. Surgery will relieve these conditions and even apparent lengthening of a short deformed digit can be obtained by deepening the adjacent web spaces.

A number of the injuries seen are produced by sharp penetrating objects which have healed more or less per primam but in which the original injury has divided the tendons either flexors or extensors. In the treatment of wounds in the field it is impractical to do primary tendon repair, and frequently because the wounds are dirty it is inadvisable to repair them later at the station hospital even should the patient arrive within 12 hours, the so-called relatively safe period for primary tendon repair. This condition is amenable to treatment and an attempt should be made to restore function by the surgical procedure of secondary tendon repair with a tendon graft. A technique of tendon grafting is described.

All wounds of the hand if left open are contaminated but fortunately most of them heal without apparent extensive infection. There is a group of cases in which virulent infectious processes develop with destruction of tissue and resultant deformities many of which are contracture deformities of a general nature. The infectious process destroys the smooth gliding action of the tendons and joints, disturbs general nutrition and the entire hand becomes painful and useless as far as function is concerned.

There is a large group of combat injuries in which the injury is extensive and all the various tissues are involved to a greater or lesser extent. These cases are combination problems of orthopedic, plastic, and neurosurgery and the problem is one of restoring all remaining structures to as near a functioning status as possible. Extensive surface scarring is

usually present and the circulation is impaired. It is necessary to replace the surface covering with a pedicle graft after the scar has been excised. This improves the general condition of the hand. The orthopedic and neurosurgical problems should be corrected before the final tendon reconstruction is undertaken.

In evaluating the extent of damage of an injured hand a history of the condition together with the previous treatment is essential. This takes time and patience on the part of both surgeon and patient and frequently a hasty diagnosis as to the condition becomes disappointing to both surgeon and patient alike when the end results are tabulated.

It is of paramount importance to make a very careful examination of the entire extremity as well as the injured hand. Local signs may have remote causes. The general condition of the hand should be observed including the circulation, the general state of nutrition and the atrophic changes. The general picture should then be outlined. Each part of the hand is checked separately for motion, pain and sensory disturbance. X-ray examination is imperative to check bone changes and deformities. The disability is noted and studied, and the anatomical basis for it worked out. This is important from the standpoint of diagnosis and evaluation and also from that of its correction. When one is able to visualize the pathological condition one is able to outline the procedure to be followed in the rehabilitation of the hand and to give a prognosis. The author believes there is no justification for subjecting a patient to the ordeal of an operative procedure which is long laborious and will offer him only little possibility of improvement. By reviewing the condition carefully, the surgeon is able to avoid this in most cases. If the hand is nothing more than a nonfunctioning mass of painful scarred tissue resulting from wounds and subsequent infection one would be performing a surgical feat rather than a sound surgical procedure to even attempt to rehabilitate it. Perhaps, amputation with prosthesis would be the solution.

After elective operative procedure is decided upon certain preoperative care is necessary. The original injury must be well healed. No induration or reaction of tissue to healing should be present. In the case of a tendon injury 3 to 6 months should elapse before secondary repair. In cases in which heavy scarring is binding and acts as a constriction—a condition which interferes with nutrition—a preliminary operation is necessary in which the scar tissue should be removed and good tissue cover supplied in the form of a pedicle graft. The patient should be encouraged to take occupational therapy also as an adjunct to physiotherapy.

Hand surgery is always difficult even when optimum operative conditions are available. Good lighting is necessary. General anesthesia is the anesthetic of choice. It is essential to provide a bloodless field in which to work and not to damage important structures, as well as to aid in making a

clean anatomical dissection. An Esmarch tourniquet is used to express the blood in the hand and forearm before inflating the cuff. While the Esmarch tourniquet is in place the blood pressure tourniquet is inflated to between 240 to 260 and, after clamping each tube to secure the pressure the Esmarch tourniquet is removed and the operation is started.

Incisions are made in the hand along the flexion creases and not over points of pressure. Mid-lateral incisions are made along the digits. Good exposure should be obtained. It is extremely important to be gentle in retracting skin flaps and in handling normal structures in order not to traumatize the tissue thus minimizing the formation of postoperative scarring. All scar tissue should be removed.

If extensive scar tissue is present and the skin is adherent to underlying structures, a pedicle graft is used to cover the defect after excision of the scar. This provides a good covering and subcutaneous fat under which tendons can glide and also healthy tissue to replace the scar thereby improving the general nutrition of the hand. Subsequent operations for nerve work or tendon grafting can then be approached through healthy tissue. After the dissection is complete the tourniquet is released. It is well to remember that after release of the tourniquet pressure should be maintained on the wound with moist sponges for 5 minutes because of the initial hyperemia. This saves unnecessary clamping of oozing points and then only active bleeders need be secured. After the operation is completed careful closure of the wound is necessary. A pressure dressing is always necessary in hand surgery to prevent undue oozing and to prevent hematoma from developing postoperatively. This can be accomplished by applying fine meshed gauze to the surface of the wound and stuffed gauze which can be compressed with gauze bandage. If fixation of the part is necessary a molded plaster or metal splint can be applied.

Elevation of the limb postoperatively for any surgery done on the hand is essential in order to minimize postoperative discomfort and swelling. Inspection of the wound can be done from 7 to 10 days after operation by opening the bandages without disturbing the hand and forearm from its splint. Sutures can be removed at this time and the dressing folded together again and rebandaged. Elevation of temperature and pain and throbbing sensations in the hand call for inspection at any time.

In the case of tendon work fixation of the hand in plaster for 3 weeks without motion is maintained and support is then given by elastic bands. The patient is encouraged to move his hand actively immediately after its removal from the cast with elastic traction used as a safeguard against sudden pull on the healing structures. Occupational therapy to engage the patient in intricate manipulative work and hand exercises, and good physiotherapy with the patient's full co-operation are essential for good results.

Rehabilitation of the injured hand is most instances probably one of the most difficult tasks

which the surgeon is called upon to perform. A careful examination and planning, together with meticulous surgery this work can be accomplished with satisfactory results in many cases. Good co-operation on the part of the patient in taking active hand exercises and following physiotherapy treatments is most essential for good results.

JAMES E. KIRKPATRICK, M.D.

Shambaugh, P.: Postoperative Wound Infection—An Evaluation of Factors Concerned with the Resistance of the Tissues to Infection. *Q. J. Med. Northwest. Univ. Med. School* 1945, 20: 176.

The factors which have been ascribed as lowering tissue susceptibility to infection are sensibility to the use of irritating suture materials, imperfect hemostasis and physical and chemical trauma. The author believes that this opinion has been accepted empirically without substantial clinical or experimental proof, and has undertaken to apply investigative methods to determine its soundness. He thinks that sensibility has rightly been accused of lowering tissue resistance to infection as the percentage of suppurating wounds in a series of 2,360 controlled hemiorchiectomies was 30 per cent higher in the patients over than in those under 50 years of age.

Experiments are cited to show that wounds closed with catgut are more liable to wound infection than those sutured with silk. The author finds no appreciable difference between silk, cotton, and possibly steel wire, although the last appears to be the most advantageous from the standpoint of infection. Furthermore, he finds no difference between treated and untreated silks. Nylon is dismissed because of the difficulty in retaining knots.

Imperfect hemostasis as a cause of reduced tissue resistance is discussed in some detail, and several experiments are reviewed. The author thinks that blood itself is not a good culture medium unless some chemical irritant has been added. A table of Fleming's is quoted to show that leucocytic activity is maintained in hematomas for only 2 days, after which there is a precipitous decline in such activity. Therefore after this period the evacuation of hematomas may be fraught with a certain amount of danger if bacteria are thereby introduced. The introduction of serum into a wound, however, was associated with a high percentage of wound infection.

Dessication by drying wounds under a lamp, surprisingly did not reveal any increase in the incidence of wound infection. Experiments with various bactericidal agents introduced into grossly contaminated wounds, revealed that they are largely innocuous and may even be harmful. Simple lavage with physiological salt solution appeared to be of some value in grossly contaminated wounds, but only to the extent of removing particulate matter without effecting any sterilization of the tissues. Soap solutions and other stronger bactericides probably produce an adverse effect because of their inhibitory or lethal influence on polymorphonuclear leucocytes.

WILLIAM C. BUCK, M.D.

## ANESTHESIA

Nicholson, M. J., and Eversole, U. H. Neurological Complications of Spinal Anesthesia. *J Am Med Ass* 1946 132: 679.

Headache, septic and aseptic meningitis, arachnoiditis, neuritis, myelitis, and the cauda equina syndrome have been the complications most frequently reported following spinal anesthesia.

These cauda equina complications are generally brought to the anesthesiologist's attention because the patient fails to regain the use of his lower extremities at the usual time. Loss of motor and sensory function is generally found to involve the lumbosacral nerve distribution. The loss of bowel and bladder function is the most ominous part of the entire clinical picture and the return of function when it occurs, is extremely slow.

The clinical manifestations of the lesions of the cauda equina might be explained by damage to the lumbosacral region of the cord to the conus medullaris or to the nerves of the cauda equina, but it seems more probable that the maximal damage is to the latter. A résumé of several possible ways in which such damage might occur follows:

1. Direct trauma as the sole cause of the anesthetic complication can fairly well be eliminated because of the thousands of diagnostic lumbar punctures that have been performed without any similar complication.

2. The rapid onset of most of these complications seems to preclude infection as an etiologic factor.

3. It seems that only those nerves exposed to the greatest concentration of the drug are affected. The

lesion is maximal in those roots of the cauda equina which are closest to the place where the drug was injected.

4. Another consideration is the possibility that spinal anesthesia may act as a precipitating factor in the evolution of certain pre-existing neurological affections.

It is almost impossible to determine from the literature the true incidence of neurological complications following spinal anesthesia since the reports show great variation. There have been 21,000 patients at the Lahey Clinic who have received tetracaine hydrochloride for spinal anesthesia since 1934. Five neurological complications resulted. In 3 cases lesions of the cauda equina type developed and in 2, the patients were later found to have a cerebrospinal fluid block from metastatic carcinoma. Two patients developed a peroneal neuropathy. In addition 2 patients in whom postspinal neurological disturbances developed and who were suspected of having permanent sequelae were found on further investigation and operation to have been suffering from tumors of the spinal cord.

There is a report of 13 cases in which neurological complications developed after spinal anesthesia. A detailed regimen for the prevention of postspinal neurological complications is presented.

A patient who shows a delay in the return of motor and sensory function following spinal anesthesia should be considered for emergency treatment and warrants immediate attention. Certain of these complicated cases may require special and intensive treatment before the patient can be rehabilitated.

MARY FRANCES POZ, M.D.



duce stretching and separation of the angular and posterior temporal arteries and their branches. In the anteroposterior projection, the position of the carotid remains unchanged and the bifurcation into the anterior and middle cerebral arteries has the configuration of a rectangular compressed U.

Tumors of the occipital lobe and adjoining posterior inferior part of the temporal lobe show less characteristic angiographic signs. In lateral arteriograms moderate elevation and forward crowding of the angular and posterior temporal arteries may be seen. The terminal branches of these vessels are definitely spread and distended as are the arborizations of the posterior cerebral artery, provided that vessel is filled. More anteriorly, the compressed arteries of the sylvian group exhibit a tendency to coil together. On the anteroposterior projection the midline shift of the anterior cerebral artery is slight or even absent. The vein of Labbe may be shifted downward and anteriorly.

Space-occupying lesions of the frontal lobe deform to a variable degree the supracallosal segment of the internal carotid artery, the anterior two-thirds of the anterior cerebral artery and its branches, and the beginning of the middle cerebral artery with its frontal ascending (rolandic) branches. The most characteristic sign of all unilateral frontal tumors is the considerable displacement and localized stretching of the anterior cerebral artery to the opposite

side. As a rule this midline shift is more marked in frontal neoplasms than in hemispherical tumors of any other location.

Representative of the subfrontal tumors are the meningiomas of the olfactory groove. These small large neoplasms arise from the floor of the sphenoid fossa and compress the orbital surface of the frontal lobe and suprasellar region; they show bilateral as often than unilateral development. On arteriograms taken in lateral projection the supracallosal, subcallosal segments of the anterior cerebral artery are displaced upward and posteriorly forming an anteriorly concave arc around the lesion (Fig 5). In large tumors, the supracallosal portion of the crural and the pericallosal knee of the anterior cerebral artery may be pushed backward. Unilateral olfactory groove meningiomas displace mainly the subcallosal portion of the anterior cerebral artery to the opposite side (Fig 6).

The group of prefrontal tumors comprises mainly astrocytomas and meningiomas (arising from the anterior portion of the falx and superior longitudinal sinus). On lateral arteriograms the carotid siphon and the beginning of the sylvian vessels are pushed slightly backward and downward. The anterior cerebral artery is displaced backward so that the curve of the vessel around the knee of the corpus callosum is blunted without losing its forward convexity. The smaller forward branches of the anterior cerebral

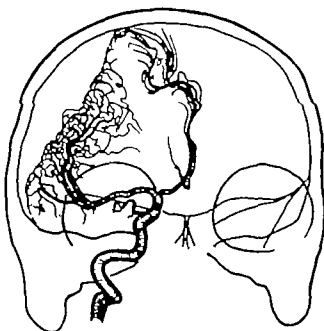


Fig. 3 (List and Hodges.) Anteroposterior arteriogram of subdural hematoma.

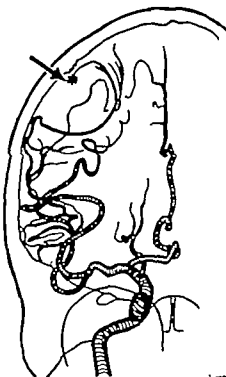


Fig. 4. Anteroposterior arteriogram of parasagittal meningioma. Arrow points to circulation at tumor attachment.

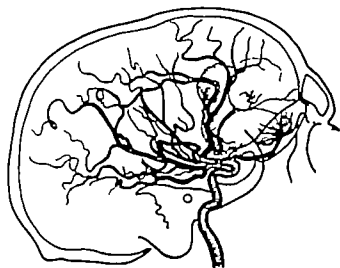


Fig. 5

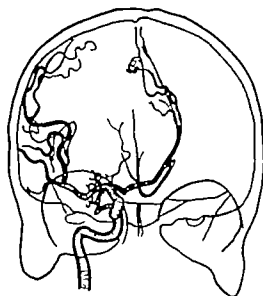


Fig. 6

Figs. 5 and 6. Arteriograms of sarcomatous olfactory groove meningioma. lateral and anteroposterior projection

artery appear distended and spread apart. Much more impressive changes are observed in anteroposterior projection. There is major displacement of the anterior cerebral artery across the midline underneath the free edge of the falx and in contrast to most other hemispherical tumors the distance between the anterior and middle cerebral arteries is greatly increased. The subcallosal and pericallosal portions of the anterior cerebral artery form a smooth round bulge and due to stretching the extended frontopolar branch leaves the main vessel without undulation. Diagrammatically the figure outlined by the carotid bifurcation and the anterior and middle cerebral arteries resembles an open O.

Premotor tumors such as the astrocytomas, oligodendrogliomas, and meningiomas, are commonly encountered. The carotid siphon as seen in the lateral projection is compressed sometimes forming an apparent sharp angle anteriorly. Instead of following a normal diagonally ascending direction the initial portion of the sylvian group is depressed taking a horizontal or even downward convex course. It is important to observe the configuration of the ascending frontoparietal artery. This vessel, which has roughly the shape of the Greek letter  $\Psi$  (psi) is difficult to trace in the normal brain, because of its redundancy. In premotor tumors, the frontoparietal artery is displaced downward and posteriorly with its terminal branches separated. The anterior cerebral artery may be depressed in its supracallosal segment and the callosomarginal branches separated if the lesion is in parasagittal location but the polar vessels show little or no spreading. The angiographic picture revealed by the anteroposterior projection is similar to that of prefrontal tumors, with the exception that the principal midline shift occurs a little higher at the knee of the anterior cerebral artery which is projected just below the edge of the falx.

In cases of frontotemporal tumors one observes meningiomas of the lesser sphenoidal wing growing underneath the frontal lobe into the beginning of the sylvian fissure glioblastomas of the posterior inferior frontal and opercular regions and diffuse astrocytomas. In the lateral projection the supraclinoid portion of the carotid forms with the middle cerebral artery a straight, diagonally ascending line. The sylvian group continues in the same direction or is as often a little elevated or depressed. The ascending frontoparietal artery is markedly stretched and its two widely separated terminal branches form a triangular pattern. Due to the stretching of the sylvian vessels the origin of the anterior cerebral artery is projected clear from superimposed vascular shadows. The pericallosal curve of the anterior cerebral artery is elevated and widened (similar to the picture seen in hydrocephalus). In the anteroposterior projection the anterior cerebral artery exhibits the bulge across the midline typical of frontal tumor. The middle cerebral artery may have a tendency to diagonal elevation as is observed in tumors of the temporal lobe. On venograms the internal cerebral vein may appear displaced upward and posteriorly. Space occupying lesions of the parietal lobe depress the sylvian vessels and the pericallosal artery. Thus the distance between the anterior and middle cerebral systems appears to be reduced in the lateral projection. There is only moderate midline displacement of the posterior part of the anterior cerebral artery because the resistant falx yields little to pressure yet there may be characteristic notching of the anterior parts of the vessel underneath the falx. In parietal tumors poor filling of the terminal cortical arteries has been observed. Presumably, the intravascular pressure of the injection is insufficient in the smaller branches to overcome the compression by the tumor.

Neoplasms of the superior parietal region (parasagittal meningiomas, gliomas) depress and sometimes separate the pericallosal and callosomarginal arteries. The vessels of the sylvian group may not be much deformed, except for separation of the terminal branches of the posterior parietal and angular arteries. Inferior parietal tumors, commonly glioblastomas, depress considerably the sylvian vessels but displace little or not at all the anterior cerebral artery in the vertical plane. In the lateral projection the sylvian group appear compressed and take an unusual horizontal or downward convex course instead of the normal diagonal fanlike arrangement. The terminal branches (anterior and posterior parietal and angular arteries) leave the sylvian group almost at right angles and ascend vertically being widely separated from each other. On venograms, some separation of the superior cerebral veins may be noted, and the vein of Labbe may be displaced downward.

In tumors of the basal ganglia and thalamus a presumptive diagnosis can be made when there is evidence of moderate hydrocephalus with the anterior cerebral artery remaining in its normal midline position. In certain lesions of the basal ganglia, however this vessel describes an unusual forward and upward bulge similar to that observed in posterior inferior frontal tumors. If the small arteries of the anterior perforate space (lenticulostriate and lenticulo-optic vessels) are visible in the anteroposterior film, they appear stretched and displaced laterally. The anterior choroidal artery may be seen displaced downward and posteriorly describing a semicircle around the optic tract and pulvinar. This is almost a pathognomonic sign for thalamic neoplasm, but unfortunately the choroidal vessel is not always visible.

FRANK L. HUBERT M.D.

Manneheimer B.: The X Ray Appearances of Pharyngeal Palsy. *Brit. J. Radiol.* 1946, 19, 385.

Fluoroscopic examination of the pharynx during attempted deglutition of thick barium paste reveals the following characteristic findings:

1. Atonic enlargement of the pharynx.
2. Retention of large quantities of barium in the pyriform sinuses and epiglottic valleculae.
3. Smooth tapering of the barium column at the junction of the pharynx and esophagus.
4. Normal first or oral phase (passage of bolus into oropharynx), but absence of the active second phase (passage through pharynx into esophagus).
5. Failure of the larynx to close during deglutition with consequent aspiration of the barium into the trachea.
6. Absent feeble, or irregular movements of the hyoid bone during swallowing as determined by myographic study.

Other points favoring but not diagnostic of paralysis are:

1. Sudden onset of severe dysphagia, almost complete inability to swallow solids after an illness of short duration.

2. Regurgitation of food through the nose.
3. Complete absence of pain in spite of severe dysphagia.
4. Roentgenographically normal trachea and laryngopharyngeal space.

The author reports 2 cases that were referred to the x ray department with a clinical diagnosis of possible malignancy. The characteristic findings were observed in both cases. The final diagnosis was pharyngeal palsy due to bulbar paralysis.

R. B. LARA, M.D.

Rakofsky M., and Knickerbocker T. W.: Recent Genitological Manifestations of Primary Pulmonary Coccidioidomycosis. *Am. J. Med.* 1945, 50, 41.

The organism, *coccidioides immitis*, is endemic primarily in California and to a lesser extent in Arizona and Texas. This organism exists in two forms: a vegetative phase which exists in nature, and a parasitic spore which is found in the tissue of the host. It is not transmissible from man to man.

Primary coccidioides manifests itself in two stages. In the first stage the clinical picture is one of an upper respiratory infection with cough, fever, chest pain, erythema nodosum, and positive pulmonary roentgenograms. This clinical picture endures from 3 to 6 weeks, and usually the patient recovers.

In a few cases, over a period of years, the disease may become secondary with skin and bone lesions, or, within a matter of weeks, may assume a fulminating character ending fatally with a military or meningeal picture. The mortality of chronic coccidioides is 50 per cent.

Fortunately most cases of coccidioides remain in the first stage. The dark skinned race, entering as endemic area for the first time, is found to be most susceptible. Many of these cases are found to progress into the stage II type. The only remnant of the stage I group is a positive skin test which may persist as long as 20 years.

The pulmonary roentgen picture consists of nodules, peribronchial infiltration, confluent consolidation, pleural effusion, hilar adenopathy and cavitation.

1. Nodules occur either unilaterally or bilaterally anywhere in the lung. Their size varies from 5 mm. to 3 cm. The nodules either resolve in a few weeks or become fibrosed.

2. Interstitial or peribronchial inflammation occurs in hilar or basilar regions.

3. Confluent consolidation occurs anywhere in the lungs and resolves somewhat slowly. Pleural effusion may also be present.

4. Hilar adenopathy is associated with peribronchial infiltration.

5. Cavities are thin walled in the periphery of the lung fields with parenchymal involvement and resolve within 8 weeks.

The pulmonary roentgen picture is one of a combination of the described findings. They may be of proportion to the clinical picture.

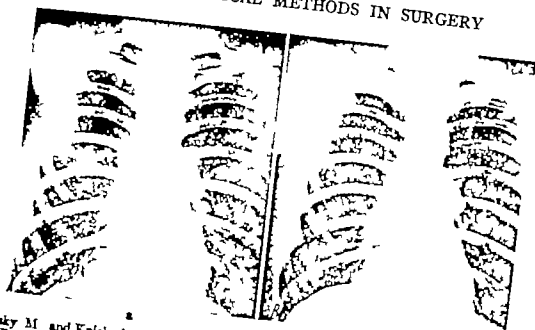


Fig. 1 (Rakofsky M and Knickerbocker T W) The nodular lesion. History and clinical features. White, male aged 30 had never previously been in California or Arizona. Admitted on October 26, 1943 with chest pain, cough, malaise and mild fever. Coccidioides (1:100) skin test was positive. Eosinophiles 13 per cent, sedimentation rate 26 mm. Complement fixation test strongly positive. Roentgen findings a, November 1, 1943. Roentgenogram shows a 2 cm. single, homogeneous nodule in the

right midpulmonary field edges are well defined. There is associated peribronchial thickening and haziness at the right cardiophrenic angle. Note the smaller sharply circumscribed nodule of slight density at the periphery of the left midpulmonary field. b, December 27, 1943 shows beginning and partial clearing of the previously described nodule in the right midpulmonary field. The right cardiophrenic angle has cleared. The smaller nodule on the left is still present. Disposition: return to duty

Diagnosis is made on the basis of a history of exposure erythema nodosum, eosinophilia positive skin test, positive complement fixation precipita-tion tests positive chest roentgenograms and, in the final analysis isolation of the spores from the sputum by culture

A series of 60 cases of coccidioides is reported. Twenty five were of the dark skinned race with low resistance. Autopsy findings in 2 of the cases are described. One was a rather unusual case of active tuberculosis and coccidioidomycosis

MAURICE D SACHS M D

Lenz M.: Tumor Dosage and Results in Roentgen Therapy of Cancer of the Breast *Am J Roentg* 1946 56 67

Two hundred and six cases of breast carcinoma in which roentgen therapy was the method of treatment were used as a basis for the present study by the author

From 1923 to 1929 78 patients received postoperative irradiation the tumor dose ranged from 300 to 1,300 roentgens. Medium low voltage (130 k.v.) was used to the chest wall and axilla, the supraclavicular regions and the opposite axilla. The dose was repeated within 2 to 3 months. This treatment was found to be inadequate. Eight patients showed skin metastases. The survival rate was not dependent on treatment but on the preoperative extent of the lesion

Results with increased voltage have not been encouraging. Therefore roentgen therapy following

mastectomy is given only when residual or recurrent tumor is still present

From 1933 to 1937 38 patients received irradiation preoperatively and 44 received irradiation alone. The tumor dose was 4,500 roentgens. High voltage (200 k.v.) and tangential fields were used. All of the patients (89) had involvement of the axilla. Skeletal or lung metastases were present in 18 per cent of the 44 patients treated with irradiation alone. Only 1 patient survived 5 years. The resolution of the primary lesion following irradiation did not influence the course of the disease. In spite of the high tumor doses (4,500 r) given tumor cells were still demonstrable in the studied specimens

From 1938 to 1941 46 patients who had not been operated upon were given a tumor dose of 6,000 roentgens, or more. Sequelae due to the high doses were minor and were not permanent. In 23 of 31 patients the breast tumor and axillary tumor disappeared 10 of these patients were living and well 5 years later

Radical mastectomy wherever possible is still advocated as the treatment of choice. Criteria as to operability are those postulated by Haagensen and Stout of the Presbyterian Hospital, New York. If the lesion is inoperable it is advisable to give a tumor dose of above 6,000 roentgens to the breast and axilla. Breast cancers with axillary involvement should be classified as operable or inoperable rather than temporizing with preoperative and postoperative plans of roentgen irradiation

MAURICE D SACHS, M D

Farfán, P. L.: Retrograde Abdominal Aortography. A Contribution to the Study of the Abdominal Aorta and Ilac Arteries. *Radiology* 1946, 47 344.

The technique of retrograde abdominal aortography is simple. The femoral artery is exposed by blunt dissection under local anesthesia at the level of Scarpa's triangle a trocar 1.5 mm. in diameter is inserted and 50 c.c. of a 70 per cent diodrast solution are injected in 1½ to 3 seconds. A tourniquet at the root of each lower extremity prevents the passage of the contrast medium downward. The maintenance of a uniform pressure during the injection is important. The author devised an apparatus permitting the injection of 25 c.c. of the opaque medium per second under a constant pressure of 15 pounds. The first roentgenogram is made when 40 c.c. of the solution have been injected and the second one immediately afterward. The trocar is then withdrawn, a suture is placed in the adventitia of the artery and the wound is closed. The administration of phenobarbital the night before and of morphine hypodermically one hour prior to the injection helps in obtaining better relaxation.

The method is of value in syphilitic arteritis showing dilatation or obliteration of the arteries and the different types of aneurysm, in arteritis obliterans, in degenerative lesions which occur more commonly at the end of the abdominal aorta, and in the iliac arteries, leading to dilatation elongation or tortuosity of the vessels and often associated with calcium deposition. The author was even able to observe valvular kinks that retarded the circulation considerably. Surgical removal of these kinks improved the circulation.

The article is illustrated with some typical roentgenograms. T. Leucutia, M.D.

Meehan, I.: A Roentgenographic Study of Spondylolisthesis, with Special Reference to Stability Determination. *Radiology* 1946, 47 249.

The author describes an improved method for the detection of spondylolisthesis and the determination of the slipped vertebral body.

Since a defect of the pars interarticularis is found in most cases of spondylolisthesis an accurate roentgen visualization of this part of the spine is important. The term "pars interarticularis" refers to the isthmus of bone lying between the superior and inferior articular processes. Actually this segment is a portion of the lamina and separates the vertebral body pedicles, superior articular processes, and transverse processes from the inferior articular processes and the spinous process. It is best visualized in the oblique view. In case of bilateral defect the detection is usually made in straight lateral views, the vertebral body becoming susceptible to anterior displacement.

The fact that the posterior margin of the slipped vertebral body bears a definite relationship to the posterior margins of adjoining vertebral bodies can be used to measure spondylolisthesis quite accu-

rately. Routine roentgenograms of the lumbosacral spine are made in recumbent anteroposterior, lateral, and both oblique views. When defects of the pars interarticularis are found, additional roentgenograms are made in erect positions, with the patient standing straight, flexing the spine, and extending the spine. The lateral projections are used to measure the degree of spondylolisthesis. Four landmarks are chosen: A is the posterior inferior lip of the vertebral body above the one in question; B is the posterior superior lip of the vertebral body below the one in question; C is the posterior lip of the superior surface of the involved vertebral body; and D is the posterior inferior lip of the involved vertebral body. Lines are drawn through AB and CD and extended until they intersect if possible. Occasionally they will appear parallel or superimposed. The intersection in the normal almost invariably occurs at the level of, or below the vertebral body in question. In spondylolisthesis the lines intersect above the vertebral body in question. The author designated from 10 to 30 degrees as indicative of slight slipping, from 30 to 50 degrees of moderate slipping and of more than 50 degrees of severe slipping. If the lines are parallel, they are 3 mm. or less apart in the normal up to 1 cm. apart in slight slipping, from 1 to 2 cm. apart in moderate slipping, and more than 2 cm. apart in severe slipping. The instability of the slipped vertebra is detected by studying the degree of anterior displacement in the various positions of the spine. A variation greater than 2 millimeters or 2 degrees is considered relatively significant of instability.

The number of cases examined by the author from April 19, 1942 to March 19, 1944 are divided into two series. The first includes 1,131 cases seen during a period of 22 months while the hospital was in a rear echelon and the second 530 cases seen during a period of 6 months while the hospital was in a forward echelon. For various reasons, which the author expounds in detail, this latter series is the more representative. Whereas in the first series defects of the pars interarticularis were noted in 5 per cent of the total, in the second series they were noted in 11.7 per cent. Correspondingly, the cases of spondylolisthesis, or borderline spondylolisthesis, increased from 3.6 per cent to 6.5 per cent. Stability studies were made in 44 per cent of the cases of spondylolisthesis of the first series and in 82 per cent of the second which gave an incidence of instability of 39 per cent and 50 per cent, respectively.

The most frequent sites of involvement were the fifth lumbar vertebra, in 73.7 per cent of the cases, and the fourth lumbar vertebra in 14.7 per cent.

Bilateral defects of the pars interarticularis occurred more than twice as frequently (69 per cent) as unilateral defects. Approximately three-fifths of patients with bilateral defects had definite spondylolisthesis, one-fifth had borderline spondylolisthesis, and the remaining one-fifth had no spondylolisthesis. One half of the slipped vertebral bodies were shown to be unstable under conditions of stress, but even if

no instability could be demonstrated the presence of localized lipping sclerosis and apophyseal joint changes indicated strain upon the adjoining supporting structures.

The article is abundantly illustrated with diagrams and typical roentgenograms.

T LEUCUTIA M.D

Scott, L. D. and Tarleton G. J.: Pyridoxine Hydrochloride (Vitamin B<sub>6</sub>) in the Control of Radiation Sickness: Preliminary Report. *Radiology* 1946 47 386

In 1941 the authors installed a shock-proof 220 kv. p. roentgen therapy unit, yielding an output of 50 r/min with 200 kv. 0.5 mm. of copper plus 1 mm. of aluminum filtration at a distance of 50 centimeters. This output permitted the irradiation of a patient with larger daily doses than was the custom formerly a fact which on the other hand led to more pronounced radiation sickness.

Since that time to combat the radiation sickness, the authors administered 50 mgm. of nicotinic acid i. d. routinely to all patients receiving 200 kilorads of roentgen therapy.

In April, 1945 another change was made. In order to shorten the rather long duration of the series of irradiation the daily dose was raised from 300 to 600 roentgens. In this manner the treatment time for various types of malignant growths was reduced by approximately one half. To overcome the radiation sickness incidental to the additional increase of the dose the authors started to give 25 mgm. of pyridoxine hydrochloride intravenously after each roentgen treatment, supplementary to the nicotinic acid.

The method was used in 35 cases. The first 20 of these are presented in tabular arrangement. The development of radiation sickness was prevented in nearly all of the patients.

T LEUCUTIA, M.D

Glenn J. C. Jr., and Reeves, R. J. Treatment of Radiation Sickness with Trasentine and Trasentine-Phenobarbital. Preliminary Report. *Radiology* 1946, 47 393

A number of articles dealing with the value of vitamins particularly thiamine chloride pyridoxine and nicotinic acid in the treatment of radiation sickness, have appeared in the literature. Jenkinson and Brown called attention to the possible value of amphetamine and d-desoxyephedrine.

Wallace, after roentgen studies on a series of patients receiving roentgen therapy over the pelvis, reported changes strongly suggesting that the immediate cause of the nausea, diarrhea and abdominal pain may be intestinal and sphincter spasm. With this possibility in mind the authors tried anti-spasmodic therapy for the purpose of relieving the symptoms.

The present preliminary report refers to 65 unselected patients so treated. They are arranged in an all-inclusive table. The antispasmodic drug was trasentine (75 mgm. per tablet) which was given alone in the first 26 patients the total dosage ranging from 225 to 1000 mgm. per day (1 to 3 tablets 3 to 4 times a day). A second group of 32 patients received trasentine-phenobarbital tablets (20 mgm. of trasentine plus 20 mgm. of phenobarbital) at the rate of from 1 to 2 tablets 3 times a day. Finally a third group of 7 patients including mostly patients with nausea and diarrhea were treated with a combination of trasentine-phenobarbital (1 tablet 3 times a day) and trasentine (1 to 3 tablets 3 to 4 times a day).

The conclusion is reached that trasentine and trasentine phenobarbital are valuable adjuncts in the treatment of radiation sickness. No toxic effect was noticed but trasentine had a tendency to depress the appetite to some degree.

T LEUCUTIA M.D

thems the fact that hyperplasia induced by the sex hormones is a functioning hyperplasia, while that induced in the thyroid by thioracil is functionless, may possibly be a determining factor in the relationship between simple and neoplastic growth of tissue

JOSEPH K. NARAY, M.D.

Hughes, R. R.: Post Penicillin Jaundice. *Brit. M. J.* 1946 2 685

While working in a military general hospital in India, the author noted that a large number of patients with infective hepatitis admitted to the medical ward gave a history of having received a course of penicillin injections within the previous 7 months. Post-penicillin jaundice was likened to post-arsphenamine jaundice.

It was concluded that the condition was transmitted from patient to patient by means of contaminated syringes. Experiments were carried out, and the mechanism by which the contamination occurred was discussed.

C. FRED GORDON, M.D.

Hueper W. C. The Significance of Industrial Cancer in the Problem of Cancer. *Occup. M.* 1946 2 90

Occupational cancer is of great importance not only as a public health problem, but also because it may be considered as a human equivalent of experimental cancer in animals.

Exogenous carcinogenic factors may elicit malignant growths through one of the following three mechanisms

1. The first group of occupational carcinogens consists of agents which apparently cause a cancerous cellular transformation by acting directly on the cellular substrate. Substances contained in tar pitch asphalt, soot mineral oil and those represented by certain aromatic amines (benzidine, aniline) may serve as examples.

2. The second group is formed by agents which exert carcinogenic properties indirectly by changing some normal chemical constituent of the cells or tissue fluid in such a way that it becomes endowed with carcinogenic properties. This mechanism may be active in the development of cancers caused by radiating energy nickel asbestos, and arsenic.

3. In a third group those carcinogens are found which have neither primary nor secondary blastogenic properties, but which elicit functional disturbances in certain organs such as the liver pituitary adrenal glands and the gonads. The functional abnormalities may in turn lead to the development of circumstances possessing carcinogenic qualities.

The age factor represented by the relative age or the average life span has no significant part in determining the degree of susceptibility to carcinogenic agents.

There is no concrete evidence that a genetic predisposition plays an important role in the incidence of occupational cancer

A multicentric development of cancer is frequent with occupational carcinogenesis. Thus

non has been observed in from 15 to 30 per cent of industrial carcinoma. The excessive frequency of primary multiplicity of occupationally induced carcinomas is evidently an expression of a more intense carcinogenic stimulation. JOSEPH K. NARAY

## DUCTLESS GLANDS

Raull, E. P.: Factors Affecting Survival in the Adrenalectomized Rat. *Endocrinology* 1946 39 1

In the course of studies on the effects of endocrine metabolism in adrenalectomized black rats maintained on diets deficient in the filtrate fraction of vitamin B it was observed that survival after adrenalectomy was greatly prolonged when the diet was supplemented with a rice bran extract. The present report is concerned with the effects of adrenocortical extract, desoxycholic acid, acetate and calcium pantothenate without 1 per cent sodium chloride solution on the survival of adrenalectomized black rats.

Experiments were made in both black and white rats. In the first series, the rats were fed diets deficient in pantothenic acid and adrenalectomized. Following adrenalectomy, a group of animals was given a 1 per cent sodium chloride solution and continued on the deficient diet. The diet and injections of the adrenocortical extract or desoxycholic acid acetate or calcium pantothenate with calcium pantothenate. The group of animals was treated in a similar manner but no sodium chloride was given.

When the sodium chloride was omitted, the survival was sharply curtailed. When 1 per cent sodium chloride was given the addition of calcium pantothenate to the diet resulted in a remarkably long period of survival, 50 per cent of the rats surviving for 150 days. The survival with calcium pantothenate and sodium chloride was less than that obtained when the rats received both calcium pantothenate and sodium chloride. The importance of sodium chloride to the survival of the pantothenic acid treated adrenalectomized rats is shown by the fact that withdrawal of sodium chloride resulted in death.

HARRY W. FINE

## EXPERIMENTAL SURGERY

McCall, J. W. and Moore, L. L.: Reoperation for Paralyzed Vocal Cord. *Laryngoscope* 1946 57

This article is a preliminary report on the results in the experimental animal, of nerve resection for paralyzed vocal cord, and subsequent reoperation for the recurrent laryngeal nerve.

Paralysis of one vocal cord only is a rare condition. It is characterized by a hoarse voice, weakness, voice change, a feeling of fullness in the throat, and a feeling of pressure on the voice or recurrent laryngeal nerve. It is the result of a variety of causes, such as trauma, infection, or a tumor of the vocal cord.





## MISCELLANEOUS

### CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

Barcroft H., and Edholm, O. G.: Sympathetic Control of the Blood Vessels of Human Skeletal Muscle. *Lancet* Lond. 1946 513

The question whether or not the sympathetic nervous system supplies the blood vessels in muscle and maintains vasoconstrictor tone during muscular inactivity is of fundamental importance in peripheral vascular disease. Animal investigations on the whole seem to point in that direction. Sympathetic nerve endings have been identified histologically in the walls of blood vessels in cat muscle. Increase in the blood flow through muscle in the dog and cat has been observed after section of the sympathetic nerve supply. Nevertheless, general opinion is against the presence of sympathetic tone in the vessels in human muscle. Recent work in Belfast however has convinced the author that such tone exists, and a summary of the evidence is submitted.

The technique of demonstrating sympathetic vasoconstrictor tone in the blood vessels of human skeletal muscles is described.

The blood flow in muscles is more than doubled by the release of sympathetic tone. Heating the body relaxes the vasoconstrictor tone in the blood vessels supplying muscles. Vasoconstrictor tone gradually returns to the blood vessels of sympathetomized subjects. Vasodilatation takes place in the muscles of the forearm after fainting, except in sympathetomized subjects. Therefore this vasodilatation is due to nervous control. It is shown that vasodilatation in the forearm muscles is not due merely to removal of vasoconstrictor tone but that it is at any rate in part, mediated by vasodilator nerves.

JOHN E. KIRKPATRICK, M.D.

Liebow, A. A., MacLean P. D., Burnstead, J. H., and Welt L. G.: Tropical Ulcers and Cutaneous Diphtheria. *Arch. Int. M.* 1946, 78 855

Ulcerative lesions of the skin are frequent in the tropics and virulent *Corynebacterium diphtheriae* are often isolated from them. Diphtheritic ulcers have been described by many with a host of different terms: erythema, desert sore, Veldt sore, garigha, etc. They are significant because of their source of *Corynebacterium diphtheriae*, their relation to nasopharyngeal diphtheria, their sequelae of myocarditis and neuritis and because of the symptoms from the skin condition per se. Although only 1 per cent of cases of nasopharyngeal diphtheria in the temperate zones develops cutaneous diphtheria in the middle East and northern India, diphtheritic lesions of the skin occur frequently and out of proportion to the cases of nasopharyngeal diphtheria. In these regions it appears endemic. This is true of military personnel foreign to these regions as well as of the

natives. Such lesions were commonly observed during both the first and the second world wars.

An extensive study was made of diphtheritic ulcers found in 174 patients involving men in Salpan, the Solomon Islands, and Leyte, in addition. Schick tests were done on many natives in these areas. A comprehensive record of each case was taken. Intense parasitological and bacteriological studies were made. Cultures of the ulcer, nose, and throat were taken. Schick tests and examinations to disclose neurological lesions, were carried out.

Tryptose agar without dextrose, and containing 5 per cent of human blood, was employed as a culture medium. Direct examination of the ulcer made was done and an attempt made to predict the subsequent bacteriological investigation. In one per cent the presence of *Corynebacterium diphtheriae* was correctly diagnosed in 83 1/2 per cent of the cases. Certain aspects of culturing were emphasized.

1. *Corynebacterium diphtheriae* grows better in a slightly alkaline medium (about pH 7.6).

2. *Corynebacterium diphtheriae* closely resembles certain other hemolytic *corynebacterium* common at these locations, which were probably *C. eryth* and *C. pyogenes*, but which the authors have designated as *Corynebacterium hemolyticum*. Although they appear alike on Loeffler's medium, on blood agar plates the colonies have large zones of beta hemolysis surrounding them.

3. By testing for toxigenicity by the intracutaneous inoculation of guinea pigs and rabbits, 44 per cent of the hemolytic *corynebacterium* proved toxigenic. The atoxic forms were relatively more common in carriers. All strains of the nonhemolytic *corynebacterium* proved nontoxic.

*Corynebacterium diphtheriae* was found concomitantly with diphtheroids, beta hemolytic streptococci, *Corynebacterium hemolyticum*, *Staphylococcus albus* and aureus. The older ulcers yielded relatively fewer toxic bacilli than the more recently acquired ones.

Regardless of the wide geographic distribution of these ulcers, a remarkably similar appearance was present among them. Usually a history of trauma or insect bite could be elicited and in the majority of instances the troops were active rather than resting. The initial lesion, for example a scratch, began to enlarge instead of healing, later it deepened and the edges first red and edematous, became rolled. Granulations failed to rise, but the bottom receded continuously, causing the ulcer to be rounded or scarpigulous, indolent, and treatment-resistant. Usually about the sharply defined sore there was a zone of induration, erythema, and violaceous pigmentation. In atypical cases the condition developed in pre-existing epidermophytosis. The lesions were multiple in 75 per cent of the cases and appeared on the extremities in 99 per cent.

*Corynebacterium diphtheriae* was occasionally isolated in shallow ulcers. Impetiginous dermatitis, chronic paronychia, desquamative and ulcerative dermatitis, and unexplained sinus tracts of the feet.

In a large number of instances it was possible to predict from the clinical appearance of the lesion whether or not *Corynebacterium diphtheriae* would be found, although it is emphasized that the lesion is not pathognomonic.

Complications noted as occurring in patients with diphtheritic ulcers were:

1. Unexplained tachycardia without electrocardiographic changes or fever. This disappeared when the ulcers healed.

2. In 2 patients with a positive Schick reaction a striking erythema and edema occurred about the ulcers following antitoxin administration. This is comparable to the Schick reaction noted in pneumococcal infections.

3. Numerous troops were tested for the Schick reaction in order to determine the relation between the test and the incidence of ulcer. The percentage of patients with diphtheritic ulcers reacting positively to the test was approximately twice that of persons who reacted positively in general.

In 174 patients with cutaneous diphtheria, nose and throat cultures revealed *Corynebacterium diphtheriae* in 19 instances. Of these, 10 had clinical pharyngeal diphtheria and 2 had fibrinous rhinitis. There were 6 pharyngeal carriers and 1 nasal carrier. In these patients ulcers generally antedated the upper respiratory infection.

Many cases of peripheral neuritis and pharyngeal and ocular palsy were seen in the Pacific area hospitals, a few of which were associated with nasopharyngeal diphtheria. The authors state that neuritis can also be secondary to cutaneous diphtheria. In instances of cutaneous diphtheria the cranial nerves were rarely involved. The symptoms of diphtheritic neuritis secondary to cutaneous lesions were those of paresthesias followed by weakness of the extremities. The deep reflexes were decreased or absent. Proprioception was often disturbed. The spinal fluid protein was elevated and although pleocytosis was not observed, changes in the Lange curves were frequent.

Hospitalization, isolation, bed rest and moist dressings were the most commonly used procedures for treatment. Patients treated in the Out Patient Department with sulfonamide pastes and dry dressings continued to have their ulcers for many weeks and served as a prolific source of *Corynebacterium diphtheriae*. The final treatment of choice consisted of bed rest and the application of an isotonic solution of penicillin to the ulcers.

Ulcers containing atoxic organisms healed more rapidly than those with toxigenic bacilli. Serum treatment did not seem beneficial. The authors state that antitoxin should be used as it acts as a prophylactic in preventing the serious complication of nasopharyngeal diphtheria. In cases in which antitoxin was given late it did not prevent neuritis.

Locally applied penicillin caused the gram negative bacillary flora to replace the gram positive organisms. *Corynebacterium diphtheriae* although sensitive to sulfonamides in vitro was not affected by these drugs when they were placed in the ulcers. Other special forms of treatment included the application of casts to secure immobilization, excision of the ulcer, and skin grafts, although these usually failed to take.

Considerable evidence has accumulated that cutaneous diphtheria is an important source of the spread of bacilli to the nose, throat and skin. In 7 persons diphtheritic infections developed before ulcers were recognized as being due to *Corynebacterium diphtheriae*. These cross infections included diphtheritic paronychia, abscesses, pharyngitis and nasopharyngitis.

The incidence of diphtheritic ulcers exceeds that of nasopharyngeal diphtheria and carriers. Among patients with diphtheritic ulcers the incidence of carriers was much higher than in the general population. The authors suggest that troops returning from areas endemic for cutaneous diphtheria may serve as carriers for spread to the civilian population. The existence of large reservoirs of diphtheria in the tropical natives was demonstrated. The high incidence of cutaneous diphtheria accounts for the gradual immunization of the natives and the early age at which this process occurs. The frequent occurrence of diphtheria in the tropics is due to (1) the warm moist condition of the skin, (2) the intimacy among the population and (3) the unhygienic state due to infrequent washing.

C. FREDERICK KITTLE, M.D.

Cantarow A., Paschke, K. E., Stasney J., and Rothenberg M. S.: The Influence of Sex Hormones upon the Hepatic Lesions Produced by 2-Acetaminofluorene. *Cancer Res.* 1946 6: 610.

The observation of the susceptibility of the stimulated goitrous thyroid to the tumor-producing action of the carcinogen 2-acetaminofluorene suggested an investigation of the influence in this connection of other agents that stimulate the growth of specific tissues. For this purpose androgenic and estrogenic hormones were chosen.

Excessive quantities of an exogenous or endogenous estrogen and androgen were found to accelerate and intensify the development of cystic and neoplastic hepatic lesions induced in Sherman rats by 2-acetaminofluorene. In the authors' opinion this phenomenon may be related to the role of the liver in the intermediary metabolism and excretion of the sex steroids. It is interesting to note that thiouracil appeared to exert a strikingly protective action on the liver as far as the development of both cystic and neoplastic lesions is concerned.

In rats receiving thiouracil simultaneously with the carcinogen, no tumors occurred in the hyperplastic target organs of the sex hormones, in sharp contrast to the high incidence of tumors of the thyroid gland. The authors advance the following hypo-

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Complications noted as occurring in patients with diphtheritic ulcers were

1. Unexplained tachycardia without electrocardiographic changes or fever. This disappeared when the ulcers healed.
2. In 2 patients with a positive Schick reaction a striking erythema and edema occurred about the ulcers following antitoxin administration. This is comparable to the Francis reaction noted in pneumococcal infections.

Numerous troops were tested for the Schick reaction in order to determine the relation between the test and the incidence of ulcer. The percentage of patients with diphtheritic ulcers reacting positively to the test was approximately twice that of persons who reacted positively in general.

In 174 patients with cutaneous diphtheria nose and throat cultures revealed *Corynebacterium diphtheriae* in 10 instances. Of these, 10 had clinical laryngeal diphtheria and 2 had fibrinous rhinitis. There were 6 pharyngeal carriers and 1 nasal carrier; these patients ulcers generally antedated the respiratory infection.

Many cases of peripheral neuritis and pharyngeal and ocular palsy were seen in the Pacific area hospital, a few of which were associated with nasopharyngeal diphtheria. The authors state that neuritis can also be secondary to cutaneous diphtheria. In instances of cutaneous diphtheria, the cranial nerves were rarely involved. The symptoms of diphtheritic neuritis secondary to cutaneous lesions were those of paresthesias followed by weakness of the extremities. The deep reflexes were decreased or absent. Proprioception was often disturbed. The spinal fluid protein was elevated and although pleocytosis was not observed changes in the Lange curves were frequent.

Hospitalization, isolation, bed rest and moist dressings were the most commonly used procedures for treatment. Patients treated in the Out Patient Department with sulfonamide pastes and dry dressings continued to have their ulcers for many weeks and served as a prolific source of *Corynebacterium diphtheriae*. The final treatment of choice consisted of bed rest and the application of a solution of penicillin to the ulcers.

Ulcers containing atoxic organisms healed more rapidly than those with toxigenic bacilli. Serum treatment did not seem beneficial. The authors state that antitoxin should be used as it acts as a prophylactic in preventing the serious complication of nasopharyngeal diphtheria. In cases in which antitoxin was given late it did not prevent neuritis.

Locally applied penicillin caused the gram negative bacillary flora to replace the gram positive organisms. *Corynebacterium diphtheriae* although sensitive to sulfonamides in vitro was not affected by these drugs when they were placed in the ulcers. Other special forms of treatment included the application of casts to secure immobilization, excision of the ulcer and skin grafts, although these usually failed to take.

Considerable evidence has accumulated that cutaneous diphtheria is an important source of the spread of bacilli to the nose, throat, and skin. In 7 persons diphtheritic infections developed before ulcers were recognized as being due to *Corynebacterium diphtheriae*. These cross infections included diphtheritic paronychia, abscesses, pharyngitis and nasopharyngitis.

The incidence of diphtheritic ulcers exceeds that of nasopharyngeal diphtheria and carriers. Among patients with diphtheritic ulcers the incidence of carriers was much higher than in the general population. The authors suggest that troops returning from areas endemic for cutaneous diphtheria may serve as carriers for spread to the civilian population. The existence of large reservoirs of diphtheria in the tropical natives was demonstrated. The high incidence of cutaneous diphtheria accounts for the gradual immunization of the natives and the early age at which this process occurs. The frequent occurrence of diphtheria in the tropics is due to (1) the warm moist condition of the skin (2) the immaturity among the population and (3) the unhygienic state due to infrequent washing.

C. FREDERICK KITZLE, M.D.

Cantarrow A. Paschke, K. E. Stansley J., and Rothenberg, M. S.: The Influence of Sex Hormones upon the Hepatic Lesions Produced by 2-Acetaminofluorene. *Cancer Res.*, 1946, 6: 610

The observation of the susceptibility of the stimulated goitrous thyroid to the tumor producing action of the carcinogen 2-acetaminofluorene suggested an investigation of the influence in this connection of other agents that stimulate the growth of specific tissues. For this purpose androgenic and estrogenic hormones were chosen.

Excessive quantities of an exogenous or endogenous estrogen and androgen were found to accelerate and intensify the development of cystic and neoplastic hepatic lesions induced in Sherman rats by 2-acetaminofluorene. In the authors' opinion this phenomenon may be related to the role of the liver in the intermediary metabolism and excretion of the sex steroids. It is interesting to note that thionauril appeared to exert a strikingly protective action on the liver as far as the development of both cystic and neoplastic lesions is concerned.

In rats receiving thionauril simultaneously with the carcinogen no tumors occurred in the hyperplastic target organs of the sex hormones in sharp contrast to the high incidence of tumors of the thyroid gland. The authors advance the following hypo-

thesis the fact that hyperplasia induced by the sex hormones is a functioning hyperplasia, while that induced in the thyroid by thiouracil is functionless, may possibly be a determining factor in the relationship between simple and neoplastic growth of tissue.

JOSEPH K. NARAT, M.D.

Hughes, R. R.: Post Penicillin Jaundice. *Brit. M. J.* 946:2 685

While working in a military general hospital in India, the author noted that a large number of patients with infective hepatitis admitted to the medical ward gave a history of having received a course of penicillin injections within the previous 7 months. Post penicillin jaundice was likened to post-arphen amine jaundice.

It was concluded that the condition was transmitted from patient to patient by means of contaminated syringes. Experiments were carried out, and the mechanism by which the contamination occurred was discussed.

C. FRED GOSWAMY, M.D.

Hueper W. C.: The Significance of Industrial Cancer in the Problem of Cancer. *Occup. M.* 946:2 190.

Occupational cancer is of great importance not only as a public health problem, but also because it may be considered as a human equivalent of experimental cancer in animals.

Exogenous carcinogenic factors may elicit malignant growths through one of the following three mechanisms:

1. The first group of occupational carcinogens consists of agents which apparently cause a cancerous cellular transformation by acting directly on the cellular substrate. Substances contained in tar pitch, asphalt, soot, mineral oil and those represented by certain aromatic amines (benzidine, aniline) may serve as examples.

2. The second group is formed by agents which exert carcinogenic properties indirectly by changing some normal chemical constituent of the cells or tissue fluid in such a way that it becomes endowed with carcinogenic properties. This mechanism may be active in the development of cancers caused by radiating energy, nickel, asbestos, and arsenic.

3. In a third group these carcinogens are found which have neither primary nor secondary blastogenic properties, but which elicit functional disturbances in certain organs such as the liver, pituitary, adrenal glands and the gonads. The functional abnormalities may in turn lead to the development of circumstances possessing carcinogenic qualities.

The age factor represented by the relative age or the average life span has no significant part in determining the degree of susceptibility to carcinogenic agents.

There is no concrete evidence that a genetic predisposition plays an important role in the incidence of occupational cancer.

A multicentric development of cancer is frequent with occupational carcinogenesis. This phenome-

non has been observed in from 15 to 30 per cent industrial carcinomas. The excessive frequency of primary multiplicity of occupational cancers is evidently an expression of a relatively potent carcinogenic stimulation.

JOSEPH K. NARAT, M.D.

## DUCTLESS GLANDS

Raill, E. P.: Factors Affecting Survival in Adrenalectomized Rats. *Endocrinology* 1946, 39, 2.

In the course of studies on the alteration of water metabolism in adrenalectomized black rats maintained on diets deficient in the filtrate factors of vitamin B it was observed that survival after adrenalectomy was greatly prolonged when the diets were supplemented with a rice bran extract. The author's present report is concerned with the comparative effects of adrenocortical extract, desoxycorticosterone acetate, and calcium pantothenate, with or without 1 per cent sodium chloride solution, on the survival of adrenalectomized black rats.

Experiments were made in which black rats were fed diets deficient in pantothenic acid and adrenalectomized. Following adrenalectomy a group of animals was given a 1 per cent sodium chloride solution and continued on the deficient diet alone, while the diet and injections of the adrenocortical hormone or desoxycorticosterone acetate, or on the diet supplemented with calcium pantothenate. The second group of animals was treated in a similar manner, but no sodium chloride was given.

When the sodium chloride was omitted, regardless of hormone administration or dietary supplement, the survival was sharply curtailed. When 1 per cent sodium chloride was given the addition of calcium pantothenate to the diet resulted in a remarkably long period of survival, 50 per cent of the animals surviving for 150 days. The survival with calcium pantothenate and sodium chloride was longer than that obtained when the rats received hormone therapy plus sodium chloride and the deficient diet. The importance of sodium chloride to the survival of the pantothenic acid treated adrenalectomized rat was shown by the fact that withdrawal of salt resulted in death.

HARRY W. FINE, M.D.

## EXPERIMENTAL SURGERY

McCall J. W., and Hoerr N. L.: Reinnervation of the Paralyzed Vocal Cord. *Laryngoscope*, 56, 9, 537

This article is a preliminary report on the results in the experimental animal of nerve suture after vocal cord paralysis, and submission of a method for regeneration of the recurrent laryngeal nerve by means of anastomosis to the vagus nerve.

Paralysis of one vocal cord only does not endanger life. Voice weakness, voice change and frequent clearing of the throat characterize this condition. Pressure on the vagus or recurrent laryngeal from a tumor in the neck or mediastinum is a frequent cause of vocal cord paralysis.

Paralysis of both vocal cords endangers life for if both cords are paralyzed they assume the median position and close the glottis. The paired posterior cricoarytenoids are the only abductor muscles of the arytnx, and when they are paralyzed the patient cannot open the glottis on inspiration. If the cricoarytenoids do not open the glottis on inspiration the flaccid cords are drawn closer together by the inspired current of air which causes the inspiratory crowing sound which is typical of bilateral abductor paralysis. Thus, it is an inspiratory dyspnea. The patient has no difficulty with expiration as the force of the current of air is strong enough to separate the flaccid cords enough to expel the air.

Contrary to general belief there is little voice change in bilateral abductor paralysis. There is not as much voice alteration in bilateral vocal cord paralysis as in unilateral paralysis, because in bilateral paralysis the vocal cords assume the median position.

Thyroid disease and the sequelae of thyroidectomy are the most frequent causes of bilateral paralysis. Neurological conditions such as cerebral lues are the next most frequent cause. During a thyroidectomy the recurrent laryngeal nerves may be severed or they may be so constricted by scar tissue post-operatively as to cease to function.

The operative procedures for the relief of bilateral abductor paralysis necessitate a certain amount of mutilation of the larynx. If the breathing is improved the voice is impaired. Hence, if short-circuiting of an injured recurrent laryngeal nerve by anastomosing the vagus to the recurrent peripheral to the lesion is accomplished it would render a mutilation of the larynx unnecessary and restore the normal function of the vocal cord.

The recurrent laryngeal nerve is usually injured in the region of the inferior thyroid artery so an approach to the recurrent nerve should be above the point where it had been severed or compressed. The recurrent laryngeal nerve leaves the groove behind the trachea and esophagus and turns laterally in the neck to enter the larynx just below the inferior cornu of the thyroid cartilage. This is above the point where it is usually injured. With a collar (horizontal) incision about 1 cm. below the cricoid cartilage beginning lateral to the sternomastoid on the side to be done and extending the incision across the midline of the neck the recurrent nerve is identified and isolated as far down in the neck as possible. The sternomastoid is retracted laterally, and the vagus is identified, dissected as far as possible in the neck, and is severed and drawn under the common carotid and strap muscles. The recurrent nerve is then severed. The vagus stump is usually long enough to suture to the recurrent stump without tension and the finest arterial silk suture that can be obtained is used.

The operation was performed on 4 dogs with good results in 3 the failure was believed to be due to the use of too large suture material and faulty technique. In the other 3 dogs the vocal cord movements

were effective and permitted a normal bark.

STEPHEN A. ZIEGLER M.D.

Kershner D. Hooton T. C., and Shearer E. M.  
Production of Experimental Portal Hypertension in the Dog; Anatomy of the Hepatic Veins in the Dog. *Arch. Surg.*, 1946, 53 425

Venous congestion of the liver by constriction of the posterior vena cava anterior to the kidneys has previously been produced. Death usually follows in from 5 to 10 hours after the complete ligation of the cava just above the renal veins. If the animal survives, such a procedure results in congestion not only of the hepatic and portal systems, but also of the systemic regions drained by the cava caudad to the obstruction particularly the kidney.

The present work was undertaken with the object of producing hepatic congestion and accompanying portal hypertension in the dog without the associated congestion of the systemic regions. A procedure has been devised for the production of venous congestion in the dog mechanically a 3 stage operation. This method has the advantage of avoiding congestion of the systemic regions caudad to the occlusion. It does so by taking into account the complex nature of the relationship between the hepatic veins and the posterior vena cava and by making use of the collateral circulation from the caudad regions of the body to the heart thus preventing caudal congestion.

That portal hypertension occurs in animals subjected to the operational procedure described has been noted in extensive physiological studies carried out on many of the dogs especially on the 4 animals that survived all the operations. The portal pressure is increased after the first operation. By partial occlusion of the postcaval vein caudad to the liver increased portal resistance is built up and the blood is forced into channels which are inconspicuous under normal conditions. These anastomoses connect the portal and systemic veins, and thereby promote a path for the return of blood from the splanchnic area to the right side of the heart. When the new collateral circulation has developed stage 2 can be performed, with minimum damage to the kidneys. When stage 3 of the operation has been performed the portal pressure is increased still further. With an original pressure of about 8 cm. of water there is no filtration from the capillaries into the abdominal viscera. With an increased pressure of 15 cm. or more of water there is increased filtration. The slow rise in pressure is evidenced by the latent period of the development of ascites, after the posterior vena cava has been partially occluded below the heart. Ascites in these animals was not observable until 7 to 20 days after operation. Increasing quantities of ascitic fluid were then formed as measured by changes in weight and by the large amounts of fluid that could be withdrawn.

Forty six dogs were used in the experiments. The operative procedure is described.

SAMUEL KAHN M.D.

Blaine G : The Uses of Plastics in Surgery *Lancet* Lond., 1946, 2 525

Plastics are chemical substances of high molecular weight. They are deformable and under suitable conditions retain an acquired shape. They are versatile since the end product can be given different physical properties: for instance some plastic might be made into a very hard object, a flexible mass, an adhesive film, or even into a yarn. They doubtless will make new surgical procedures possible. Generally they are grouped according to their physical and chemical behavior and divided into absorbable and nonabsorbable materials, according to living tissue reaction. A few interesting facts follow.

Of the plastics used in bone surgery, acrylics have been found most useful. Despite little reaction early they tend to become loose, often after 6 months, although no tendency to work themselves out has been observed.

Acrylics are currently used with the "dental impression" technique. This necessitates a 2 stage operation: the first stage being the taking of the impression and the second, the fitting of the prosthesis. The technical difficulties of this procedure led to the 1 stage operation which may be done in one of two ways. The first consists of the setting of activated acrylic dough by means of the ultraviolet ray. The second method makes use of the thermoplastic properties of the preformed unplasticized methyl methacrylate sheet. This sheet heated to 130 C and while soft is molded into the exact shape desired. This shape is retained on cooling. Either of these methods can be completed within 15 or 20 minutes.

Acrylic jointcaps have been used in the treatment of arthritis of the hip and in the reconstruction of the small joints of the hand. Acrylics have been used as spinal jackets and they have been used as Gunning splints in the treatment of fractures of the edentulous jaw.

Some of the disadvantages of acrylics are that the temperature at which the plastic is moldable is quite uncomfortable for the patient and the operator; they do not absorb moisture and therefore allow sweat to accumulate; pruritus to develop and a foul odor to manifest itself. Occasionally a severe dermatitis has resulted.

Acrylic contact lenses and artificial eyes do not break easily but are very easily scratched and are rather expensive. The polyvinyl plastic substances have been used as drainage tubes, for anesthetic airways and for soft tissue prostheses, but they cannot be worn indefinitely and are photosensitive. Plastic chemistry has introduced the very popular nylon suture material.

The greatest use of the absorbable plastics has been in the field of hemostasis. Such articles as oxidized cellulose, fibrin foam and gelatin sponges have proved of great value surgically.

The latest development in absorbable plastics is a derivative of seaweed known collectively as the alginate group. Certain alginate products are absorbable in tissue, sterilizable by heat, and compatible with penicillin. They have been found satisfactory as "puncture patches" over scleral defects. Alginate gels have been reported useful in the sealing of bronchi in the surgical treatment of pulmonary tuberculosis.

LOUIS T. BRANT, M.D.







*Iron Abell*

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# SURGERY

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### IDEALS IN SURGERY

W EDWARD GALLIE, M.D. F.A.C.S. Toronto Canada

**T**HIRTY THREE years ago a group of very wise men founded the American College of Surgeons. It was their hope that by gathering together in such a College all the surgeons and surgical specialists who were known to be morally and ethically fit and who had demonstrated by their training and by their standing in the professional world that they were properly qualified, the standard of surgical care might be raised to the level that a great people deserves. It was hoped too that with the lapse of a few years the diploma of Fellowship in the College would become so desirable and so necessary that all who proposed to practice surgery would seek it and that by and by it would constitute a clear index whereby those who were qualified to do surgery could be distinguished from those who were not.

Since the day of its foundation the College has grown and prospered and it has done those things to a superlative degree for which its founders so fondly hoped.

As time went on, however, and the future of the College had been firmly established there arose both within it and without, a demand for a definite raising of the requirements for admission to Fellowship, both in the form of longer and better practical training and of proficiency not only in surgery but also in all the basic sciences related to it. The College recognized this demand by two modifications,

in the past eight years of the length and character of the training required. Others felt, however that all those who proposed to specialize should be forced at an early stage in their graduate training to demonstrate to a court of examiners that they were proficient in the principles of surgery and in the allied basic medical sciences. From this arose the American Board of Surgery and the boards of the various surgical specialties, to which the College elects representatives.

The aim of both the College and the Boards has been the improving of the quality of American surgery and both have been successful. The College insisted on minimum periods of apprenticeship, evidence of high moral and ethical standing, and proof that the candidate had shown ability in practice. It concerned itself with the raising of the standards of the hospitals in which its Fellows would study and work, it busied itself with advanced surgical education, as indicated by this Congress today and it is now engaged in what may prove to be its greatest effort on behalf of American surgery the establishment of adequate graduate training. The Boards have outlined more sharply the periods of hospital training that are required and have made sure by requiring the candidates to pass searching examinations, that they have an adequate knowledge not only of the art of surgery but of the basic sciences, without which no man can be a true surgeon.

Speaking now not as President of the College, but as a Canadian and a most frequent

Address of the retiring President, before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.

onlooker I recognize the same high motive in both the College and the Boards, and I see great virtue in what each has done. It seems to me however that it is a pity to have two separate roads to public recognition and that a combination of the two with adoption of what is best in each would add great strength to the crusade for higher standards and would ultimately serve the people best.

But while the setting up of standards for qualification to practice surgery is a step in the right direction it will prove quite futile if conditions are such that these standards can not be achieved. What does it profit to tell a young graduate that he must serve a period of supervised training in an approved hospital, extending over a period of 3 or 4 years if a sufficient number of such hospitals do not exist? A survey of the hospitals of Canada has shown that only a few can at present be approved for graduate training and the same lamentable state of affairs obtains in the United States as well. Only in a few of the hospitals attached to medical schools is there any attempt at the planned training of internes and residents and in very few of these any provision for instruction in the basic sciences. How many hospitals do you know where a three year assistant residency is offered or where regular ward rounds or conferences are held or where supervised courses of study are provided in anatomy, applied physiology and applied pathological chemistry? And how many hospitals do you know where internes are encouraged to make use of the libraries or to take part in surgical research? The answer is, very few. There are of course outstanding examples to the contrary where the training of the interne is a major interest of the staff but when one adds up the number of these hospitals and makes up the grand total of the graduates receiving such training it will be found that the number is very small.

This is the reason for the present activity of the College in graduate training and for its effort to induce hospitals to make the necessary reorganization of their staffs and to adopt the resident system.

Unfortunately the reformation that the College has in mind is by no means so simple as

one might suppose. While most hospitals are interested to a certain extent, because certification by the College that a hospital is approved for graduate training would ensure a constant supply of good internes, yet many of these hospitals balk at the radical staff reorganization involved and hesitate to put the time and effort into a teaching program that could be considered adequate. It is clear that to make a success of its graduate training plan the College will require the good will of the public and the whole medical profession and the strong support of all the Fellows.

In support of the program of graduate training I propose to discuss with you briefly the plan which has been in operation in the University of Toronto for the past 18 years. I have no thought that it is adaptable to all situations nor have I any notion that it is as good as that in many of the great American universities, particularly those with sufficient endowments to enable them to grant numerous fellowships toward graduate training. It does illustrate, however, what can be done by long term planning and by persistent effort at reform.

Twenty five years ago the Toronto General Hospital (1,000 beds) staffed by the best surgeons in the land, all members of the Medical Faculty, had never trained a surgeon. Internes came for a year or two and departed, usually into general practice. Those who aspired to become surgeons sometimes went to New York to seek a further internship, or more often went to London or Edinburgh to study for the coveted diploma of Fellowship in one of the Royal Colleges. These Fellowships were won by passing the stiffest kind of examinations in anatomy, physiology, pathology and surgery and they were a guarantee that the successful candidate at at least one stage in his career had been familiar with what the textbooks said about them. They did not, however guarantee that the Fellow had any satisfactory apprenticeship or had become a master of his craft. It was only when he returned to his home and had received a junior hospital appointment that his practical training began.

Under this system a small group of surgeons was developed from which the medical school and the hospitals selected their staffs.

Then came the era of the building of small hospitals and with it the enormous increase in the number of surgical operations. These operations, of necessity were performed by practitioners of very little training who had learned what they knew from books from observational tours, and from the hard experience of trial and error. I know one such hospital serving a neighborhood of six or seven thousand people where the operating rooms are busy every day from nine to one and where not a single operator ever had more than a rotating internship. It was to try to force an elevation of the standards of education of these surgeons that the American College of Surgeons was founded.

Recognizing that the raising of standards was useless unless provision were made for training candidates to meet those standards the University of Toronto 18 years ago embarked on a program of graduate surgical education which gradually became standardized and which now constitutes the chief source of supply of trained surgeons for the Province of Ontario and indeed for the whole country.

The course is based on the theory that if the highest type of medical graduate is attracted to it, the best results will be obtained by combining the virtues of the apprenticeship system with those of the tutorial system. We had in mind that to ensure that the student profit most from his years of surgical residency he must be forced to undertake systematic study. To do this we arranged a definite curriculum composed both of practical training in hospital and of the instruction and study necessary to enable the candidate to face examination for the Master's degree M.S.

The following is the minimum course

1. A rotating internship in an approved hospital with at least 6 months of general medicine
2. At least 6 months in pathology
3. One year on a general surgical ward
4. Six months in each of three surgical specialties.

At the end of this minimum course many of the candidates qualify for the M.S. and go out to practice. Others who have shown outstanding qualities and are thought worthy of Uni-

versity staff appointments here or elsewhere are selected to remain as Fellows in general surgery or in one of the surgical specialties. During this period they rank as junior members of the staff and are permitted to assume independent responsibilities.

This plan of graduate training is quite elastic. As I have outlined it, it is a minimal course which may not be shortened but which may be lengthened as circumstances seem to require. Thus for the young man whose object it is to leave the university and go into practice at a distance, we suggest that he take in addition to his general surgical training as many of the surgical specialties as possible. Six months assistant residencies in orthopedic surgery gynecology, urology and the surgery of childhood are of great value to him. On the other hand for the man who has made up his mind to devote himself to one of the specialties such as orthopedic surgery we release him from service in gynecology and urology and limit him to 6 months in neurosurgery and an extra 18 months fellowship in orthopedics.

For men who because of their scholastic attainments general aptitude, and qualities of mind are considered as possible candidates at some future date for residencies and ultimately for staff appointments, a longer course is provided. These men after their rotating internship spend one or more years in the Departments of Anatomy, Physiology, Pathological Chemistry or Pathology before finally embarking on their surgical training. Then if as assistant residents they have continued to do well they are sent abroad for a year in some active surgical center before returning for their period of residency and ultimate appointment to a Fellowship in Surgery and a junior post on the staff. Often before finally settling down to their staff appointment these men spend a year in one of the more active producing surgical laboratories, a preparation for research work when they come home.

As already mentioned this planned apprenticeship is combined with a prescribed curriculum of studies leading to the degree of master of surgery. To win this degree the candidate must pass a stiff examination in surgical anatomy and in applied physiology and pathological chemistry. Later he faces

written and clinical examinations in pathology and surgery. Finally he must present a thesis on some clinical or experimental studies conducted by himself during his years of training.

To encourage these young men to take full advantage of their opportunities the University has given them the privileges of the anatomical laboratory and has provided first class tutors. Half of the assistant residents go to the laboratory on one night a week and the other half on another. In this way they review the whole human anatomy in two years.

Similarly the Department of Physiology conducts a series of lectures and discussion groups on applied physiology and the Department of Pathology does likewise.

And finally in order that these young men may be prepared for the examination for Fellowship in one of the Colleges or for certification as specialists by one of Canadian or American Boards, a series of evening discussion groups are directed by younger members of the staff on the principles of thoracic surgery, vascular surgery, neurosurgery, urology and orthopedic surgery, which many of the assistant residents may have missed in their selection of specialties.

Such a program may appear pretty extensive and to require a great deal of organization. This is not so however for the various departments involved have shown keen interest in graduate education and are glad to have students who are in earnest in their search for knowledge. The Department of Anatomy affords a good example. In these days when the time allotted to the teaching of anatomy to undergraduates is being so reduced that none but a superman could be expected to acquire any practical knowledge of it, the department welcomes the opportunity to teach students who have the time to devote to it and who really want to know what is under the skin.

The real difficulty in inaugurating such a planned course of graduate training will be met with in the Department of Surgery itself. The idea that as members of the surgical staffs of teaching hospitals our most important duty is to train surgeons has not been appreciated by many and is an idea which requires propaganda to inculcate. The old plan of using

internes and assistant residents as servants must be abandoned if we are to get good results. Indeed I am convinced that even in many old established teaching hospitals a rebirth in the ideals and aspirations of the staff will be required before real progress is made. I suggest to you that the ideal of the teaching surgeon should be not how skillful and impressive he can make himself by constant practice and repetition but how many young men he can train to be as good or better than himself. Only when such an ideal is established can we hope to supply the needs of our country.

The difficulty is that busy surgeons often find it irksome to stand on the opposite side of the table assisting a young tyro in his first difficult operations. Too often they impatiently do the operation themselves or turn the job over completely and take no further responsibility for it. This, in my opinion, is poor teaching and is clear evidence that it is time for a change in the personnel of the staff. There is, of course no excuse whatever for the old custom in which a star performer at some well known metropolitan hospital posts a list of operations for certain days in the week and does them all himself. Fortunately that sort of thing has almost passed away.

The truth is that in modern first class teaching hospitals the diagnosis should be made, the type of treatment selected and the operation performed by the resident staff under the constant guidance and supervision of their teachers. The attending staff should reserve for itself only special groups of cases on which they are conducting clinical research and those cases which obviously require more experience and skill than the assistant residents have so far acquired. These are the hospitals with huge lists of applicants and which attract the high honor graduates from near and far. Such hospitals are famous across the land for the quality of the men they produce.

But, as I have already pointed out, I feel that there should be added to this program a planned purposeful course of study leading to an examination for a higher degree and to Fellowship in our Colleges. Such a curriculum, spread over 3 or 4 years, is no hardship to the student and I feel sure that a review of the basic sciences carried out concurrently with

clinical work, and a definite program of clinical study and instruction results in a far sounder surgical education than the haphazard methods of other days.

But even with all the teaching hospitals of America supporting such a plan, not nearly enough opportunities for graduate training will be provided. To give such opportunities to the crowds of young men now demobilized from the Armed Forces and to meet the urgent needs of the country other means must be found to secure for these men the 3 or 4 years of clinical training necessary and to give them an opportunity to review the basic sciences. This is the basis of the present 'Graduate Training' campaign of the College. It is really an effort to persuade the larger non-teaching hospitals to adopt the 'resident system and certain minimum standards considered by the College and the Boards as essential to the proper training of a surgeon or surgical specialist.

If this campaign is successful it will undoubtedly overcome the present dearth of qualified surgeons. It can be successful however only if it has the overwhelming support of the Fellows and it is for this that I appeal tonight.

To make it work the hospital must have a sufficient number of public ward beds to provide an adequate service for a resident staff. The attending staff must be persuaded that in return for privileges of their appointment it is their duty to train the internes. The staff should be small and should contain one or more men who have been trained in the resident system in a teaching hospital. They must be prepared to give much time to a teaching program, much as is done in teaching hospitals, and to compensate younger members of the staff an honorarium of some sort should be provided.

In order that an assistant residency in these hospitals may qualify a candidate for admission to examination by one of the Boards or for Fellowship in the College provision must be made for instruction in the basic sciences. This calls for an arrangement with a neighboring medical school and may require a moderate expenditure to defray the expenses of the school. If the hospital is in the same town the

problem is simple but if it is at a distance it is more difficult. It can be overcome, however, as has been done in Hamilton, Ontario, where the assistant residents come 40 miles by train to spend one evening a week in the anatomical laboratory and to attend a lecture on applied physiology.

Now while I am urging that it is the plain duty of all surgeons on the staffs of public hospitals and particularly the Fellows of this College to join in this campaign I should point out that the reward for hearty co-operation in it will be great and the penalty for failure will also be great. You must all have observed that with the establishment of higher standards for qualification by the Boards and the College those hospitals known to provide approved courses of training are being so inundated with applications that they are able to fill their resident staffs with the pick of the graduating years. On the other hand those hospitals which have not been approved for graduate training or are known to provide in different courses, have very few applications and these only from graduates who are not acceptable elsewhere. The result is too obvious to require comment.

As the years have rolled along it has been interesting to observe the results of our planned course of training. Some of the graduates who have shown aptitude for teaching or research have won appointments on teaching hospitals and a few have become professors. The outstanding result, however was that when the Canadian Armed Forces needed highly qualified young surgeons they were ready and were able to give our soldiers, sailors and airmen a service that has hitherto been unsurpassed. And now with demobilization these officers are settling into civilian life and bringing to the Canadian people both in the cities and towns a quality of service of which their teachers are very proud.

This group which now has grown to seventy-five has banded itself into a club which meets once a year to spend a day at the hospital where they were trained and to enjoy a clinical program and a dinner. To this gathering are brought all the trials and difficulties of practice and it is seldom that the trouble is so great that it cannot be solved. Through it

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there has developed an excellent esprit de corps and a tradition which ensures that the general plan will long continue.

It is the opinion of this group that the young surgeon recently certificated and accepted to Fellowship in one of the colleges should limit himself entirely to surgery or his particular specialty. At first it was thought that this could not be done and that a surgical practice could only be acquired through general work. It has been shown beyond a doubt however that this is wrong and that, on the contrary it is the surest and quickest road to success. The explanation is that general practitioners are far more willing to refer surgical work to a specialist who is not in competition with them for general practice than to another general practitioner. They do it too without asking a share of the fee which is something on which to ponder.

In thinking over our experience of the past 18 years in this planned course of graduate training I commend to your consideration the following suggestions.

First. In order that the student may acquire a satisfactory knowledge of anatomy applied physiology and applied physiological chemistry he should be provided with a plan of curriculum of studies running concurrently with his apprenticeship.

Second. In order that he may be stimulated to engage in these studies earnestly and not perfunctorily he should be confronted with written and oral examinations.

Third. The awarding of a degree such as 'Master of Surgery' to candidates who have shown a practical knowledge of the basic medical sciences and who have demonstrated to a

court of examiners skill in the art and science of surgery gives a stimulus to the whole course. Gradually the tradition develops that the M.S. is more than a diploma won by examination but that it is a written guarantee that the holder is known to his teachers to be thoroughly qualified to practice his profession. Because of this fact the attainment of the degree is much desired.

I have taken long to tell you the story of our efforts in Toronto. As I said earlier I have no notion that our plan is an ideal one or that better plans do not exist. At this time, however when the College is engaged in a great campaign to provide an increased supply of qualified surgeons it may be helpful to those who will be engaged in organizing and administering somewhat similar plans, to hear of the difficulties and disappointments and the triumphs of a plan that has been in operation for 18 years.

The honor of being President of this great College throughout the whole of the European and Asiatic war has been far beyond my deserts. The last Clinical Congress took place in Boston just before Pearl Harbor and you elected me to the presidency in order that you might do honor to my country which was already deeply involved in war. Thank God, as we came through safely together and can now turn our minds to the urgent problems of peace. Of these none is more important than the health of the people and as far as this College is concerned, than that each one of our citizens, be he in the heart of the city of New York or on the fringes of Arctic civilization may be assured in some way or another of competent surgical care.

# INTERRUPTION OF THE DEEP VEINS OF THE LOWER EXTREMITIES IN THE PREVENTION AND TREATMENT OF THROMBOSIS AND EMBOLISM

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IT is now well established that most pulmonary emboli arise in the deep veins of the legs. Illness parturition trauma, and surgical procedures are conducive to thrombus formation although this phenomenon may rarely occur in an ambulatory and otherwise apparently healthy individual. Infarct to the lung is frequently the first warning of the true situation and is often diagnosed and treated as coronary occlusion atelectasis pleurisy or pneumonia. Sudden death with out warning is common and often the massive pulmonary embolus responsible is unsuspected until found at autopsy. There are some physiologic changes in the blood following trauma or illness, particularly those concerning the platelets, that must be taken into consideration regarding the cause of thrombosis. We believe however that stasis in the leg veins dependent on bed rest and muscular inactivity is in fact the chief underlying basic principle in the establishment of thrombosis.

In consideration of this problem from any point of view one must bear in mind certain established facts. There are definitely two distinct types of thrombosis in the leg veins. Homans (11) has used the terms bland or quiet thrombosis to describe a noninflammatory process producing loose clot within the vein. Ochsner and DeBakey (16) have coined the term 'phlebothrombosis' for the same condition. Both these authorities are distinguishing this type of lesion from the inflammatory thrombosis known as thrombophlebitis. The latter situation is easily diagnosed since the patient is made aware of it by pain in the leg. Associated with swelling of the extremity

and fever we have in its extreme phase phlegmasia alba dolens so commonly seen in the past following childbirth and often called by the layman milk leg. This condition is not as dangerous as bland thrombosis from the standpoint of pulmonary embolism but if allowed to run its course causes great and often permanent disability due to persistent edema and frequent ulceration.

Phlebothrombosis is often unrecognized until serious emboli have been carried to the lung or until the character of the lesion has changed into the inflammatory process of thrombophlebitis. Bimodal inspection and palpation of the legs may result in an early diagnosis. Mild swelling of the ankle dilatation of the superficial veins of the foot and minor discomfort on palpation of the calf muscles are often enough to lead to the assumption that a bland thrombus exists within the deep veins of the leg. The concomitant slight elevation of temperature pulse and respiration is reliable evidence that phlebothrombosis is present and that a small infarct has occurred. It is in this type of thrombosis that the greatest immediate danger exists. The long almost uninterrupted femoral vein may contain a complete cast of loose thrombus and if this becomes detached en masse the resultant occlusion of the pulmonary arteries is nearly always fatal.

The age of the patient appears to be the most important consideration regarding the frequency and seriousness of thrombosis of the leg veins. In our own cases (1) of thrombophlebitis only 5.7 per cent were in patients under 30 years of age 12 per cent were between 30 and 40 18.5 per cent between 40 and 50 and the peak incidence of 25.3 per cent occurred in the decade between 50 and 60. A total of 82.3 per cent were beyond the age of 40. It is apparent to us that sudden massive

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embolism is far more common in the aged. Al though we have no definite evidence that phlebothrombosis is more prone to take place in the older age-group than is thrombophlebitis, there is a great deal to support this assumption in the analysis of the problem in our clinic. That some younger patients do have a bland type of thrombosis is evident, but the fulminating inflammatory thrombophlebitis is certainly more commonly seen in this age-group than in the older. We have observed all gradations of the disease. A considerable number of patients will develop an apparently noninflammatory thrombosis, especially if left untreated, and occasionally if treatment is carried out the condition will gradually change into thrombophlebitis. It is probable that this situation occurs more frequently in certain clinics and certain geographical locations than in others. Vasospasm may account for some of this variance since in cold damp climates it may be more constant than it is in warmer and dryer regions. The chronic upper respiratory tract infections with exacerbations during the colder months may play a rôle. Certainly our peak incidence of 32.9 per cent in the winter months as compared to 18.9 per cent in the summer seems significant.

The prevention of and the treatment of thrombosis and embolism must be considered separately. There has not been sufficient emphasis on these two distinct methods of meeting the problem. By prophylactic measures we refer to those carried out in anticipation of thrombosis in the leg veins. Treatment of the condition in any form after the establishment of the probable or obvious diagnosis of thrombosis or infarct is a different matter. Further, more patients in various age-groups or according to the character of their ailment or injury may be treated differently. It is unwise to overlook these separate categories in the management of this problem as a whole. Reports on the effectiveness of one method of treatment or prevention as applied to all patients are apt to be misleading. That methods of prevention and those of treatment must overlap is obvious.

*Methods of prevention of thrombosis and embolism* are numerous and all should be considered on a logical basis dependent on vary

ing circumstances. Certain primary principles such as suitable preparation of the patient for operation, gentle surgical technique, and the prevention of stasis in the leg veins during convalescence are commonly agreed upon by all clinicians. Elevation of the foot of the bed, leg exercises, early postoperative walking are all considered useful. These measures alone have apparently reduced the over-all incidence of thrombosis and fatal embolism in postoperative cases from 1 in 333 to about 1 in 800 at the Massachusetts General Hospital (20). There are many patients, however whose type of disease, trauma, or other infirmities make it impossible to carry out such maneuvers. It seems to us that a selection of methods must be used on individual, age or disease group indications.

Our records show that patients under the age of forty are less prone to develop the complication of phlebothrombosis and that when thrombosis of any type occurs, it is less likely to be followed by a fatal embolism. These younger individuals are basically more healthy and active, and can co-operate more readily with the clinician and nursing staff in the routine measures for the prevention of venous stasis. There are however many conditions afflicting this age-group that are conducive to thrombus formation in leg veins and these must be evaluated and treated accordingly. All patients in this group must be carefully watched for early signs of thrombosis. If the condition manifests itself there is usually time to prevent a prolonged convalescence or the more important fatal embolus. Since 12 per cent of our cases of thrombosis and embolism occurred in patients between the ages of 30 and 40 years, it is probably better judgment to include this decade in the next age-group to be considered.

In patients between the ages of 40 and 65 years, we have carried out the usual general measures of prevention when possible and, in addition, have treated a small number (133) of suitable cases with dicoumarol postoperatively (2). In comparison with a control group of the same age and type the incidence of thrombosis and embolism was reduced 75 per cent. We did not use this drug on patients

with increased prothrombin time or in those with planned multiple operations, liver or renal disease, diabetes, arthritics taking aspirin in thoracic cases, hyperthyroidism or arteriosclerosis. Our dosage was smaller than usually recommended and was only 200 milligrams on the 2nd or 3rd postoperative day and repeated 48 hours later if the prothrombin time remained unchanged. The sensitivity to this drug in some patients as well as the lack of measurable effect on others was noted. No fatal bleeding took place in any patient treated. It is obvious to us that this drug is useful in many cases but that it should not be used without careful laboratory control. There are in this age-group many debilitated patients who should be considered in the next category especially those whose disease or infirmity makes thrombosis and embolism a common occurrence and those with definite contraindications to anticoagulant drugs must be protected by other methods.

Since the danger of phlebothrombosis with death from massive pulmonary embolism increases with the patient's age we have selected the group beyond the age of 65 for prophylactic bilateral superficial femoral vein interruption. This is done immediately distal to the profunda femoralis vein and as close to the bifurcation of the common femoral as is technically feasible. We have been so impressed by the negligible symptoms following this procedure on the normal femoral vein that we feel it should be more widely used. Up to October 1, 1946 there have been done at the Massachusetts General Hospital 458 such bilateral prophylactic femoral vein interruptions. In only one patient so treated did fatal embolism occur and in this case the vein was found at post mortem to have been divided 3 centimeters distal to the profunda. It is possible that this elderly obese woman with a large ventral hernia had thrombosis prior to the vein interruption. It is more likely however that the proximal segment of femoral vein acted as a nidus for the propagation of thrombi higher in the venous system. There was a firm thrombosis in this proximal remnant of vein at autopsy. In 5 other patients who were subjected to prophylactic femoral vein division there was a history of mild phle-

bitis in one or both legs following interruption. This occurred within 24 hours in 1 patient, and the longest interval was 6 weeks. In a comparable group of 458 patients who did not have prophylactic femoral vein interruption there were 55 cases of thromboembolic syndrome with 26 instances of fatal pulmonary embolism (Table I).

The operation should be done at the time of or within 48 hours after bed rest becomes necessary. Particular attention should be paid to this method of protection in patients with fractures near the hip joint. The danger of this complication in such cases is emphasized by Golodner and associates (10) as well as by Bauer (5). In 110 consecutive elderly patients with fractures of the hip region prophylactic femoral vein interruptions were done in our clinic. In 2 of these thrombophlebitis did occur but none died of pulmonary embolism. In the immediately preceding 110 patients of the same type 11 died of massive embolism. Two additional patients in this group died suddenly with signs and symptoms of pulmonary embolus but in these 2 the possibility of coronary occlusion was raised.

Almost as spectacular are the comparative studies on a group of thigh amputation cases. Veal (19) stressed the need for high femoral vein interruption in such patients for the prevention of pulmonary embolism several years ago. In 49 patients in this group receiving prophylactic femoral vein interruption, there were no deaths from embolism. In similar patients not so treated there were 6 who were proved at autopsy to have died from this cause. In the diabetic arteriosclerotic group having femoral vein interruption one instance of gangrene of the opposite extremity occurred. This may have been coincidental but the effect of vasospasm or even damage to the calcified arterial wall must be considered as a possibility.

We think many patients of the elderly age group can have prophylactic vein interruption prior to the main surgical procedure. It may be well to withhold it until after operations in the pelvis are completed particularly in resections of the rectum since venous bleeding in the field of operation is temporarily increased by division of the femoral veins.



TABLE II.—FEMORAL VEIN INTERRUPTIONS

Massachusetts General Hospital  
1937 to October 1946

	Patients
1937-1946	202
1943	165
1944	280
1945	411
1946 (Oct. )	460
Total	1518

Homans (12) is responsible for calling our attention to interruption of the femoral veins in the groin to prevent pulmonary infarct. With a cautious approach to this method of treatment 10 years ago we soon became convinced of certain definite facts. The operation in itself can be accomplished without harm to the patient. In no case in our institution has a patient lost his life or his limb as a result of this procedure. Most of them had no further infarct and those who did usually recovered. If the operation was done in the stage of phlebothrombosis, clots above and below the site of interruption could be removed with a carefully used glass suction tip. The amount of residual edema of the leg was dependent upon the duration of the disease. Thus in patients operated upon before thrombophlebitis began few had any swelling of the leg during convalescence. If the operation was undertaken for thrombophlebitis the earlier the procedure the shorter the duration of postoperative edema. This expected sequel to deep vein interruption was of surprisingly little significance as far as incapacity was concerned. There has been only one instance of postphlebotic ulceration in this group of patients.

Up to October 1, 1946 1518 patients have been subjected to femoral vein interruption at the Massachusetts General Hospital (Table II). Four hundred fifty-eight of these have been done on elderly or debilitated patients as a prophylactic measure before at the time of or within 72 hours after bed rest became necessary. One thousand sixty patients were treated by femoral vein interruption after thrombosis or infarcts had occurred. Less than 5 per cent of these had further infarcts after this procedure. In most instances these were of minor importance. In some of these anticoagulants were used with good effect. In

TABLE III.—INCIDENCE OF THERAPEUTIC AND PROPHYLACTIC FEMORAL VEIN INTERRUPTION IN 1518 CASES

Massachusetts General Hospital			
1937 to October 1946			
	Therapeutic	Prophylactic	Total
1937-1942	202	0	0%
1943	150	15	9%
1944	208	72	26%
1945	233	178	43%
1946 (Oct. 1)	267	193	42%
Total	1060	458	1518

those with pain and swelling of the leg due to a continuation of the inflammatory process of thrombophlebitis procaine lumbar sympathetic blocks were employed. In 5 patients in this group death occurred following further emboli. All of these had had one or more infarcts before femoral vein interruption and thereby had a lowered pulmonary vital capacity so that additional small emboli were sufficient to prove fatal. All but one of these 5 patients were well advanced in years and were suffering from incurable diseases. Prophylactic femoral vein interruption if it could have been carried out would have prevented these fatalities from embolism.

It is of course, impossible to determine accurately the number of deaths from embolism that would have occurred in this group of 1518 patients if femoral vein interruption had not been done (Table III). In fact, a fair proportion of the operations were undertaken on the basis of shortening the period of convalescence from thrombophlebitis with its usual disabling sequelae. The majority of them however were in patients whose age, disease, and infirmity would have allowed us to expect that a considerable percentage of them would have had subsequent lethal emboli. This opinion is based on previous experience with this cause of death in our own hospital. Although we have not convinced all members of our staff of the rationale of prophylactic femoral vein interruption there are few who would not urge the operation as soon as thrombosis was suspected and none would prefer other methods with the diagnosis definitely established.

The indications for this procedure now run about as follows: prophylactic interruptions 40 per cent, signs of thrombosis on examina-

tion of the legs 35 per cent and infarcts 25 per cent. There was a gradual change in the trend of indications up to 1945 when a more or less constant level was reached (Table IV). Not all patients who complain of a little soreness in the calf muscles are considered to have thrombosis. Many will exhibit such manifestations after exercise if closely questioned. Tenderness on pressure however should be strongly suspected. Slight swelling and dilatation of the veins of the foot are of great importance in the diagnosis. Late manifestations of the process are a positive dorsiflexion sign and definite swelling above the ankle. The concomitant slight rise in temperature, pulse and respiration is a reliable sign of phlebothrombosis and infarct. Pain in the chest is to be considered on the basis of infarct until proved otherwise. We do not believe that phlebograms are necessary to make the diagnosis. Furthermore the careful interruption of the normal femoral vein is definitely harmless. It is therefore obviously better judgment to err on the side of action than it is to lose a patient from a sudden massive embolism. These occur too frequently in a patient apparently doing well. Often these charts can be studied and a warning sign can be found that could have been recognized in ample time to protect the patient from that type of death. In some instances however there is no recorded evidence either on the chart or in the clinical notes that would lead one to suspect phlebothrombosis until proved at autopsy.

The site of deep vein interruption has interested us greatly. At one time we felt that this should be determined on the basis of the level of thrombosis. We are free to admit that the best results are obtained if the operation can be done at a level above the thrombosis. On the other hand one must take into consideration the dangers associated with such procedures. We have had so few complications and such a high percentage of successes by selecting the femoral vein just distal to the profunda femoris as the level of division that we now feel that this should be the site chosen in the routine case. Here we have a segment of the deep vein that is usually free of muscular branches. This eliminates troublesome bleeding during the isolation of the vein.

TABLE IV — INDICATIONS FOR FEMORAL VEIN INTERRUPTION—MASSACHUSETTS GENERAL HOSPITAL

	1937 to October, 1945				
	1937-1941	1941	1942	1943	1944-1945
Leg alone as first symptom	24	17.5	45.4	11	5
Chest pain as first symptom		3.5	3.3		
Prophylactic interruption		9	25	25	1

We did in our earlier series select the common femoral vein as the site of interruption in a considerable percentage of cases. This decision was usually based on the finding of thrombosis above the level of the superficial femoral. The occasional trapping of large quantities of blood in the leg after common femoral interruption particularly if the femoral vein itself is not completely thrombosed produces a dangerous immediate engorgement in the leg. This has been stressed by Deans (7) and by Homans (13) and has been observed by us. We now feel that the added risk of exposure of the short common femoral with its multiple radicals has little advantage and is attended by sequelae unwarranted in this type of interruption. If one finds the profunda femoris thrombosed at the time of superficial femoral vein interruption it is not difficult to ligate it in continuity after the main trunk below the bifurcation has been divided. The ratio of superficial femoral vein interruption to the common femoral in our series is about 4 to 1. In the future it will probably be rare instances only that the higher segment of the vein is selected as the site of division. In the 5 deaths from further emboli after vein interruption 2 occurred after the common femoral and 3 after the superficial femoral had been divided. In only 1 of these did it appear at autopsy that the profunda femoris was probably the source of the final lethal embolus.

Homans (11) believed at one time that the common iliac vein on the side affected was the logical site for interruption under certain circumstances. This attack was supported by Fine and Starr (8) and by Bancroft (4). The approach should be used only when there is obvious long standing deep thrombosis extending well up into the iliac vein on one side.

Occasionally, in a well preserved or younger patient, it is a justifiable procedure. It has been pointed out by Homans that the colateral venous return is greater following common iliac division than it is after common femoral interruption. So frequently is it necessary to interrupt the veins on the opposite side that this difficult bilateral operation under general anesthesia seems rarely indicated. Homans (13) in a later report apparently feels that when the thrombosis is well established in the iliac veins low vena cava interruption is more logical since it can be accomplished at one operation instead of two. He further points out some of the difficulties of exposure and division of the iliac vein which can be friable and hard to manage under certain circumstances.

Ligature of the inferior vena cava has gained too much attention. Good results following this procedure have been reported by O Neil (18) Northway and Buxton (15) Gaston and Folsom (17) and by Kern and Berman (14). Linton, in our clinic, has performed this operation in 13 patients. All have survived the procedure but 3 have developed leg ulcerations afterward. Collins and associates (6) have stressed the importance of ligation of the ovarian vessels with vena cava interruption for septic thrombosis of the pelvic veins. It is our opinion that this procedure may at times be life-saving. It should be reserved, however, for patients having obvious septic infarcts from thrombosis that have originated in or extended into, the deep veins of the pelvis. Approach to the region has varied from flank to paramedian incisions. A few advocate the transperitoneal route. Linton prefers a long right paramedian incision with reflection of the peritoneum and abdominal viscera toward the left. Care must be exerted in freeing the segment for ligation since troublesome bleeding from injury of the friable lateral veins may influence the outcome.

#### TECHNIQUE OF OPERATION

Technique of operation in the interruption of the deep veins of the lower extremities should be carefully considered. We may have been remiss in our earlier communications on this subject (3) in stressing the simplicity of

the procedure. This was brought about by the fact that such a large percentage of our cases had been operated upon by the junior residents. We had failed to make it clear that these men had been properly instructed in the approach and the technique of the operation. Since our attention has been drawn to certain serious difficulties encountered by some surgeons who had not studied the problem beforehand we feel that the following details are worthy of emphasis.

The patient should be placed on the table with the upper part of the body slightly elevated. Although we have had no instance of infarct during the operation we believe that such might occur if negative pressure in the veins above the thrombosis was encouraged. The usual skin preparation for any emergency procedure is used. One per cent procaine without adrenalin is introduced by local infiltration. A vertical 8 centimeter incision is made from the crease of the groin distalward over the course of the deep vessels guided at the upper level by the pulsating femoral artery. The skin is carefully excluded by towels which are even more important in this region than in many others. Dissection should be parallel to the course of the vessels with as little lateral division of tissues as possible. This step allows for the retraction of most of the lymphatics since transection of them as often occurs in a transverse or an oblique incision will increase the hazard of postoperative edema and lymph drainage from the wound. The vein is more or less mesial but often almost completely beneath the femoral artery. The artery should be freed only enough to allow gentle retraction laterally. It is better not to retract the artery with rubber tubing or ligation material, since damage to a calcareous vessel with resultant thrombosis and gangrene of the leg by this method has been brought to our attention.

The segment of vein to be interrupted lies in the exact center of the wound if made according to these directions. The bifurcation of the common femoral vein can easily be determined by a bulge at the upper end of the superficial femoral. Exposure of the radial free upper 2 centimeters of the vein is sufficient. Ligatures for elevation of the vein are placed and not

tied at this time but the ends are held as hemostats. The anterior half of the vein is then divided transversely halfway between the two guy ligatures. If thrombus is present at this level, it will extrude through this opening. We clear the upper segment of vein of all clot by the use of forceps and carefully apply suction through a glass tube. After free bleeding is obtained the lower segment of vein is freed of as much thrombus as possible. Often free bleeding from the distal segment can be thus acquired. The ligatures are then tied above and below and the vein is completely divided. Transfixion ligatures are then placed on each divided end of the vein.

After irrigation of the wound with saline solution a layer closure is accomplished with fine cotton sutures. Care should be used not to leave open an obvious divided lymph vessel. Also the anterior crural nerve should be avoided during the closure. A complete change of gloves, instruments, and drapes is made for the opposite side. The bilateral operation should be adequately and safely accomplished within an hour. Dependent on previous inflammatory reaction in the vascular bundle and occasional friability of the vein the operation may take a little longer. Often in a thin subject with normal structures, the operating time is reduced to 20 minutes or less to the side.

This method has been followed by very satisfactory results. Postoperative edema is minimal in most instances. If the process is subacute and thrombophlebitis with swelling in the extremity is already present the edema lasts longer but is rarely incapacitating. There has been less than 2 per cent of wound infection in our series and most of this has been of minor importance. Lymphorrhea has rarely occurred and is transient. Patients are treated in the same manner with or without this procedure. It has not increased the hospital stay or delayed ambulation. The only complaints have come from those occasional patients who have had trauma to the anterior crural nerve and these have not been severe.

#### SUMMARY AND CONCLUSIONS

1. Bilateral interruption of the deep veins of the legs is a safe and adequate method of

preventing thrombosis and embolism. The procedure is particularly adaptable to aged and debilitated patients requiring prolonged bed rest and those who have had trauma to the leg or hip region. Subsequent edema in the legs following division of the normal superficial femoral vein is negligible.

2. Treatment of phlebotrombosis by thrombectomy and interruption of the deep veins of the legs is highly satisfactory. Early diagnosis permits the division of the vein above the thrombosis at the superficial femoral site. It is rarely justifiable to perform a higher division of the venous system under any circumstances.

3. Thrombectomy and superficial femoral vein interruption is an effective method of treatment in early thrombophlebitis. Patients with continued infarcts following this procedure should have anticoagulant therapy. Those with continued pain and swelling of the extremity following femoral vein interruption should be treated by lumbar sympathetic procaine blocks.

4. Division of the common femoral vein is not recommended. If the profunda femoris is thrombosed at the time of superficial vein interruption this radial can be separately tied in continuity.

5. Bilateral femoral vein interruption should be done since often the fatal embolus arises in the opposite apparently normal vein.

6. The collateral venous circulation is better following common iliac interruption than it is after common femoral division. Occasionally in a definitely unilateral process extending into the pelvis in a good risk patient, the common iliac vein may be the site of choice for operation.

7. Inferior vena cava ligation should be reserved for those patients who are having repeated septic infarcts. These emboli may have originated in the pelvic veins or progressed to this area by direct extension from the leg veins. In pelvic suppurative thrombophlebitis, the ovarian or spermatic vein should be interrupted at the time of vena cava ligation.

8. There have been no deaths and no patient has lost a limb as a result of femoral vein

Interruption in 1518 patients so treated in the Massachusetts General Hospital

# REFERENCES

1. ALLEN, A. W. LINTON R., and DONALDSON G. J. *Am. M. Ass.*, 1945 128, 6 397.
2. Idem., *Am. M. Ass.*, Surg. Sect., 1946 July.
3. ALLEN A. W. *Bull. N. York Academy* 1946 22 169-184.
4. BAMCROFT F. W. *Ann Surg.* 1945 121 175-184.
5. BAUER, G. *Acta Chir. Scandinavica*, 1944, 90 229-248.
6. COLLINS, C. G. JONES, J. R., and NELSON E. W. *N. Orleans M. & Surg. J.* 1943 95 324.
7. DEDMONS, C. *Surgery* 1945 17 264-269.
8. FINE, J. and STARK, A. *Surgery* 1945 17 232-239.
9. GASTON E. A., and FOLSBOM H. *N. England J. M.* 1945 233 229-233.
10. GOLODYER, H. MORSE, L. J., and AMQUIST A. *Surgery*, 1945 18 418-423.
11. HOMANS, J. *Surg. Gyn. Obst.* 1944, 79 70-82.
12. Idem. *N. England J. M.*, 1944, 211 993.
13. Idem. *N. England J. M.*, 1946, 235 163-167 193-198.
14. KERN H. M. and BERMAN E. *Am. J. Surg.* 1945 69 120-125.
15. NORTHWAY R. O. and BUXTON R. W. *Surgery* 1945 18.85-94.
16. OCTENBLOM, A., and DEBAKEY M. *N. England J. M.* 1941 225 207-227.
17. Idem. *J. Am. M. Ass.*, 1940, 114 117.
18. O'NEIL, E. E. *N. England J. M.*, 1945 232 641-646.
19. VEAL, J. R. *J. Am. M. Ass.*, 1943 121 240-244.
20. WELCH, C. E. and FAXON H. H. *J. Am. M. Ass.*, 1941 117 1502-1508.





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# THE AMERICAN SURGEON, A U S

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## SHOCK

**I**N choosing the accomplishments of the surgeon of World War II as the subject of this first Franklin H. Martin Lecture, I realize that I have set myself a difficult task. The American Surgeon, A U S is a Rip Van Winkle, already packed off into the Catskills for a long sleep. His return to the platform may be accepted with tolerant politeness but his experience is considered an affair of the past without reference to the immediate future. An acceptance of the challenge to present this subject means that I hold a deep conviction that there are many significant things that have not yet been said about the surgical experience of the recent war.

The nature of the shock exhibited by a wounded man has been made a matter of mystery for many years. During World War I observations on the shock of wounded soldiers showed that "the vasomotor center was efficiently at work and the heart was capable of assuming any reasonable burden placed upon it." (4) Attention then centered on the discrepancy between blood volume and the capacity of the vascular bed. A fruitless search for the "lost blood" led to the concept that the fluid portion (plasma) had been lost through the capillary wall by a generalized increase in its permeability. An assumption was made that toxic products derived from injured tissue damaged capillaries remote from the site of injury.

The full impact of war experience on surgical theory and concept has by no means been measured. One reason, perhaps, is the preoccupation with novelties that characterizes the profession of today. No novelties emerged from the past war. There is no fancy packaging that leads the buyer to believe he can obtain something new and important. There were few, if any novel technical achievements. In fact, war tends to submerge the importance of technical details. Surgeons from all sections of the country are brought together in a common task with the result that specific techniques oftentimes taught as essentials in a parent school are recognized as unimportant details when placed against a broad perspective. The vast experience of war provides a view of surgery comparable to an aerial reconnaissance photograph in which the significance of a single bomb crater is lost in the display of the pattern as a whole.

At the risk of repeating what may be familiar material I shall point out certain aspects of surgery that have profited by the clarification that can come only from the impact of broad experience.

In the period between the wars this loss of plasma was localized more definitely to the areas that had been injured and both the assumptions of a traumatic toxemia and of a generalized change in capillary wall permeability were questioned. Observations were extended beyond the intravascular space to the interstitial fluid compartment. Certain electrolytes, sodium and chloride were found to move freely in the vascular and interstitial spaces but observed to meet an effective barrier to entering the cell. Others notably potassium, magnesium and phosphorus were admitted to cells, even though in low concentration.

The toxicity of potassium when given intravenously and the high level of potassium observed in certain instances of advanced shock led to the concept that it might represent a noxious agent. It was even referred to as a possible H-substance (19) a generic term that had been used to designate the products of tissue injury. At any rate no one considered that an actual deficit of potassium or other electrolytes within the cell might be an important component of injury.

World War II was started with the concept that plasma for the intravascular space and

The First Martin Memorial Lecture of the American College of Surgeons, presented before the Clinical Congress of The American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.  
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sodium chloride solution for the interstitial space were therapeutic measures adequate to re-establish equilibrium in a wounded man. Experience in North Africa immediately demonstrated the inadequacy of this therapy and showed the necessity for whole blood (15). As soon as equipment could be obtained a blood bank, organized by the Theater with service troops as donors, supplied the full needs of the Mediterranean forces to the end of the war.

The loss of whole blood following wounding far surpassed that estimated at the beginning of the war and the degree of shock closely paralleled the amount of blood lost (16). The obvious explanation of why whole blood is needed rather than plasma is that replenishment of red cells maintains the required oxygen-carrying capacity. Future investigation will test the validity of certain less obvious explanations. Red cells form an appreciable portion of the mass of blood and a portion that cannot be lost into an area of trauma without actual disruption of vessel walls. The physical action of cells as a filler for the intravascular space may be significant, because it is not clear how long plasma administered in the face of a low hematocrit remains in circulation.

Again there is the problem of the electrolytes to which I have referred. Potassium appears in considerable concentration in the urine following hemorrhage (18). From what cells it is lost and by what mechanism is not clear. The specific effects of the departure of the potassium ion from cells on recovery from shock or recovery from other effects of the wound remain to be explored. Suffice it to say that potassium and also phosphorus are virtually lacking in plasma but present in large quantity in red cells.

Other considerations have led the attention of the surgeon beyond the capillary wall, across the interstitial compartment to the cell. The term *irreversible* borrowed from elementary chemistry is found in writings on shock. The issue is kept clear only if its use is restricted to the effects of shock and not extended to the condition of shock itself. Shock, defined as reduced blood volume flow, is reversed by replacement of blood volume. Selective death of organs or tissues brought about in whole or in part by shock is not reversible. It is probable

that each tissue and organ has a different threshold at which it succumbs to asphyxia. Functional impairment or complete suppression of function may appear in certain organs, for example the kidneys, and delayed death of the entire organism ensue, despite the fact that other organs have been reconstituted and the direct effects of the missile repaired. In this sense the effects of the wounding as reflected on the kidney in many cases have been irreversible—at least with our presently available modes of therapy.

In the past war replacement of lost blood reached an extraordinarily high level of effectiveness. It is certain that hundreds of injured men survived the immediate effects of wounds that under slightly less favorable circumstances would have proved fatal. Irreversible shock as such was not encountered. An appreciable number of the wounded survived, however, only to die about the tenth day with complete anuria. A chain is as strong as its weakest link. When links are strengthened where the chain has broken previously new weak spots appear simply because the chain holds to test them. The obvious weak link in the severely wounded in this war was the kidney.

Death from suppression of urine attracted attention for two obvious reasons. First, the syndrome is readily recognized provided the urinary output is observed; second, the time of death is quite remote from the immediate sequelae of the wounding. When the chain breaks within the first 48 hours of wounding it is oftentimes impossible to tell which of many links gave way first. Thus it is entirely possible, indeed there is evidence to indicate, that other organs may be mortally damaged by the indirect effects of trauma. The liver and the adrenal cortex come to mind as organs that deserve careful study in this respect. Any specific effects of the functional suppression of these organs are so likely to be obscured by the whirlwind of events in the first 48 hours after severe wounding that clinical observations still remain inexact and fragmentary.

At one time in World War II there was a trend which, if allowed to develop, might well have separated the treatment of shock from surgery. The following is an extract from an

# CHURCHILL THE AMERICAN SURGEON A U S

official report of the Surgical Consultant,  
North African Theater of Operations dated 2  
July 1943

Hospitals receiving battle casualties from the field establish a Resuscitation Ward to which patients requiring resuscitation are sent from the Reception Ward. A Resuscitation Team of Medical Officers is constantly on duty. This is an efficient arrangement and absolutely essential when casualties arrive in overwhelming numbers. There is one drawback which if clearly recognized may be guarded against. Resuscitation comes to be regarded as a subspecialty of military surgery and as such becomes a goal in itself. One central fact must be kept in mind and although it appears obvious it is often overlooked both in theory and practice. *A wounded man is resuscitated not only to save life but to prepare him for necessary surgery.* Starting from this axiom a number of principles become clear.

(1) Any delay in resuscitation prolongs the crucial interval between time of injury and operative treatment. Also delay in the reversal of shock increases the deleterious effects of circulatory failure. Delays in resuscitation procedures have been observed that were attributable to

(a) Insufficient grasp of these fundamental principles chiefly on the part of junior grade ward officers with inadequate training in surgery. This is of course a reflection on

(b) Failure of the operating surgeons to follow closely the clinical course of patients in the Resuscitation Ward. They wait for them to be served up to them. This divorce of surgeon from shock is a disquieting outgrowth of the war that cannot be too strongly condemned. Resuscitation in every case prepared for operation is an integral part of the surgical management of trauma and must remain so if optimal results are to be achieved.

In the Italian Campaign Dr Henry K. Beecher made many important observations both clinical and quantitative, on the preparation of the wounded for surgery and presented a broad definition of resuscitation that includes operation as an essential component.

"The enemy has produced the worst wound he could and its consequences are cumulative—decohydration increased by unusual fluid loss in sweat and vomitus, continuing hemorrhage or plasma loss, pain making rest impossible, increasing emotional exhaustion, developing infection—these and other factors are set in operation by the initial wound. Their progress in the seriously wounded is to be checked in most cases only by surgery or by death. Resuscitative measures give a temporary stay and make successful surgery possible in the severely wounded but in most cases true release from the consequences of the wound is effected only by surgery. Surgery is

not only the goal but is itself a part of resuscitation in the broad sense. Any other view is likely to lead to unfortunate separation between the activities of the shock team and those of the surgical team. Care of the wounded man must be continuous and supervision uninterrupted (2)

This point of view, developed during the war has a direct bearing on such practical matters as the design and placement of surgical hospitals. Converging litter carries and ambulance shuttles come to a junction at the Clearing Station of the Division. Here casualties are sorted and their disposition determined. During the campaign in Sicily (6) it was determined that the surgical hospital for treatment of the severely wounded should be placed alongside of the Clearing Station so that a short litter carry would place the casualty in the hands of a competent surgical team equipped not only for resuscitation in the narrow sense but for the major procedures of surgery. One reason for this location of the hospital was to avoid the holding of a seriously wounded patient in a station not equipped for surgery while futile efforts were made by the infusion of plasma or blood to prepare him for another ambulance lift, even though it were a short one.

Upon entering the surgical hospital the wounded man's response to blood replacement therapy was carefully observed. If the response was transient or unsatisfactory particularly in the case of an abdominal wound it was assumed that either continuing hemorrhage or spreading infection was present and operation was immediately undertaken. By this aggressive course many lives were saved.

To clarify thinking resuscitative measures carried out in the field, forward of a surgical hospital were considered as temporary and designed only to preserve life during transportation. They thus became both qualitatively and quantitatively different from those combined with surgery. It was necessary to rely on plasma as the chief measure to support the patient during transport but this was used in minimal amounts without intent to restore the volume flow to a normal level. Resuscitation within the hospital included additional plasma, whole blood. Initial wound surgery

and ancillary measures such as bronchoscopy oxygen therapy and nerve block to relieve pain.

The resuscitation of severely wounded soldiers provides a lesson pertinent to the management of the victims of civilian accidents. In transportation to a hospital equipped for major surgery only such delay should be countenanced as is essential to deliver the patient to the hospital alive. Similarly hospitals likely to receive such patients must be organized so that there can be no delay in the institution of the resuscitative measures that must carry the patient to the operating room and through the essential life-saving surgical procedures.

What has been called the pathology of shock (Moon) that is the microscopic changes in the tissues that are attributable to shock, has long been a matter of discussion and confusion. Blalock succinctly stated:

The length of time that the patient lives with an inadequate supply of blood and oxygen to the tissues determines the alterations that are to be found in them. (3) Again Yandell Henderson remarked that unless one is burned alive, the tissues of one's body always die of asphyxia. (10) It is apparent that postmortem studies must distinguish between those changes that are common to death from whatever cause and those changes that result from the exposure of the tissues to the insult of a period of reduced blood volume flow. Such a beginning has been made on the basis of war material by Dr. Tracy Mallory (13) and it may be expected that another area of confusion in the so-called shock problem will be resolved, at least in part, by the establishment of the pathology of shock as contrasted with the morbid anatomy of death.

#### WOUND INFECTION

The subject of wound infection is so closely linked with the surgical management of wounds that it will be dealt with briefly. Only rarely does anaerobic infection complicate the injuries of civil life yet it may reach almost epidemic proportions in war. The predominance of bullet wounds over high-explosive shell wounds until the year 1914 tended to keep the incidence of gas gangrene low then

came the catastrophic experience of the British Expeditionary Force in France and Flanders. The striking reduction in the incidence of gas gangrene in the latter period of World War I proved, as Archibald states:

The incidence of gas gangrene can be taken as the one reliable yardstick by which to measure improvements in field evacuation and in forward surgery. (1)

Taking up the subject during the campaign in the Western Desert, Major J. D. MacLennan (12) of the Royal Army Medical Corps clarified the approach to anaerobic infections for the surgeons of World War II. He attacked the widespread impression that the anaerobes constitute a small and highly dangerous group of organisms rarely found, difficult to grow and productive only of spores, bad smells, tetanus, and gas gangrene. He showed, further, that the absence of anaerobic bacteria from war wounds is a "matter for surprise rather than satisfaction, their presence for resignation rather than alarm." MacLennan's emphasis on the fact that anaerobic infections are clinical, not bacteriologic, entities provided the substance for a vigorous educational campaign. Setting up the entity of *anaerobic cellulitis* as distinguished from *clostridial myositis* brought clarity of definition and an understanding of anaerobic infection to hundreds of surgeons upon whom rested the responsibilities for preservation of life and limbs. That this concept needs emphasis in civilian teaching and the civilian practice of the surgery of trauma is immediately apparent to surgeons returned from the war.

It is difficult now to recapture the confusion in the prevailing doctrines regarding sulfonamide prophylaxis and therapy that was turned over from civilian surgery to military surgery at the time of Pearl Harbor. War experience completely unseated the dangerous teaching that wounds could be salted down with sulfa drugs as an alternative to prompt surgical treatment. The civilian surgeon entered World War II obsessed with the efficacy of the topical application of the sulfonamides in the prophylaxis of wound infection. He returned from war with faith in the therapeutic use of penicillin and at times, sulfadiazine, adma-

tered systemically to control impending or established invasive infection<sup>1</sup>

The ability to check invasive infection by hemotherapy freed the surgeon from inhibitions that long have stayed his hand. The fear of fanning the fires of infection by the surgical manipulation of infected tissues following trauma was banished. A bold revolution in the management of wounds took place. This has led to changes in the basic concept of the surgical approach to wounds and traumatic injuries.

#### REPARATIVE SURGERY

By the acceptance of the term "reparative surgery" in a War Department Technical Bulletin (TB MED 147, March, 1945), the Surgical Consultants Division of the Office of The Surgeon General gave official recognition to a concept of wound management that originated in the Mediterranean Theater of Operations. The validity of the concept was strengthened by subsequent experience in the field. The cessation of combat in northern Italy found it firmly established among the surgeons of the Theater.

This phase of wound surgery follows the débridement or initial wound surgery established as a basic procedure in World War I and perpetuated in the recent war as the key stone of wound management. Reparative surgery has been described as follows: "A highly significant and far reaching advance in military surgery has taken place in the base hospitals with the development of what may be called reparative surgery. Wounds left unsutured at the initial operation are routinely closed by suture usually at the time of the first dressing. With the use of penicillin as a safeguard against infection, the management of wounds complicated by fracture or joint involvement has been revolutionized. Surgical procedures in special fields of surgery—thoracic,

cranio-cerebral, abdominal—have also been radically altered by the application of similar principles. The significance of this development and its effect on returning an increased number of wounded soldiers to duty and in preventing deformity, disability, and death in the seriously wounded can hardly be overestimated.

"Reparative surgery is not to be confused with the reconstructive surgery of the Zone of the Interior. Reparative surgery is designed to prevent or cut short wound infection either before it is established or at the period of its inception. Once established wound infection is destructive of tissue and at times of life. In many instances it permanently precludes the restoration of function by the most skillful reconstructive efforts.

"If the initial wound operation has been a complete one, wounds of the soft parts may be closed by suture on or after the fourth day. The dressing applied in the evacuation hospital is removed under aseptic precautions in an operating room of a general hospital at the base. Following closure, the part is immobilized preferably by a light plaster encasement, or if this is impractical, by bed rest" (5).

A parallel evolution in wound management, differing only in unimportant details, took place in the Central Mediterranean Forces of our allies, with whom a close and cordial professional relationship was enjoyed from the time of the invasion of North Africa. Brigadier Harold C. Edwards (9) Consulting Surgeon A.F.H.Q. in a Report to the Director of Medical Services covering the period March 1 to October 31, 1944 referred to the subject as follows: "It is not too much to claim that the surgery of war wounds has undergone a radical change since the first mass experiment in delayed suture was planned before the battle of Cassino.

*'The accepted treatment of all wounds is a two stage operation'* irrespective of whether an open fracture exists or not. This conception has led to an immense diminution in invalidism as a result of chronic sepsis of pain and discomfort, and of numbers of dressings. It has led to an incalculable saving of hospital beds (one analysis has showed the saving to be

Italics by the writer

<sup>1</sup>That deep instinct of the surgeon to anoint the wound with healing balms, salves or antiseptics and to keep it open with setons, tents or tubes, finds its roots in the mysticism and polytheism of the ancients. It still plagues our craft in the usage of the precise tools of chemotherapy and antithiobiotic agents. A long line of illustrious surgeons, basing their experience more often than not on the battlefield, have combatted the doctrine that the healing of a wound is governed by the topical applications of the surgeon. This line of dissent extends from Lord Mynaghan, the great septic of world War I, through Lister, Wurtz, Park, Henry of Mondeville, Hugh of Lucca and Theodoric, Celsus, and the Good Samaritan, to Hippocrates.

as 24-35) and in consequence of manpower Men are fighting now<sup>1</sup> who have already twice recovered from wounds since the 'D' Day for Cassino—May 12th. Furthermore the result ing scars have been firmer less adherent and less liable to break down.

In the Royal Army Medical Corps the terms delayed suture and secondary suture were retained and the program as a whole referred to as the treatment of a wound by a two-stage operation.

The adjective *reparative* was chosen by the U S Army Medical Corps to set apart the phase of surgery under discussion from the initial operation (débridement) that precedes it and the reconstructive surgery that may follow. Reparative surgery has been referred to as surgery of necessity for a limited time exists following the initial surgery during which its maximum benefits may be secured. It is neither emergency surgery on the one hand, nor elective surgery in the sense that it may be postponed, on the other. The word *reparative* was chosen with reference to the technical procedures that repair damaged and distorted anatomic parts also it indicates that the surgery coincides with the period of greatest biologic activity in wound repair. This starts on the fourth day the time selected on purely clinical grounds as the optimal time for surgical repair of a soft tissue wound. There is no sharp end point, but for the simple wound the optimal phase for surgery closes at approximately the tenth day. This time interval for reparative surgery is fixed by biologic laws to which military planning must accede unless grim necessity demands sacrifice of that part of the potential combat strength of the force evacuated as lightly wounded.

The application of the procedures of reparative surgery requires an analysis of a wound in terms of the structures that have been damaged for the repair of each tissue and structure is subject to different laws. It also stimulates a precise analysis and recast of terminology to achieve uniformity in definition and clarity in thinking.

It is important that the scope of the term reparative surgery be clearly understood. It is by no means synonymous with delayed

<sup>1</sup>The report is dated 6 December 1944.

primary suture, delayed suture, and secondary suture." Reparative surgery defines a phase of wound management during which these procedures, referred to as the second stage of the two-stage operation by Edwards are carried out. In addition, other operations such as decortication of the lung, the early removal of foreign bodies, the repair of nerve injuries, and the final reduction of battle fractures are considered as reparative surgery because they are designed to prevent or cut short wound infection either before it is established or at the period of its inception or concerned with restoration of the function of the part by anatomic repair.

Wounds are referred to as simple<sup>2</sup> or soft tissue wounds when the injury is confined to skin, subcutaneous tissue and fascia, and muscle damage is not extensive. A complex<sup>3</sup> wound has, in addition to the soft tissue wound, damage to nerve, bone, tendon, joint or major vascular trunk, or extensive damage to muscle that will materially interfere with function. In the management of a complex wound subsequent to the initial surgical débridement, separate consideration must be accorded each component part of the wound, such as the wound of the soft tissue, the wound of the bone or that of the nerve. The timing, the sequence and the extent of the reparative surgical procedures carried out on a complex wound are determined by its component parts, their extent and nature, and the wide variety of combinations in which they may be present.

Thus the term "reparative surgery" designates a phase of wound surgery applicable to complex wounds as well as simple wounds.

<sup>2</sup>The term "simple gunshot wound" was defined and used by G. J. Gethrie in recording the epidemics and practice of the surgical Department of the B. 10th Army at the termination of the Wars in Spain, Portugal, France, and the Netherlands, in 1918 and 1919. Simple wounds were "Wounds in Parts of the Body by Portance or Comparative Consequence in the Human Tissue."

<sup>3</sup>Various terms have been used to describe wounds that are more extensive than simple wounds. The adjective "compound" is closely linked by usage with open injuries of bone and joint and has thereby acquired specialized significance. The term "traumatic" implies "complications" such as secondary hemorrhage or infection, and for this reason is best reserved for wounds with sequential pathologic entity. Also, "spunked" means less developed in bone and joint surgery and "compound" refers to one with adjacent injury to other structures such as nerve or joint. In the sense used here, *complex wound* is an archaic and important anatomic components that are involved. It contrasts neatly with the simple wound of the military surgeon of the past.

rather than any single technical procedure such as delayed suture of the soft tissues. It includes a wide variety of operative procedures for complex wounds as well as closure of the skin and underlying soft tissue. Also as a comprehensive term it includes a number of methods of closure of simple wounds that find a constant application when large numbers of casualties are being treated. The terms 'delayed primary suture' and 'secondary suture' describe the closure of the skin in terms of the time interval that has elapsed before closure is attempted. Universal agreement is lacking as to the actual time intervals that are implied by the use of these two terms and experience has shown that, after all, no sharp line exists so far as the ultimate result is concerned provided the surgical technique employed is adapted to the specific problem at hand. For this reason the inclusive term 'reparative suture' has come into use implying a delay and contrasting with primary suture.

In general the following principles will be found valid in the management of a simple wound or the soft tissue component of a complex wound.

1 When the initial surgery (débridement) has been complete and the wound has been protected from subsequent contamination by an occlusive dressing and adequate splinting the optimal time for closure is the fourth post-operative day. At this time muscles and fascial planes may be sutured with catgut, cotton or silk, and closure of the skin defect may be aided by the advancement or rotation of flaps or the application of a split thickness graft.

2 As the time interval is increased beyond the fourth day, the feasibility of anatomic layer closure diminishes and there is a steadily increasing number of cases in which closure must be performed by single sutures passing through all layers.

3 On or about the tenth day it will be found necessary to undercut the cutaneous margins, with or without the removal of surface granulation tissue to obtain skin approximation. The incidence of kindly healing will be appreciably lessened and the ultimate scar will tend to spread.

4 Again as the time interval is extended beyond the fourth day there will be found an

increasing indication completely to excise the wound before suture thus to restore flexibility and permit layer closure. This procedure is limited to wounds in anatomic regions where additional loss of tissue will not interfere with the ultimate functional or esthetic result. In very late wounds (3 weeks to 6 months) complete wound excision is an essential prelude to closure by suture and may be necessary or advisable preceding skin grafting.

5 When the initial surgery (débridement) has not been complete and devitalized tissue remains in the wound a purulent exudate at times associated with a foul odor will be apparent by the fourth day. Under these circumstances the residual necrotic tissue may be excised and the wound closed immediately or following excision the wound again may be left open and closure undertaken when it is certain that all dead tissue has been removed and invasive infection is not to be reckoned with.

6 When invasive infection is present, free drainage is established and tissue devitalized by the infection or by the original trauma is excised. The interval before closure may be attempted varies with the severity and extent of the infection but usually falls within the 10 day period following the operation.

Management of the soft tissue component of a complex wound is modified by the treatment that must be directed to those injured structures that are important to the ultimate function of the part. In a complex wound the goal of reparative surgery is not limited to the closure of the soft tissues and skin but extends to the repair of the wound of the bone, the nerve or the important muscles that have been divided. In general early closure of the skin is greatly desired to exclude further bacterial contamination but it may be delayed deliberately. For example following reparative suture of a transversely divided quadriceps femoris or deltoid muscle the skin may be left unsutured in selected cases to provide free escape for blood and wound exudate. Skin closure is then carried out in approximately 4 days. Battle fractures are complex wounds and usually the most important component of the wound is the fracture rather than the soft tissue defect. After accurate re



duction is secured closure of the muscles over the fracture site is the most vital step of reparative surgery. Suture of the skin may be delayed, or if the defect is small, spontaneous healing may be anticipated long before the fracture is united. Again complete or partial division of a nerve may be the most important component of a wound. Here the first step may be complete suture of the soft tissues and skin to obtain clean healing with minimal scar formation. Repair of the nerve then may be undertaken at a 3 week interval. When nerve and bone are both injured still more elaborately staged procedures may be indicated, always with the goal of the restoration of the ultimate function of the extremity in mind.

The surgical principle that has emerged may be summarized as follows. Following an open traumatic injury excision of dead and devitalized tissues should be done at the earliest opportunity. This may be considered as an initial operation and care is taken to conserve all viable parts that are important to subsequent function. Dressings and splinting are designed to minimize swelling and prevent further damage to structures by motion. Invasive infection is held in check by systemic chemotherapy. The patient may then be transported to receive the full benefit of whatever specialized technical skills are required for the reparative surgery of complex injuries. The application of this principle in civilian trauma is readily apparent.

#### THE PATTERN OF TRAUMA

The war experience with traumatic injury emphasizes the need for further understanding of what may be called the pattern of trauma. When individuals are simultaneously subjected to trauma or sequentially exposed to the same trauma, the resulting injuries conform to a type pattern. This has long been recognized in civilian injuries, and entities such as miner's elbow and bumper fracture are surgical classics. It is a familiar finding in disasters and I need only mention the Cleveland Clinic fire and the Boston Coconut Grove fire to emphasize the necessity for immediate recognition of the pattern of trauma. There were similar incidents during the war such as the Bari air raid and of course most

notably the atomic bomb attacks on Hiroshima and Nagasaki. Recognition of the pattern of trauma must be prompt in disaster to point the way toward effective treatment of the survivors. A recurring pattern in injuries sustained sequentially under similar circumstances leads the surgeon to propose preventive measures.

#### PREVENTIVE SURGERY

World War II witnessed a rudimentary but clear appreciation of preventive surgery as undeveloped phase of our craft. Preliminary explorations were made in the use of protective armor against flying missiles. Protective body armor in the form of a "flak suit" was adopted early by the Air Force. Careful analyses on the lethality of weapons and the distribution of wounds document the assertion by DeBakey (8) that the application of existing knowledge on body armor might "reasonably be expected to reduce the number of those killed in action by 12 per cent and of those wounded in action by 8 per cent. Although the war ended before body armor could be used in any area of land combat, other protective devices, in addition to the familiar steel helmet, were introduced by surgeons. Sir Alexander Hood (11) points out that the familiar crash helmet of the British Army was designed by a neurosurgeon (Hugh Cairns). Surgeons of the European Theater of Operations (7) assisted the medical service of the Air Force in a vigorous effort to prevent high altitude frostbite. With protective equipment and procedures this crippling injury of expert bomber crews was virtually eliminated. Ophthalmologists conducted extensive field studies on the use of shields designed to protect the eyes from the hazards of land mine and booby trap explosions.

The control and prevention of blast injuries of the ears were effected by joint study of Ordnance and the National Research Council. The incidence of aero-otitis, a common disability that grounded highly trained air crews was greatly reduced by control measures. Footgear effective in the prevention of trench foot was developed through Medical Department liaison with the Quartermaster. Tetanus, an ancient scourge of the battlefield, was vir-



Members of the Council of National Defense and the Advisory Commission Seated, left to right David F. Houston, Josephus Daniels, Newton D. Baker, Chairman of the Council, Franklin K. Lane, William B. Wilson. Standing

left to right: Grosvenor B. Clarkson (Secretary), Julius Rosenwald, Bernard M. Baruch, Daniel Willard, Dr. Franklin H. Martin, Hollis Godfrey, Howard E. Coffin, Walter S. Gifford (Director).

tually eliminated by the inoculation with toxoid.

It is clear that this preventive phase of surgery must be developed with vigor and imagination to keep pace with the traumatic hazards of modern life or surgery will remain solely a salvage service. Although the surgeon is historically the senior practitioner of the battlefield, his place of importance has been yielded to the expert in preventive medicine in the conflict of mass armies. With the awful increase in the lethality of weapons and the destruction of the civilian population as the strategic objective of the enemy, it seems unlikely that military surgery will ever regain its ancient position by virtue of its salvage func-

tion alone. As the military power of this country depends upon highly specialized personnel operating extremely complicated weapons and machines, the military surgeon of the future must be an expert in the prevention of traumatic injury in addition to its alleviation.

#### THE DOCTOR AT WAR

Having discussed certain ways in which his war experience may have modified surgical theory and concept, I shall deal briefly with broader phases of the experience of the American Surgeon A. U. S. Pearl Harbor found the civilian medical profession in a maze of poorly integrated but highly developed specialism in remedial medicine. The prevailing tactical



There were many lessons of the first World War that were promptly forgotten or the significance of which at the time were really not appreciated. In looking back at the experience of World War I with the perspective of the recent war there is no single item that has more profound significance than the position occupied by Franklin H. Martin as the representative of the medical profession during the first conflict. It contrasts with the lack of a medical statesman at that level in World War II. On October 11, 1916, President Woodrow Wilson appointed Franklin H. Martin to the Advisory Commission of The Council Of National Defense. The story is graphically told by the pen of Dr. Martin (17) himself in his *Digest of the Proceedings of the Council of National Defense during the World War*. Representation of the profession in an advisory capacity at the Cabinet level insured that the voice of Medicine could be heard.

In this respect I would be remiss not to pay sincere and deserved tribute to our own Dr. Fred W. Rankin. Without the strategic advantage of position granted to Dr. Martin in World War I it was inevitable that General Rankin's well designed efforts should meet with frustration time and time again. Nevertheless, by skillful and untiring efforts as Chief Surgical Consultant he stands out as the Sponsor of the American Surgeon A US and the corner

stone upon which the achievements of American Surgery in World War II were erected.

## REFERENCES

1. ARCHIBALD, EDWARD W. Unpublished manuscript notes. Medical Historical Section Canadian Army.
2. BEECHER, HENRY K. *Ann Surg* 1945 121: 869.
3. BLALOCK, ALFRED. *Principles of Surgical Care* P 120. St. Louis: C. V. Mosby Co. 1940.
4. CANNON, WALTER B. *Traumatic Shock*. P 31. New York: D. Appleton & Co., 1923.
5. CHURCHILL, EDWARD D. *Ann. Surg.* 1944, 120: 268.
6. Circular Letter No. 3. Office of the Surgeon II Corps. In the Field. August 7, 1943.
7. DAVIS, LOYAL, SCARFF, JOHN E., ROGERS, NEIL, and DICKINSON, MEREDITH. *Surg. Gyn. Obst.* 1943, 77: 501.
8. DEBAKEY, MICHAEL E. *Military Surgery in World War II*. To be published.
9. EDWARDS, H. C. *Lancet*, Lond., 1945 1: 583-585.
10. HENDERSON, Y. J. *Am. M. Ass.* 1933 101: 261.
11. HOOD, SIR ALEXANDER. *Lancet*, Lond. 1945 1: 711-715.
12. MACLENNAN, J. D. *Lancet*, Lond., 1943 2: 63.
13. MALLORY, TRACY B. Personal communication.
14. Memorandum. Subject: War Department Circular Clarifying Responsibilities of The Surgeon General. War Department. Office of The Chief of Staff. April 13, 1945.
15. Report to The Surgeon, North African Theater of Operations, by The Surgical Consultant. Subject: Whole Blood Transfusion. April 16, 1943.
16. Report of a Board for the Study of the Seriously Wounded, Mediterranean Theater of Operations. August 14, 1945.
17. Senate. Document No. 193. 73rd Congress, 2d Session. Washington: U. S. Government Printing Office, 1934.
18. STEWART, JOHN D. and ROURKE, G. MARGARET. *J. Clin. Invest.* 1936 15: 697.
19. ZWIEMER, RAYMUND L., and SCOTTER, JOHN. *Surgery* 1938, 4: 510.



TABLE I—COMPARISON OF THE INCIDENCE OF THE CAUSES OF DEATH IN PENETRATING WOUNDS OF THE ABDOMEN BEFORE AND AFTER CHEMOTHERAPY

Cases admitted between January 1938 and January 1942			6 cases admitted between January 1942 and May 1948		
Per cent			Per cent		
Mortality rate 27.9			Mortality rate 11.6		
Cases	no.	Per cent	Cases	no.	Per cent
Peritonitis	9	31.0	Hemorrhage	7	30.4
Hemorrhage	7	24.1	Pneumonia	4	17.4
Shock	6	21.3	Putrefactive	4	17.4
Pneumonia	5	17.2	Empyema	4	17.4
Uremia	1	17.2	Peritonitis	3	8.7
Retroperitoneal cellulitis	1	3.4	Meningitis	3	8.7
			Uremia	1	4.3
			Undetermined	1	4.3

death in only 2 instances in the patients treated with sulfonamides. There is also evidence that systemic sulfadiazine therapy has had a similar beneficial effect in operations for resection of the bowel by greatly reducing the incidence of postoperative peritonitis

#### THERAPEUSIS

The value of sulfonamide therapy has been unquestionably established in acute infections produced by a hemolytic streptococcus the pneumococcus and the gonococcus but it is of little or no value in those caused by the hemolytic staphylococcus (2 4 12 13 18). Its advantages of low cost, ease of administration and high bacteriostatic action often make it the drug of choice in these infections

Sulfadiazine is still a valuable drug in certain mixed infections produced by various gram negative and gram positive bacteria of the intestinal tract. *In vitro* studies on examples of mixed bacterial floras show that its marked bacteriostatic action is usually superior to that of penicillin in the usual concentrations which are built up in the blood during systemic therapy (Fig 1). Clinical experience has likewise demonstrated the effectiveness of this form of chemotherapy in mixed infections. More recently very large doses of penicillin have proved to be very effective in the management of mixed infections. However certain limitations of sulfonamide therapy have become increasingly apparent including (1) the presence of bacterial species and group resistance (2) the inactivation of bacterio-

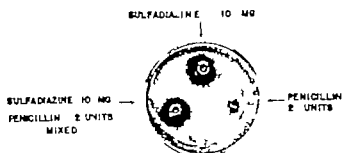


Fig 1 Blood agar plate showing the superior bacteriostatic effect *in vitro* of sulfadiazine over that of penicillin on a mixed culture of both gram negative and gram positive bacteria. *Pseudomonas aeruginosa*, *Staphylococcus aureus*, resistant to penicillin *Escherichia coli* *Streptococcus viridans*, resistant to penicillin hemolytic streptococcus, susceptible to penicillin *Staphylococcus aureus*, susceptible to penicillin nonhemolytic streptococcus, resistant to penicillin.

static activity by inhibitors found in pus wound exudates and necrotic tissue (3) the development of drug fastness by many of the infecting bacteria (4) the occurrence of some toxic reactions when its administration was not carefully controlled (5) its inability to penetrate areas of pus and necrosis and (6) the occasional occurrence of drug idiosyncrasy

With the introduction of penicillin many of these limitations have been overcome. The sulfonamide inhibitors have little or no effect on the bacteriostatic action of penicillin and its extremely low toxicity has been of equal significance. Doses of one million units every 3 hours have been used repeatedly and in one instance a child received 100 000 000 units each 24 hours for 2 weeks without evidence of toxicity (13). The toxic reactions that have occurred during penicillin therapy have been due largely to impurities or idiosyncrasies and the threshold of toxicity as yet is undetermined

At the present time penicillin is the most effective chemotherapeutic agent available for the treatment of many surgical infections particularly those caused by the staphylococci, the aerobic streptococci the gonococci and the anaerobic streptococci. Evidence of its superiority over the various sulfonamides in the therapy of staphylococcal infections is overwhelming and its effectiveness in infections caused by sulfonamide-resistant strains of the streptococcus and gonococcus have been outstanding. The micro-organisms sensitive to its action *in vitro* are listed in Table II and

TABLE II.—PENICILLIN ACTIVITY IN VITRO—  
SENSITIVE MICRO-ORGANISMS

<i>Gonococcus</i>	<i>Clostridium histolyticus</i>
<i>Meningococcus</i>	<i>Clostridium septicum</i>
<i>Streptococcus</i>	<i>Clostridium sordidus</i>
hemolytic	<i>Clostridium oedematiens</i>
viridans	<i>Clostridium sporogenes</i>
microaerophilic	<i>Clostridium fermentans</i>
anaerobic	<i>Bacillus diphtheriae</i>
<i>Staphylococcus</i>	<i>Bacillus pseudodiphtheriae</i>
aureus	<i>Lactobacillus</i>
albus	<i>Cryptococcus hominis</i>
anaerobic	<i>Spirillum minus</i>
<i>Micrococi</i>	<i>Streptobacillus moniliformis</i>
<i>Pneumococcus</i>	<i>Treponema pallidum</i>
<i>Bacillus subtilis</i>	<i>Bacillus alkaligenes</i> (some strains)
<i>Bacillus anthracis</i>	<i>Leptospira icterohemorrhagiae</i>
<i>Actinomyces bovis</i>	<i>Erysipelothrix rhusiopathiae</i>
<i>Clostridium tetani</i>	
<i>Clostridium tetanomorphum</i>	
<i>Clostridium botulinum</i>	
<i>Clostridium welchii</i>	

those resistant in Table III. More recently the very low toxicity of penicillin has permitted exploration of the clinical value of very large doses in infections produced by bacteria resistant or slightly susceptible to its action. The encouraging results obtained justify a more thorough investigation of the therapeutic possibilities of large doses up to one million or more units every 3 hours in this type of infection.

In the 4 years between November 1942 and November 1946 704 surgical infections treated with penicillin surgery when indicated and the general and local supportive measures for correction of altered physiology have been studied and they included the following:

Staphylococcal infections	47
Pneumococcal infections	70
Anaerobic streptococcal infections	80
Aerobic streptococcal infections	40
Gonococcal infections	7
Actinomycotic infections	9
Human bit infections	8
Ratbite fever infections	
Gas gangrene infections	
Pyoderma gangrenosum infections	4

Experience has shown that penicillin is the chemotherapeutic agent of choice in the treatment of all staphylococcal infections in surgery having replaced all previous forms of chemotherapy. An arbitrary tabulation of the clinical results obtained with penicillin in the treatment of the 427 cases with established staphylococcal infections is given in Table IV.

TABLE III.—PENICILLIN ACTIVITY IN VITRO—  
RESISTANT OR SLIGHTLY SUSCEPTIBLE  
STRAINS OF MICRO-ORGANISMS

<i>Bacillus coli</i>	<i>Acne bacillus</i>
<i>H. influenzae</i>	<i>M. tuberculosis</i>
<i>Bacillus typhosus</i>	<i>Bacillus tularensis</i>
<i>Bacillus paratyphosus</i>	<i>Brucella melitensis</i>
<i>Bacillus dysenteriae</i>	<i>Brucella abortus</i>
<i>Bacillus proteus</i>	<i>Bacillus anthracis</i>
<i>Bacillus enteritidis</i>	<i>Moraxella mallei</i>
<i>Bacillus pyocyaneus</i>	<i>Moraxella mallei</i>
<i>Aerobacter aerogenes</i>	<i>Blaschkeomyces</i>
<i>Bacillus fluorescens</i>	<i>Tetrasphaera</i>
<i>Bacillus friedlanderi</i>	<i>Bacillus mycoides</i>
<i>Bacillus prodigiosus</i>	<i>Lymphococcus caryocarpus</i>
<i>Bacillus pestis</i>	
<i>Vibrio cholerae</i>	

The effects of penicillin therapy were particularly apparent in the treatment of the severe staphylococcal infections with massive manifestations. If the infection was in the diffuse or cellulitic stage, penicillin therapy was often followed by complete and spontaneous resolution and a minimal amount of local destruction of tissue (Fig 2). If the diagnosis

TABLE IV.—RESULTS IN PENICILLIN THERAPY  
STAPHYLOCOCCAL INFECTIONS

Clinical Diagnosis	N cases	Results			
		Excellent	Good	Questionable	Failure
Septicemia	30	11	5		14
Carbuncles	5	34	14		
Cellulitis	40	31	16		
Furunculosis	29	23	4		
Acute hematogenous osteomyelitis	60	25	29		
Chronic osteomyelitis	54	0	11	12	8
Infected wounds	23	37	16		4
Abscess	4	8	6		
Flask infections		6	3		
Abscesses of lung	3	5			6
Brain abscess					
Bursitis	6	5			
Postoperative paronychia	6	4			
Chronic lymphadenitis with lymphadenoma	4		4		
Abdominal abscess	4				3
Hydrocele scapularis	9	7			
Pericarditis					
Spinal epidural abscess					





TABLE V — STAPHYLOCOCCAL SEPTICEMIA

	40 Cases treated with sulfadiazine, bacteriophage, etc. 1940-1943 Per cent	40 Cases treated with penicillin 1944-1946 Per cent
Mortality	67.6	30
Recovery	32.5	70.0
	Morbidity	
	Hospital days	Hospital days
Fatal Cases	18	22.8
Recovered Cases	80	53.8

The obvious values and limitations of penicillin therapy in the management of this condition are illustrated in a recent study of 90 cases of hemolytic staphylococcus septicemia at the Cincinnati General and neighboring hospitals between 1940 and 1946. A total of 40 cases of staphylococcus septicemia were treated with sulfonamides, surgery when indicated or bacteriophage between 1940 and 1943 and a similar series of 50 cases were treated with penicillin in addition to other medical and surgical medical measures between 1943 and 1946. Table V compares the two series in respect to mortality and morbidity indicating the profound effect penicillin has had upon this infection.

It is apparent that penicillin has approximately reversed the mortality and recovery rates. Whereas only 32.5 per cent recovered under sulfonamide bacteriophage and other forms of therapy 70 per cent recovered under penicillin therapy. A further analysis of the fatal cases reveals some of the limitations of penicillin therapy (Table VI).

The results in the cases developing vegetative endocarditis particularly early in the series were very poor and this condition accounted for almost half of the deaths. Of the remaining 8 fatal cases, 5 of the deaths occurred within 12 to 48 hours after their admission to the hospital and start of penicillin treatment. In these instances, the fulminating infection or moribund condition of the patient produced death before the maximum chemotherapeutic effect could become manifest. In the case of the infected burn the *Staphylococcus aureus* was resistant to the action of penicillin.

The outcome in the individual case was dependent upon many factors (2-12) including the age of the patient, the susceptibility of the strain of staphylococcus to penicillin, the site

TABLE VI.—FATAL CASES OF STAPHYLOCOCCAL SEPTICEMIA

Diagnosis	No. of cases
Vegetative endocarditis	1
Pneumonia	3
Infected burn of 60 per cent body surface.	
Cavernous sinus thrombosis	
Otitis media with lateral sinus thrombosis	
Periphrigias	1
Acute osteomyelitis (terminal)	

and nature of the primary infection, the location of the bacteriemia, the presence and location of secondary or metastatic abscesses, the accessibility of the primary or secondary infections to surgical drainage, and the presence of other associated and complicating diseases. Inadequate treatment predisposed to relapse. Experience has shown that treatment is most successful in young adults or children in whom the diagnosis of staphylococcal bacteremia is made early, penicillin therapy given early and intensively and surgical drainage is possible when indicated.

**Carbuncles.** A carbuncle is essentially a spreading and necrotizing staphylococcal infection of the deeper layers of the skin and subcutaneous tissue which may result in extensive necrosis, sloughing, liquefaction of the subcutaneous tissue, septicemia, and death. The many forms of treatment which have been devised for carbuncles are an indication of our inability to control the locally or generally invasive characteristics of this infection. The great majority of surgeons have learned to employ crucial incisions or excision and because of the tendency of carbuncles to extend locally or invade the general circulation, the treatment of choice at many clinics, including the Cincinnati General Hospital, has been radical excision. Sulfonamide therapy in general has been disappointing due principally to the natural resistance of the hemolytic *Staphylococcus aureus*.

The marked effect of penicillin on the management of carbuncles is shown in a group of 40 cases with carbuncle which we have treated with penicillin between February 1944 and October 1946. 8 of which received both penicillin and sulfadiazine. The dosage employed was 15,000 to 20,000 units every 3 hours given intramuscularly in every instance but one in which it was given intravenously. The average

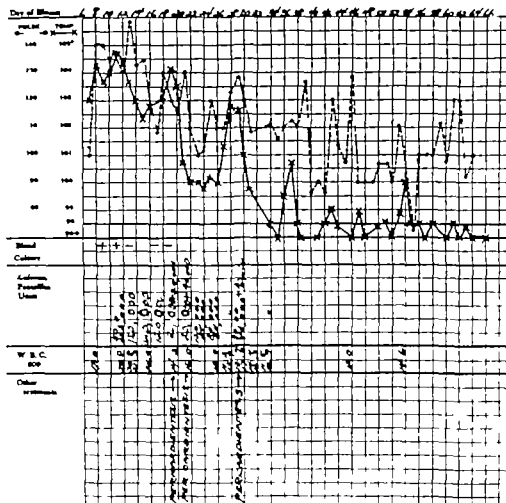


Fig 3. J. B. aged 8 years acute hematogenous osteomyelitis with bacteremia and metastatic pericarditis. Chart shows failure of response to penicillin therapy until metastatic infectious complication in the form of a pericarditis is recognized and treated as indicated.

total dose was 927 000 units and the average duration was 7 days

The results of treatment indicate that penicillin is obviously the chemotherapeutic agent of choice in this type of infection. When given early in sufficient amounts and over a long enough period of time it brought the general and local invasive manifestations under control within a period of 48 to 72 hours and so modified the subsequent course that both mortality and morbidity were reduced. In our experience penicillin therapy was followed by complete and spontaneous resolution in 26.5 per cent of the cases (Figs. 4 and 5) by partial resolution with centralized necrosis in 22.4 per cent of the cases with partial resolution and abscess formation in 49.0 per cent of the cases, and by failure in 2 per cent of the cases. Thus it was not necessary to subject these patients to emergency total excision of the lesion in

order to control this infection. Since the invasive qualities have been controlled so effectively with penicillin more limited surgical procedures are recommended when indicated consisting of incision and drainage of abscesses occurring during therapy and cruciate incision for the removal of necrotic tissue.

*Acute hematogenous osteomyelitis* In the past the results of treatment in this condition have been unsatisfactory for several reasons. Difficulties in diagnosis often resulted in delay and spread of the process with extensive destruction of the bone. When early diagnosis

TABLE VII.—RESULTS OF PENICILLIN THERAPY

	Cases	Per cent
1. Spontaneous resolution	13	26.5
2. Partial resolution with necrosis	11	22.4
3. Abscess formation	24	49.0
4. Failure	1	2.0



Fig. 4. F. H. aged 43 years, admitted to Cincinnati General Hospital, August 3, 1944, with a large carbuncle of the neck of 10 days duration. Temperature and pulse remained normal after the third day. a, left, Appearance of carbuncle on August 3, 1944, b, start of treatment with penicillin. b, August 12, 1944, disappearance of the carbuncle and almost complete healing have occurred in 9 days.

was made, the principal method of arrest and control of the necrotizing process was emergency decompression of the involved area by surgical drainage followed by prolonged periods of immobilization. More recently chemotherapy with the sulfonamides used as a supplement to surgical intervention aided in the control of the infection but left much to be desired. Penicillin on the other hand has had a profound effect upon acute hematogenous osteomyelitis and has greatly modified both its management (8, 14, 19) and roentgenographic interpretation (9). In the group of 64 cases of acute hematogenous osteomyelitis treated with penicillin the mortality rate was remarkably low being 1.5 per cent. In general the other results of penicillin therapy varied primarily with the time of diagnosis and start of treatment falling into 4 groups.

The first group included those cases in which the correct diagnosis was made within the first 3 or 4 days, and adequate treatment was started immediately. The results were truly excellent surgical intervention usually being unnecessary and abscess formation infrequent. After a period of 36 to 72 hours, the fever, rapid pulse, bacteremia, and other general

signs of the severe infection began to disappear. At the end of a week the temperature was usually normal and the patient looked and felt quite well. The local signs of infection, such as tenderness, edema, and redness, also began to recede after a similar latent period. During the next 1 to 6 months a series of roentgenographic changes occurred in the involved bone which were minimal consisting of localized periosteal reaction or small areas of patchy decalcification of the underlying cortex, or both. These findings occasionally were hard to see and could be easily overlooked.

In the second group in which the diagnosis and treatment with penicillin were moderately delayed for 4 to 7 days, the general and local infections were brought under control by penicillin less promptly after a period of 2, 3, or more days during which little or no clinical response was evident. Localized soft tissue abscesses occasionally developed and when small, they were successfully treated by aspiration and local injections of a solution of penicillin. When large surgical drainage by incision was done to minimize further tissue destruction by the accumulated necrotizing bacterial toxins. If surgical drainage was insti-



Fig 5 V L., aged 33 years. a left, Carbuncle of face with diffuse cellulitis, thrombophlebitis of facial external, and anterior jugular veins, staphylococcal bacteremia, and bilateral pneumonia. Temperature, 106 degrees F at start of penicillin therapy b Effect of 10 days therapy with penicillin.

tuted the fall of temperature was usually prompt and not delayed for 36 or more hours as in the case treated without surgical intervention

After a week or more had elapsed periosteal reaction and localized patchy demineralization of the underlying metaphysis became evident in the roentgenograms and increased in extent and degree becoming most marked 1 to 5 months after the onset of the infection. Recalcification of the demineralized areas followed with re-establishment of a more normal appearance of the bone. Sequestration rarely occurred in this group.

The third group included cases in which the diagnosis and treatment were delayed for 7 to 10 or more days and those in which the infection was unusually severe. The local destruction of bone became very great and soft tissue abscess formation and sequestration occurred in most, but not all of the cases. The local infection was arrested with more difficulty in this type of case and longer periods of treatment with penicillin were usually required. Small abscesses were treated by aspiration and large ones by incision and drainage. Prolonged immobilization by cast in these cases seemed to be definitely indicated.

The bony changes as revealed by serial roentgenograms at the start of penicillin treatment showed extensive bone destruction which increased on subsequent examinations. Se-

questration occurred in most cases and in many instances the smaller sequestra were gradually absorbed spontaneously.

The fourth group included certain fulminating infections in which the patient would not live 48 or more hours to permit the maximum effect of penicillin. Surgical intervention after adequate preoperative preparation was necessary as an emergency measure in addition to intensive penicillin therapy.

In general the effects of penicillin included control of the generalized infection with sterilization of the blood stream, reduction of the mortality rate and decrease in the incidence of metastatic or secondary infectious complications. If metastatic complications such as staphylococcal pneumonia, pleuritis, pericarditis, thrombophlebitis, etc. already existed, penicillin was a powerful chemotherapeutic agent aiding in their control as an adjunct to surgical or conservative treatment as indicated. Thus the morbidity was also decreased.

There seems to be little doubt that adequate penicillin therapy can eliminate the necessity of emergency surgical intervention in most cases of early acute hematogenous osteomyelitis (8, 14, 19). It must be emphasized that early diagnosis can be made only on clinical grounds and that little or no help is to be expected from the roentgenograms for 10 or more days. If there is any doubt as to the presence of an acute osteomyelitis, it is better



Fig. 6 M. K. a, left, Severe acute hemolytic streptococcal cellulitis of face, neck, and scalp, with gangrene which was resistant to sulfonamide therapy. Temperature as 3 degrees F at start of penicillin therapy. b, Appearance of lesion after control of infection, separation of slough, and preparation of area for skin graft.

to start penicillin therapy rather than wait until the diagnosis is proved.

Of particular interest were the resultant roentgenographic changes which occurred in the involved bone treated with or without surgery. During the period of penicillin therapy evidence of bone damage was absent or confined to minimal changes such as slight periosteal reaction or small areas of demineralization in the underlying cortex. After the cessation of chemotherapy the periosteal reaction and mottled appearance of the underlying bone progressively increased, reaching a maximum 1 to 5 months after the onset of the infection. In this way the bone always looked worse a month or more after penicillin therapy than during it. This picture has been interpreted as being the result of spontaneous absorption of bone destroyed early in the infection and not as the result of continued destruction of bone by an extending chronic osteomyelitic process. Following this recalcification of the involved areas occurred often very rapidly. Meanwhile normal growth of the metaphyses, calcification of the adjacent

epiphyses, and return of function occurred. These facts suggested that adequate penicillin therapy may sterilize the infected bone converting an area of septic necrosis to one of aseptic necrosis. One of the most important aspects of this problem remains unanswered as yet: the question as to whether or not the infection has been completely cured.

*Chronic osteomyelitis.* In chronic osteomyelitis the results were usually disappointing unless penicillin therapy was used in conjunction with radical surgery. Spontaneous resolution of an acute exacerbation was noted in only a few instances. In the remainder surgery was necessary along with penicillin to clean up the local infective process.

*Acute secondary or postoperative parotitis.* The control of acute secondary parotitis by chemotherapy is desirable since its arrest by conservative measures is uncertain and its control by surgical incision and drainage has certain disadvantages. Incision may result in unsightly scars, occasional injury to the facial nerve, salivary fistulas, or troublesome secondary infection (5). In addition a general ant-

TABLE VIII.—AEROBIC STREPTOCOCCAL INFECTIONS—RESULTS OF PENICILLIN THERAPY

Clinical diagnosis	No. cases	Results			
		Excellent	Good	Questionable	Failure
Septicemia	26	13	6	1	6
Cellulitis	6	12	4		
Acute hemolytic streptococcal osteomyelitis	3				
Acute streptococcal gangrene	5	1	2		
Meningitis	4				
Erysipelas	3		2		1
Pericarditis	2	1			
Peritonitis	2				
Liver abscess	3		1		2
Acute mastoiditis with lateral sinus thrombosis	2	1	1		
Septic abortion	1	0	2	2	

TABLE IX.—ANAEROBIC STREPTOCOCCAL INFECTIONS—RESULTS OF PENICILLIN THERAPY

Clinical diagnosis	No. cases	Results			
		Excellent	Good	Questionable	Failure
Bacteremia	6		1	1	2
Septic abortion	0	2	6		1
Chronic buccal swelling	5			3	
Chronic progressive cutaneous gangrene	2				1

In the treatment of anaerobic streptococcal infections, penicillin was far superior to the sulfonamides (3). *In vitro* studies showed its bacteriostatic action under anaerobic conditions for the anaerobic streptococci to be far greater than that of the sulfonamides. We have had an opportunity to use penicillin therapy on 22 cases of anaerobic streptococcal infections and the results are shown in Table IX.

**Pneumococcal infections.** The average pneumococcal infections seen in surgical practice respond very well to sulfonamide therapy in much the same manner as do the hemolytic streptococcal infections. Penicillin therapy was therefore reserved for those cases which were sulfonamide resistant and the results obtained in 70 cases are shown in Table X.

**Tetanus.** A clinical study (6) of 22 cases of established generalized tetanus seen in and about Cincinnati has failed to show evidence of any beneficial effect of penicillin on the course of this disease. There was no obvious

TABLE X.—SULFONAMIDE RESISTANT PNEUMOCOCCAL INFECTIONS—RESULTS OF PENICILLIN THERAPY

Clinical diagnosis	No. cases	Results			
		Excellent	Good	Questionable	Failure
Bacteremia	33	20	4		9
Erysipelas	8		8	2	6
Meningitis	9				5
Arthritis					
Pericarditis	1				
Abscess of neck	4		3		
Acute hemolytic streptococcal osteomyelitis	1				
Peritonitis					

thetic and operation unquestionably throw an added burden upon the patient greatly weakened by some other primary disease which pre-disposed to the development of the acute parotitis. The simplicity of administration and the directness of action of effective chemotherapy largely obviate these disadvantages. Of 6 patients treated with penicillin 4 underwent complete and spontaneous resolution. A fifth responded satisfactorily to penicillin after failing to respond to Lugol's solution. The sixth underwent partial resolution with the formation of an abscess which was incised.

The general response of this infection to penicillin therapy followed the general pattern seen in other surgical infections treated by chemotherapy. An interval of 24 to 48 hours following the start of treatment preceded the development of obvious signs of clinical improvement. Thereafter the improvement was progressive and usually rapid.

**Aerobic hemolytic streptococcal infections.** While most of these infections respond promptly to sulfonamide therapy, penicillin is also very effective and particularly valuable in those cases resistant to the sulfonamides (Fig. 6). The results of therapy in cases of hemolytic streptococcal infections treated at this Hospital most of which were sulfonamide resistant, are summarized in Table VIII.



Fig 7 G B a, left, Severe case of gas gangrene complicating compound fracture of tibia and fibula. Infectious process had produced complete gangrene of leg distal to wound and had spread through thigh to inguinal region.



Treatment consisted of mid-thigh gillows, septic penicillin parenterally and peroxide topically and antiseptic therapy. b, Appearance of amputation. Good show of amputation has been brought under complete control.

fall in the temperature or pulse rate as has been repeatedly seen in other infections susceptible to its action: no decrease in mortality or morbidity nor any definitive decrease in the severity, duration or frequency of the convulsive seizures which could be attributed to the action of penicillin. Exceptions were found in cases complicated by pneumonia or other secondary infections susceptible to penicillin in which the improvement that occurred was due to the effect of penicillin on the complicating infection and not on tetanus. The evidence indicates that the successful management of tetanus depends not on chemotherapy but on early diagnosis, adequate serotherapy for neutralization of free toxin, control of the convulsions and the administration of general supportive measures.

**Human bite infections.** When once established this type of infection has been controlled with considerable difficulty in the past. Its necrotizing burrowing characteristics have resulted in prolonged morbidity, extensive septic necrosis of the tissues including bone, toxemia, impaired function and even amputation. The results with penicillin therapy in 9 cases have been very promising and they indicate that penicillin is a valuable therapeutic agent for this condition, being superior to the sulfonamides. In 5 of the cases the response to paren-

teral penicillin therapy, rest, immobilization and elevation was excellent, the infection subsiding quickly and spontaneously with little or no evidence of residual infection or damage. The response was good in 3 other cases when penicillin was used in conjunction with incision and drainage, and questionable in the remaining infection.

**Ratbite fever.** Ratbite fever is essentially an invasive wound infection of two clinical types: (1) *sodoku* caused by the *Spirillum minus* and (2) the *septicemia* form produced by *Streptobacillus moniliformis* (10). The endemic Japanese form, *sodoku*, has responded to antiseptic therapy but no satisfactory form of treatment was known for the streptobacillary type. The first 4 cases of ratbite fever caused by the *Streptobacillus moniliformis* which were treated with penicillin were studied at the Chosenai General Hospital. The results of penicillin therapy in these 4 cases were excellent: in 3 with sterilization of the blood stream, each fall in temperature and pulse, disappearance of rash and arthritis, and shortening of the course of the disease. In addition studies *in vitro* indicated that penicillin has a powerful bacteriostatic effect on the *Streptobacillus moniliformis*.

**Gas gangrene.** Penicillin is by far the chemotherapeutic agent of choice in the control of

established gas gangrene. Clinical investigations indicate that parenteral penicillin used in conjunction with surgery gives encouraging results, but only when it is given in relatively large doses of 200 000 to 400 000 units and 800 000 units per day (11 16 18). In a study of experimental gas gangrene (7) the therapeutic value of penicillin has been determined quantitatively.

Average doses of penicillin had no measurable effect but large doses corresponding to approximately 1 000 000 units given every 3 hours had a very definite effect reducing the mortality prolonging the life of the guinea pigs and localizing the lesions. Without surgery however discontinuation of penicillin was followed by prompt spread of the lesion and ultimate death. These experiments indicate clearly that penicillin in large doses is a valuable adjunct to adequate surgery in the treatment of established gas gangrene since it limits the spread of the lesion prolongs the period during which surgical decompression and excision of involved muscles can be done successfully and reduces mortality. This corresponds to the clinical impression of Jeffrey and Thomson obtained in 33 cases of gas gangrene that penicillin can arrest the progressive myositis but that radical surgery is still the main factor in treating the disease. In our clinical experience of 12 cases of gas gangrene the use of penicillin in conjunction with surgical decompression or amputation seemed to be of definite value in overcoming the invasive manifestations of the infection. If the diagnosis was made at an early stage while the gangrene was more or less localized and incipient, radical decompression of the involved fascial compartments by free longitudinal incisions and excision of the infected muscle usually resulted in the arrest of the process and the saving of the extremity. If the diagnosis was made late when the process was extensive and had caused irreversible gangrenous changes in the extremity implying loss of function of the limb open amputation of the guillotine type or some modification became necessary (Fig 7). At the present time it is inconceivable that any type of chemotherapy or chemotherapeutic agent can replace good surgery in the treatment of gas gangrene.

*Actinomycosis* Penicillin has been much more effective than the sulfonamides in the treatment of actinomycosis but in our experience it is used most effectively in conjunction with sulfadiazine or sulfamerazine. Penicillin given in full doses over a prolonged period of at least 4 to 8 weeks in association with sulfadiazine which is continued under control for an additional 4 to 6 months has given us the best results. Very satisfactory results were obtained in the cervicofacial type and other cases of both abdominal and thoracic actinomycosis have undergone arrest and rather spectacular regression under this management with progressive decrease in size and finally disappearance of the tumor masses and pain. Whether or not complete cures have been obtained in these cases remains to be seen.

#### SUMMARY

It is evident that the sulfonamides and penicillin are very effective and useful agents in the treatment of many infections commonly encountered in the practice of surgery. Penicillin is far superior to the sulfonamides in the treatment of infections caused by the staphylococcus and it has been particularly useful in the cases of infection caused by sulfonamide resistant gonococci hemolytic streptococci and pneumococci. It is also the chemotherapeutic agent of choice in gas gangrene ratbite fever actinomycosis anaerobic streptococcal infections and human bite infections. The use of increasingly large doses of penicillin permitted by its very low toxicity is gradually extending the field of effective chemotherapy in other infections produced by less susceptible bacteria. Penicillin has been strikingly effective in diffuse or generalized staphylococcal infections which have been diagnosed and treated early with penicillin with the exception of those caused by a resistant strain or those complicated by acute vegetative endocarditis. The early treatment of diffuse infections caused by the staphylococcus or streptococcus often was followed by such prompt and complete arrest of the destructive bacterial process that suppuration did not develop and surgical intervention either became unnecessary or limited to more localized measures. In



the management of suppurating surgical infections caused by susceptible bacteria, penicillin therapy has had a striking beneficial effect on mortality and morbidity but the fundamental surgical principles of early accurate diagnosis, early treatment, rest, adequate external drainage, correction of altered physiology, and vigilant supportive treatment remain as important as ever.

## REFERENCES

1. ALTMEIER, W. A. *Surg. Clin. N. America*, 1946, 26: 1-52-60.
2. Idem. *Southern M. J.* 1944, 37: 494-506.
3. Idem. *Surg. Clinics, North America*, 1945, 5: 202-8.
4. Idem. *Lancet*, 1945, 65: 93-100.
5. Idem. *Surgery*, 1946, 20: 9-18.
6. Idem. *J. Am. M. Ass.* 1946, 70: 67.
7. ALTMEIER, W. A., FURST, W. L. and CHILDS, W. R. The value and limitations of chemotherapy in experimental gas gangrene. Unpublished work.
8. ALTMEIER, W. A., and HILSON, G. M., *J. A. M. A.* 1945, 81: 379-383.
9. ALTMEIER, W. A. and ROSENBERG, H. G. *Int. J. Radiat.*, 1945, 34: 437-443.
10. ALTMEIER, W. A., SKYDOR, H. and HARRIS, G. *J. Am. M. Ass.*, 1945, 37: 270-273.
11. JEFFREY, J. S., and THOMPSON, S. *Brit. J. Surg.* 1944, 3: 55-157.
12. KEEFER, C. S. Personal communication.
13. LOCKWOOD, J. S., WHITE, W. L., and MCGEE, F. D. *Ann. Surg.*, 1941, 50: 3: 2-349.
14. MCADAM, J. W. *Brit. J. Surg.* 1945, 33: 267.
15. MACLEOD, J. D. *Lancet*, Lond. 1944, 1: 371.
16. MACLEOD, J. D. and MACLEOD, M. G. *Brit. M. J.* 1944, 683.
17. MULLIN, F. L. *Bull. N. York Acad. M.* 1944, 515-537.
18. Idem. *Surg. Gyn. Obst.* 1945, 80: 241.
19. TRUETA, J. *Lancet*, Lond. 1945, 1: 170.

# CANCELLOUS BONE GRAFTS TO THE JAW

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**T**HE problem of bone grafting in the lower jaw merits serious consideration even though it is met with infrequently in civilian practice. Distortion of appearance which results from mandibular loss in the course of surgery of malignancy and following severe infection or trauma is secondary in importance to disturbance of

speech and to the impairment of mastication and deglutition which affects profoundly the individual's entire nutritional status. In war surgery the necessity of bone grafting to the lower face arises rather commonly because of the high incidence of massive maxillofacial injuries from bullets and shell fragments.

Mandibular bone grafts were first employed 30 years ago during World War I by the German, French and English American groups of workers with perhaps a thousand cases re-

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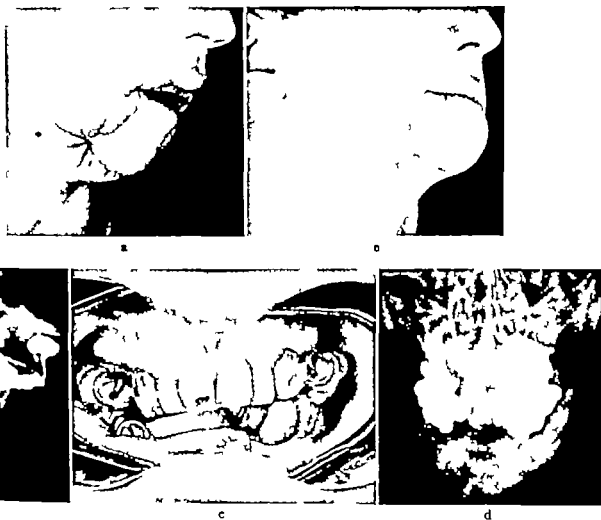


Fig. 1. O. R. I., Pfc., age 21 years, received a shell fragment wound June 29, 1944, with loss of considerable soft tissue of the chin and bony loss of the symphysis and anterior half of the right body of the mandible. It was necessary to readjust soft tissues for better coverage before insertion of a bone graft, and a labioalveolar sulcus was created later by a stent graft in order that a functioning

denture could be used. a, Appearance on admission. b, Roentgenogram showing bone loss. c, Interlocking cap metal splint for immobilization. d, Roentgenogram showing cancellous bone graft bridging the defect. e, Appearance following bone graft.

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Fig. 2. B. V. Pirt. Age 24 years, received a machinegun bullet wound of the face with loss of the greater portion of the left body and angle of the mandible, March, 1944. a, Appearance before operation after subsidence of reaction. b, Roentgenogram on admission showing large loss of substance on the left and nonunion on the right. c, Flange cap metal splint to maintain the fragment in normal position during the healing period and at the same time allow function of the jaw. d, Interlocking cap metal splint, used for immobilization of the jaw. e, Roentgenogram showing large cancellous bone graft in position. f, Stent graft to create sulcus for denture. g, Final denture before disposition. h, Final contour. (b, g are reproduced through courtesy of the J. B. Lippincott Company from article by Blocker.)

ported in all. A variety of sources were employed in the remedy of small losses of bone and in ununited fractures. These include

1. Sliding or pedicle grafts from the mandible for losses not greater than 3 centimeters in the symphysis or body

2. Cortical grafts from the tibia

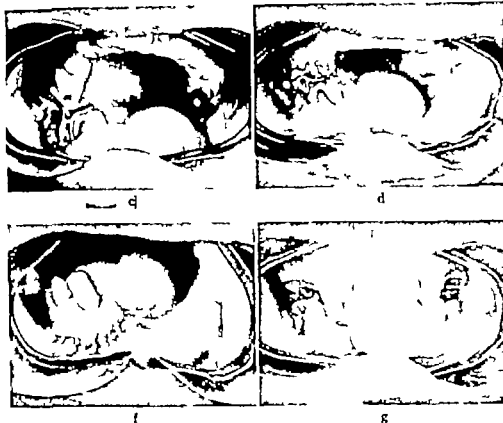
3. Osteoperiosteal grafts—thin shavings of bone and periosteum about 2 millimeters in thickness—for small bony defects not associated with disturbance of contour

4. Rib grafts

5. Clavicle grafts employed in pedicles from the neck for restoration of the symphysis and overlying soft structures of the chin

6. Grafts from the ilium, particularly for large losses of bone and distortion of normal contour

During recent years the use of iliac grafts has been the method of choice although some workers, notably Barrett Brown, employ the rib whenever practicable.



(Legend on opposite page)

The literature on theories as to the mechanism of bone regeneration is voluminous and has influenced considerably the operative technique. For a long time it was felt that periosteum was indispensable but experimental and clinical evidence has demonstrated that neither periosteum nor cortical bone is necessary for successful grafting. The superior qualities of cancellous or spongy bone provide for rapid vascularization and earlier stabilization and union for this reason small chips of part-cortical part-cancellous bone are becoming increasingly popular in orthopedic and maxillofacial surgery when it is felt that immobilization can be maintained without the use of cortical bone as a splint for fragments. The employment of large blocks of pure cancellous bone from the ilium is the most recent innovation in bone grafting. And while other workers may be able to demonstrate equally good results with other methods of reconstruction of mandibular defects we have found cancellous block grafts an extremely satisfactory medium of repair. The ilium is readily accessible and furnishes a large amount of available spongy bone. Following removal

of all cortex the graft is easily cut and shaped to fit the requirements of the individual case. The use of chips alone is rather haphazard and it is difficult to maintain good contour. For extensive defects such as angle-to-angle loss of bone we have employed at times a tantalum tray to give proper shape to the jaw. In these cases more than one block graft is used, and cancellous chips are packed around the open spaces.

With present-day dental appliances there need be no dependence on the mandibular graft for any part of fixation. Cancellous bone very quickly develops strength and evidence of firm bony union within 8 to 14 weeks time after operation when dentures may usually be fitted. We have been able to observe grafts directly 5 to 6 months after surgery when exposure is made to add a cartilage implant for improvement of chin contour. They show smooth white bone with a well-developed pseudoperiosteum and on stripping of this membrane numerous nutrient vessels are seen entering the bone.

The most important requirements for success in bone transplantation are adequate sup-

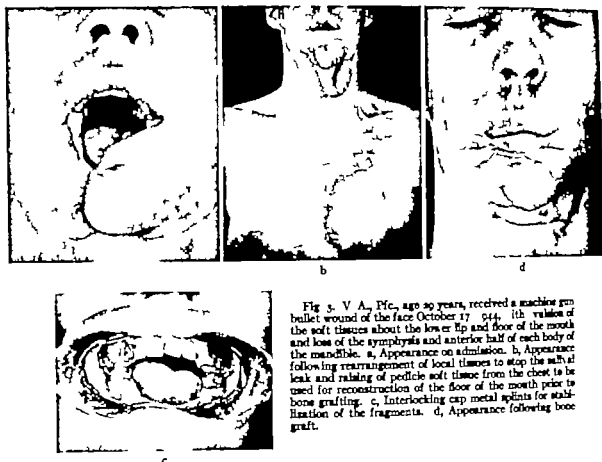


Fig. 3. V. A., 30 years, received a machine gun bullet wound of the face October 17, 1944, with avulsion of the soft tissues about the lower lip and floor of the mouth and loss of the symphysis and anterior half of each body of the mandible. a, Appearance on admission. b, Appearance following rearrangement of local tissues to stop the salivary leak and raising of pedicle soft tissue from the chest to be used for reconstruction of the floor of the mouth prior to bone grafting. c, Interlocking cast metal splints for stabilization of the fragments. d, Appearance following bone graft.

ple cover free of scar tissue and induration, absence of infection and avoidance of contamination at the time of operation and proper preoperative and postoperative immobilization of fragments. The necessity of having resilient soft tissue covering has not been adequately stressed and here time is an inescapable factor in the elimination of wound reaction. For avulsion deformities pedicle flaps from the thorax and abdomen must be employed. Less severe defects may be taken care of by rotational flaps and other methods of rearrangement of local tissues. Even small adherent scars should be removed several weeks before bone grafting with complete excision and wide undermining to give relaxation in closure. Operation should never be performed through a wide cicatrix or through an indurated area. Removal of loose sequestra and fragments of teeth hastens the subsidence of localized drainage and infection. We are not yet convinced that early operation is advisable

even with the use of penicillin and it has been our custom to delay bone grafting for a minimum period of 2 months following last drainage from the area. The great majority of our cases have waited over 6 months after subsidence of active evidence of infection.

Bone grafting to the jaw requires close cooperation of both surgeon and dentist. The dental surgeon assumes charge of all mechanical devices for immobilization of fragments before and at the time of operation and looks after the patient's oral and dental hygiene. Proper emphasis must be placed upon improvement of the general physical condition as well with correction of anemia, weight loss, and protein imbalance.

The chief problem in individual bone graft procedures of the mandible is the method of fixation and immobilization to be employed. Various factors must be taken into consideration: size and character of the defect, position of teeth in the upper and lower jaw and state



Fig. 4. R. M. B. Corporal aged 25 years, received a shell fragment wound June 10, 1944, with avulsion of soft tissues of the chin and floor of the mouth and loss of the right body and symphysis of the mandible. a, Appearance on admission showing granulations and draining sinuses.

b, Exposure of mandibular defect at operation 1 year after admission. Soft tissue loss has been replaced with a pedicle flap from the chest. c, Tantalum tray containing cancellous block graft. d Appearance following operation. e, Profile view.

of occlusion of the fragments. Because of the danger of opening into the oral cavity at the time of operation the position of fragments cannot be altered at that time except in angle defects or where the fragments are edentulous.

If both fragments are edentulous some modification of the Gunning splint is used during the waiting period and also following bone grafting. At operation we usually employ some type of internal fixation such as a piece of perforated tantalum shaped over an impression of a normal cadaver mandible.

Where one fragment is edentulous and the other contains teeth the latter is kept in occlusion by a flange splint. The edentulous portion at operation is liberated on all surfaces, placed as nearly as possible into normal

position and maintained there by a wire through the angle tip or ramus which protrudes through the skin and attaches to a bar coming around the face from the intraoral splint.

Where both fragments contain teeth a cap metal splint with rigid crossbar is very satisfactory preoperatively. At the time of insertion of the graft two interlocking cap metal splints are used to hold the jaws absolutely immobilized. At the time of operation we have employed either endotracheal anesthesia or a combination of (1) high bilateral intraoral mandibular block with 2 per cent novocain, (2) local novocain infiltration and (3) spinal anesthesia for removal of bone from the ilium. We prefer the second method because of the advantage of novocain adrenalin solution in

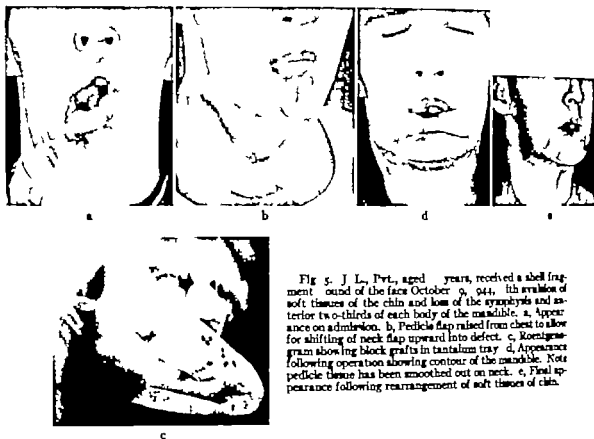


Fig. 5. J. L., Pvt., aged years, received a shell fragment, round of the face October 9, 1944, with avulsion of soft tissues of the chin and loss of the symphysis and anterior two-thirds of each body of the mandible. a, Appearance on admission. b, Pedicle flap raised from chest to allow for shifting of neck flap upward into defect. c, Roentgenogram showing block grafts in tantalum tray. d, Appearance following operation showing contour of the mandible. Note pedicle tissue has been smoothed out on neck. e, Final appearance following rearrangement of soft tissues of chin.

minimizing bleeding in the operative field. In addition the patient is less likely to develop postoperative respiratory distress and nausea when a general anesthesia can be avoided.

#### TECHNIQUE

The operative technique is as follows:

Incision is made parallel to the lower border of the mandible with care taken to prevent injury to the mandibular branch of the facial nerve. This nerve can be avoided by dissection downward external to the platysma for about 2 centimeters below the inferior border before approach is made to the bone fragments. About 2 centimeters of bone is exposed on each side where fragments contain teeth. For ramus, angle, or posterior edentulous fragments exposure can be made by stripping the periosteum for long distances without danger of entering the oral cavity. Edentulous fragments are detached thoroughly and replaced in normal position.

Eburnated ends of fragments are cut off by sharp rongeurs, and the outer cortex of the

mandible in the recipient areas is removed with a dental burr until an area of bleeding bone sufficient for good contact is obtained.

Meanwhile the iliac crest has been exposed subperiosteally by another operative team. A large section of ilium is cut out with a sharp osteotome and placed on a wooden block for removal of all cortical bone, which is then discarded. The donor area is closed in layers with a deep removable No. 32 wire suture and No. 36 interrupted sutures are used for the skin. Pressure dressing is applied.

The graft is shaped with sharp-cutting rongeurs, and all cancellous chips are saved to be packed later into open spaces in the graft bed. The transplant is placed in position as both an inlay and onlay graft and is immobilized by a single strand of No. 32 stainless steel wire at each end. At least 2 centimeters should be in contact with the bleeding bone on each fragment. Although there may be marked protuberance externally at first, rapid absorption takes place and the contour of the mandible is quickly established after function begins.

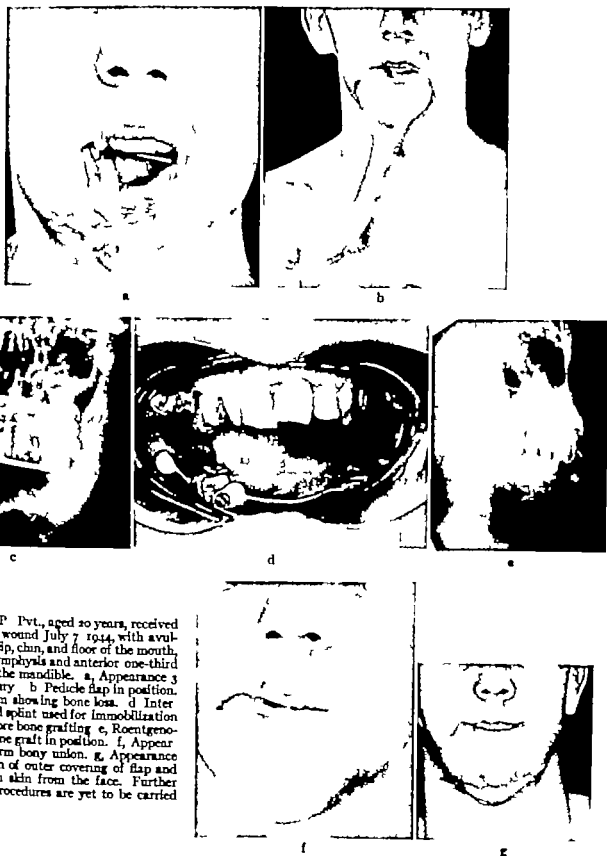


Fig. 6. F W P Pvt., aged 20 years, received a shell fragment wound July 7, 1944, with avulsion of the lower lip, chin, and floor of the mouth, and loss of the symphysis and anterior one-third of each body of the mandible. a, Appearance 3 months after injury. b, Pedicle flap in position. c, Roentgenogram showing bone loss. d, Interlocking cap metal splint used for immobilization of fragments before bone grafting. e, Roentgenogram showing bone graft in position. f, Appearance following firm bony union. g, Appearance following excision of outer covering of flap and replacement with skin from the face. Further "touching-up" procedures are yet to be carried out.

Complete hemostasis is obtained by ligation of all bleeding points with No. 40 wire. Closure is made in layers, and firm pressure dressing is applied. It cannot be too strongly em-

phasized that there must be no tension on the wound edges and it may be necessary for proper relaxation of the tissues to undermine the skin for considerable distance.





Fig. 7 J. P. P. D., aged 39 years, received shell fragment wound of the face June 24, 1914, with fracture of the left mandible and maxilla. Following removal of an unsuccessful cartilage graft because of drainage, a large cancellous bone graft was placed over the remaining portion of the maxilla, with good contour resulting. a, Appearance on admission. b, Final contour.  
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Fig. 8 C. C. Mc., aged 39 years, received shell fragment wound of the face July 5, 1914, with avulsion of soft tissue and loss of the major portion of the left maxilla. The soft tissue loss was replaced by pedicle skin prior to restoration of contour by cancellous block graft. a, Appearance on admission. b, Appearance following operation. It is planned to remove the outer covering of the pedicle flap as completely as possible at a later date and replace it with a rotational flap from the neck.  
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In over half of our cases closure was made with fine silk, but as we felt that in two instances drainage occurred as a result of buried silk sutures, we began to use a single removable stainless No. 36 wire for the deeper layers and continuous running stitch of No. 38 wire for the skin.

#### AFTER-CARE

Postoperatively patients are kept in a semirecumbent position and watched closely for evidence of respiratory difficulty. In one instance we found it necessary to open an intraoral splint for 24 hours to relieve obstruction. Liquids are given by syringe or tube and gradually the patients learn to put semisolid foods around the splints with the fingers. Protein and vitamin intake is given careful attention.

Routinely we have given for 5 days postoperatively 20,000 units of penicillin in  $\frac{1}{4}$  per cent novocain solution every 3 hours. Pressure dressings to both donor area and face are maintained for 10 days, and frequent mouth wash is used for oral hygiene. Patients are usually ambulatory by the end of 2 weeks. After 7 or 8 weeks the cap metal splints are released, and the state of clinical union is inspected. If the fragments are not absolutely rigid, splints are left in place for another 2 to 4 weeks before removal. Dentures are fitted within 8 to 14 weeks if normal buccal and labioalveolar sulci are present. Otherwise these must be reconstructed by stent grafts 4 to 6 months later.

During the past  $2\frac{1}{2}$  years we have seen in an army plastic surgery center 68 patients who have required bone grafting because of mandibular loss greater than 2 centimeters. Eight of these showed massive avulsion wounds which required replacement of soft structures by pedicle flaps prior to bone grafting. Two of the 68 patients are still waiting final operation pending subsidence of tissue reaction.

In the remaining 66 cases blocks of pure cancellous bone from the ilium have been employed for defects varying from 3 to 15 centimeters in length. Drainage has occurred in 10 instances twice from buried silk three

times from inadequate coverage and in 5 cases from accidental opening into the oral cavity. Half of these cases have had successful union in spite of drainage. Four have had partial loss of graft. 2 of these have since been regrafted without complication. In the fifth case it was necessary to remove the transplant because of infection. Failure has been attributed in 3 instances to insufficient cover plus difficulty in fixation for one reason or another in 2 there had been infection following entrance into the mouth.

No disability has been noted in any patient from the removal of bone from the ilium. Drainage has occurred in 2 instances once from buried silk and once from a small piece of rubber tissue inadvertently left in the wound.

In addition to 68 bone grafting procedures to the mandible in 66 patients cancellous iliac grafts have been employed for restoration of contour in 18 deformities of the maxilla. 5 of the nose and 2 of the supraorbital margin. Drainage occurred in one instance but successful final union was obtained in every one of these cases.

#### SUMMARY

In summary we believe that iliac block grafts of pure cancellous bone form the most satisfactory material for relief of large and small bony defects in the mandible. The large percentage of cases without failure cannot be attributed to the choice of graft alone however. We must not overlook the value of chemotherapy in the treatment and prevention of infection nor disregard the importance of suitable mechanical fixation of fragments. Above all we must not forget that the background of all transplantation procedures is the proper preparation of the tissues themselves. In no other branch of surgery is the old adage so true, that haste makes waste.

#### REFERENCES

1. BARKER, A. *Surgery* 1943, 18, 755.
2. BLOCKER, T. G., JR., and WELLS, L. R. *Ann. Surg.*, 1946, 123, 622.
3. BROWN, J. B. Personal communication.
4. DICK, J. L. *J. Bone Surg.*, 1946, 28, 1.
5. HOGA, S. L. *Surgery* 1945, 28, 15.
6. MACCARTHEW, A. B. *Proc. R. Soc., Lond.*, 1945, 38, 31.

# MODERN METHODS IN THE TREATMENT OF FRACTURES

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**I**N the early days of the human race, nearly all fractures were caused by falling from a sufficient height and were usually simple fractures of the long bones. As the centuries rolled by and warfare became developed to a higher grade than wooden clubs and stone axes, compound fractures became more common and were less easily repaired. With the advent of gunpowder and the hazards of more rapid transportation fractures occurred with much greater frequency and began to attract the serious consideration of the physicians and surgeons of those times.

Seventy years ago a compound fracture of an arm or leg almost invariably required immediate amputation to save the patient's life, but the development of antiseptic and aseptic methods of treatment began to offer more hope of saving these damaged limbs. Forty years ago the rapidly increasing numbers of automobiles introduced the tremendous risks of high speed travel on the highways and the byways of the world. Thirty years ago the first World War produced the enormous dangers of high explosives and fast airplanes and these dangers were multiplied many times over in the war which ended only last year. Or has it really ended?

What has been learned in the last few decades about the treatment of fractures? Since 1900 forty six years ago I have been interested in orthopedic surgery and in fractures. I have seen the rise and sometimes the fall of many different methods and ideas in the treatment of broken bones.

The one dominant purpose of treatment is to produce a satisfactory union of the fracture, with re-establishment of the normal function in the shortest possible time.

In the Fracture Oration of 1935 Paul Magnuson presented briefly and graphically

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Fracture Oration, presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 18-20, 1944.

the salient points of fracture treatment from the days of the Egyptians 4500 years ago, the Hippocratic era 2400 years ago, and the works of Galen up to the year 900 Anno Domini. Then came the long centuries of the Dark Ages when no progress was recorded until the Renaissance. In the 14th century interest in fractures was revived and from that time the value of many of the almost forgotten old principles began to be recognized. Methods of traction and countertraction, the basic foundation of the treatment of fractures of the long bones, became simplified and improved. Buck's extension Thomas's splint (which was originally designed for knee disorders) and the Hodgson suspension splint gradually assumed their well deserved importance, together with the improved types of adhesive plaster. Then in 1895 came Roentgen's discovery of the x ray which visualized both the good and the bad results of treatment, and made possible some much needed improvements in the handling of fractures.

Now it became easy to determine accurately whether or not the alignment of a fractured femur was satisfactory or whether the traction was pulling the bones too far apart.

Next came the development of skeletal traction by Steinmann's pin and Kirschner's wire, in cases in which adhesive plaster could not be used. These devices were not free from the danger of infection and had to be carefully watched.

In 1910 Arbuthnot Lane popularized his method of applying a steel plate, by open operation screwing it across the fracture line by four or six or eight screws. This simple and easy way of reducing and securing fractures of the long bones swept the country like a tornado. It seemed so rational and so satisfactory that hundreds of surgeons purchased the plates and the few special instruments, and without following the meticulous technique perfected by the originator proceeded to plate many simple fractures of the long bones. I do not know how many times I have been asked

to see a boy or a girl with a fractured femur who was about to have a Lane plate applied by an enthusiastic surgeon. In most of these cases when it was explained that the overriding and the malposition could be corrected by a few days of traction and suspension in a comfortable Thomas splint, and that in 6 or 8 weeks union would be strong enough for a caliper splint or a plaster-of Paris spica the doctor and the patient were willing to avoid the operation.

There are two basic reasons entirely apart from the danger of infection why a plate of the Lane type or the Sherman type or any similar type is not the ideal method of treatment. First, it does not immobilize the fracture completely, because a certain small amount of motion will always be present in rotation and in lateral bending toward the plate. Both of these motions could be avoided by applying a similar plate to the opposite side of the bone but few surgeons have had the hardihood to attack the bone on both sides. In oblique fractures a transfixion screw applied at right angles to the line of fracture will prevent most of the mobility but does not work so well in transverse fractures. Secondly when a Lane plate is applied the ends of the fragments undergo a small amount of absorption so that a definite space is left between the ends. It is true that in many cases enough new bone is formed to obliterate this empty space, and the fracture unites but it does not unite as rapidly as it would if the bone ends were in firm contact. Moreover the external callus formation develops upon the opposite side of the fracture and does not cover the plate, except in children so that the ultimate ossification of the fibrous tissue between the ends of the bones is greatly delayed. This external callus may become very large when the immobilization of the fracture is inadequate. Even a long plaster-of Paris cast, from the chest to the toes does not furnish complete immobilization in most cases of fracture of the shaft of the femur.

I do not deny that in many hospitals and clinics the plating of simple fractures of the long bones has shown excellent results but such operations should be performed only when a satisfactory result cannot be obtained

by conservative mechanical means and when the surgical standards of the operator and of the hospital are of the very highest grade.

Because of the many disappointments following the widespread use of the early types of the Lane plates whether from mechanical defects technical errors or infections, other investigators have been busily devising different methods. The old and reliable principles of manual reposition traction and counter traction and fixation by plaster of Paris and splints have become less understood and less popular. This I think is largely due to the fact that the conservative mechanical treatment of long bone fractures requires the careful time consuming attention of the surgeon himself. He cannot safely delegate this attention to anyone else. A leg or an arm in a traction apparatus must be seen every day by the man who is responsible for the ultimate result. Residents and internes do not always notice that the adhesive plaster is cutting into the skin or is losing its pull at important points. Because this constant attention is necessary and because a day has only so many hours, it is perfectly natural that busy surgeons should welcome any methods which would reduce the time element required for proper results. If such methods are safe, sane and satisfactory we should use them but we must always remember that the union of a fracture takes so many weeks or so many months and that we cannot make broken bones grow together any faster in 1946 than the Egyptians could four thousand years ago.

What are some of these newer methods and to what extent can they be recommended for general use?

Many years ago various types of nails and screws were employed in attempts to fasten together the broken bones. Considerable success resulted in many cases but the ever present danger of infection made such treatment always a definite hazard. The advent of the sulfa drugs penicillin and other fungus derivatives has removed some of these dangers but there is still no substitute for aseptic surgical technique. Stainless steel and vitallium have replaced iron and plain steel and we can no longer use metals which under go erosion or cause electrolytic reactions in the

body tissues. Metallic fixation of fractures has assumed a very important place in bone surgery especially in certain kinds of fractures. The neck of the femur the olecranon process of the ulna, the patella, and the shaft of the tibia may present problems which may legitimately be considered suitable for open operation. Years ago Kellogg Speed in one of these Fracture Orations applied the name 'The Unsolved Fracture' to the very dangerous fracture of the neck of the femur. The medical literature has been full of articles about different methods and devices for the treatment of this lesion. When I was a young man some of the surgeons were using carpenter's screws or nails, with occasional success but with frequent failure. Smith Petersen's three-flanged nail was an enormous improvement over the earlier types, but even today there are clinics where lag-screws, threaded wires, and other devices are preferred to the flanged nail.

Some of the recent publications do not emphasize sufficiently the enormous necessity of accurate reduction of the fracture before it is nailed or screwed. In many of the articles, roentgenograms are shown which reveal imperfect replacement of the fracture before the nail was inserted. This did not always produce a failure of union but it is certainly not desirable and it is usually the result of inadequate x ray control. Anteroposterior x ray films cannot be relied upon to show accurate reduction of the fractured ends and it is extremely difficult to make satisfactory lateral films with the patient's legs fixed firmly in the traction apparatus. No surgeon should attempt to nail a fracture of the neck of the femur unless he can obtain good lateral films on the operating table at all stages of the operation, without disturbing the hip-joint or the operative technique. This means that such patients should be cared for in a hospital with all of the requisite equipment and personnel. It is major surgery of the most difficult type.

The purpose of this lengthy discussion is to emphasize the tremendous importance of developing in every community a team of surgeons who will be able to treat properly the cases of fracture of the neck of the femur and who will have the requisite instruments and

x ray facilities and technicians, without which no one can accurately reduce and nail such fractures. One day in August I examined the x ray films of 3 cases of this kind which had been nailed in other cities. Not one of these fractures had been properly reduced before the nailing and all 3 had failed to unite. It is highly probable that these unfortunate results were due to imperfect lateral x ray films made on the operating table, and I have seen many similar examples, a of them occurring in my own practice. Unless the x-ray control is clear and accurate it will be necessary to open the hip-joint in order to be sure that the reduction is satisfactory and that the nail is put in the proper place. This type of open operation adds greatly to the danger of shock and of infection and is practically never necessary when good x ray films are available during the operative procedures.

To make my position perfectly clear the following plan seems to be the best for the treatment of fractures of the neck of the femur.

The patient is placed upon an orthopedic traction table of the Albee, Hawley McKenna, or similar type. The displacement is carefully reduced by the Leadbetter maneuver or by traction. X ray films are made in anteroposterior and lateral planes, one of the two portable tubes being located between the thighs, the other directly over the hip-joint and two or three feet above the field of operation. The perineal post on the sacral support should be of wood or aluminum, so that no manipulation will be necessary for the lateral views. When the reduction is shown to be satisfactory both legs are securely fastened to the traction apparatus. A 5 inch incision is now made to expose the outer surface of the femur and a long wire marked in half inches, is drilled upward and inward from a point well below the trochanter. It is wise to make a hole through the outer cortex with a quarter-inch drill before starting the wire, so that the direction of the wire can more easily be changed without blinding or bending in the thick cortex. When the wire has been inserted to a depth of 3 or 3½ inches, new x-ray films are made to check its position. If not satisfactory the wire is withdrawn and reinserted until it is

in proper position. This may require one or two trials, with corresponding x ray films. A little time may be saved by using another wire, leaving the first in place as a guide. When the position is found to be correct, a cannulated stainless steel or vitallium Smith Petersen nail is threaded upon the wire and is driven along it into the neck and head of the femur. The length of the nail is estimated by the calibrations of the wire. Again x ray films are made in both directions, and if satisfactory the wire is pulled out and the wound closed.

You will see from this description the enormous importance of the x ray examinations, and the complete futility of attempting this kind of operation unless such rapid and accurate roentgenographic control can be furnished. Good anteroposterior views can be made with great ease but the lateral views require special equipment and technique.

I have not mentioned the use of screws, lag screws, or the various threaded or unthreaded wires, because I believe that the Smith Petersen Johansson nail is better than any of them for general use.

A few words about the after treatment. Over the usual dressings a firm, elastic spica bandage should be applied from the waist to the knee, and a foot-piece or sling should be used to prevent outward rotation of the thigh.

It is important to prevent outward rotation of the thigh as the patient lies in bed because the weight of the thigh and leg exert a downward and outward pull upon the nail tending to separate the fragments. It is not wise to allow early sitting and standing without some form of partial immobilization of the affected hip although some writers encourage it.

We must remember that at least 4 months are required for bony union in these cases and that union is made by the internal deposit of new bone, and not by external callus formation.

Aseptic or avascular necrosis of the femoral head is a complication of intracapsular fractures seen less frequently than after dislocations of the hip but nevertheless sufficiently often to influence the ultimate prognosis. The artery in the ligamentum teres supplies only a small portion of the head, and, indeed is some-

times absent. The main blood supply comes from the arteries of the capsule and if these arteries are occluded or are too small the head becomes necrotic. At present, there is no certain means of improving the blood supply although drilling and bone-grafts offer some hope. Perhaps the best form of treatment is to prevent any weight bearing on the femoral head by the use of crutches and a caliper splint, or by long-continued traction trusting that Nature will provide a new blood supply by the slow in-growth of small arterioles and by creeping substitution. This requires a long time and in some cases fails to occur in which event the patient has a painful and disabled hip-joint which may need a reconstruction operation or an arthrodesis to produce an ankylosis of the joint.

Let us now consider the other types of fractures which may usually be considered suitable for operative treatment. The patella and the olecranon process of the ulna if the fragments are widely separated will unite more satisfactorily and more rapidly if they are mechanically fastened together by one of the accepted operative methods. Spiral or oblique fractures of the shaft of the tibia may be extremely difficult to retain in good position by conservative treatment and it may be wise in such cases, to fix the fragments together by transfixion screws, or even by stainless steel plates. The fibula unites much more rapidly than does the tibia and sometimes holds the fractured surfaces of the tibia so far apart that they cannot unite. Cases of this kind require operation.

For many years the surgical literature has been flooded with articles advocating the use of mechanical devices for the reduction and the fixation of fractures of the long bones. The catalogues of the instrument makers and the published articles of the designers show in fascinating detail the very ingenious devices and the remarkably successful results. The basic principle of all of these contrivances is identical. This principle is to drill two strong pins into the shaft of the bone above the fracture and two more similar pins below the fracture as far away from the fracture itself as possible and to connect each pair of pins with a clamp to hold them rigidly to-

gether. These two units are then used to manipulate the fractured ends into accurate apposition. In difficult cases an ingenious traction frame has been devised to aid in this manipulation. When good position has been attained, the pin units are connected by rods clamped firmly to them, or by short plaster-of-Paris casts molded around the pins. It is not to be denied that this method is very valuable in certain types of fractures. It furnishes good apposition and good control of nearly all types of fractures, and allows early and free movement of the joints at either end of the broken bone. It is, however, neither so simple nor so safe as the inventors and manufacturers would have us believe. It requires considerable skill and experience to drill the pins into the proper positions, whether the pins go entirely through the limb or stop after penetrating both cortices of the bone and project only from one side of the limb. It is also not easy to prevent infection from occurring along the track of the pins, as there is always some seeping discharge from the pin holes, but the advocates of the method state that osteomyelitis is very rare.

The best known of these devices are the Stader, the Haynes, the Griswold and the Roger Anderson types, and of these the Anderson instruments seem to be the most generally satisfactory. They are all modifications and improvements of the old Lambotte ideas, and in a very small proportion of fractures they may be very useful.

Another revival of ancient methods was described by Kuntscher in 1940, who drove a long steel rod into one end of a fractured long bone down through the medullary canal across

the line of fracture. These rods were used chiefly in Germany during the second World War and have achieved some popularity in the United States. One of the advantages of this method is that the broken ends of the bone are pulled into close apposition by the action of the muscles, so that union is much more rapid than when Lane plates are used. The fact that the medullary canal is plugged up by the rod seems to have no deterrent effect upon the union of the fracture.

About thirty years ago Hey Groves treated a fracture of the upper third of the femur in this way, using an iron rod, but he complained that the rod was not strong enough to resist the muscle-pull, and so the femur became bent at an angle. If he had put the leg up in a Thomas splint or in plain traction apparatus, after the operation, the result might have been better. With the new stainless steels, the method may be useful in selected cases.

It must be admitted, in discussing the various kinds of operative treatment of simple fractures, that the advent of the sulfa drugs and the fungus derivatives has made open surgery much safer than it was a few years ago, but we must not lose sight of the fact that the majority of fractures can be treated successfully by the older conservative methods. We are going through a transitional period at the present time, both surgically and politically, and I do not want our young physicians impressed with the idea that fracture treatment necessarily means a machine-shop full of tools to repair every kind of broken bone.

The best fracture surgeon uses the fewest gadgets.

# THE SURGEON AND HIS TRUST

## With Special Reference to Safe Conduct of the Patient through Operation

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THE safe conduct of a patient through operation demands the following (1) adequate preparation of the surgeon (2) careful and precise preparation of the patient (3) satisfactory preparation of the patient after operation. All of these items are important. Inasmuch as many of the important items relating to care of the patient before and after operation the subject of this symposium discussion have been dealt with in an eminently satisfactory manner by the other participants I have elected to devote my remarks principally to a somewhat philosophic consideration of the surgeon's own preparation for his responsible tasks. I do not interpret my opportunity of speaking last as affording me the privilege of acting as moderator in this discussion. In the final analysis, you and time are the ultimate arbiters and umpires of what is said here.

### THE FUNCTIONS OF SURGERY

The very nature of surgery stamps it as a sacred trust. By general agreement, surgery is invoked only when the desired objective cannot be achieved satisfactorily by non-surgical means. It is the purpose of surgery to preserve life and to restore normal function in so far as is possible and at the least risk to life and without compromise of the patient's future welfare.

### FORMALITIES OF SURGERY

Any enterprise which achieves its ends through employment of such extreme means as surgery must of necessity observe certain formalities. In saying this I am not alluding to fatuous conventions and empty ceremonies but to compliance with rules of conduct which

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time and practice have shown to be valuable guides.

The items listed above which have to do with the safe conduct of a patient through operation are mutually interdependent. One component is unlikely to afford promise of success without the co-operation of the others. A well trained surgeon who comes well prepared for the operation and who performs a superb dissection but who neglects the preparation of his patient before operation or his care after operation is not doing the best for his patient, and the surgeon who bungles the dissection stands in the way of recovery of his patient. Yes poor preparation of the dissection is alas the agency through which some patients who undergo surgery with the hope of having their lives made happier and longer have them shortened. How poor management of the problem of hemostasis in any type of surgery but particularly in operations involving large blood vessels or performance of anastomosis in the gastrointestinal canal which is architecturally unsound may shorten the lives of patients needs no elaboration. What surgeon would not prize highly an opportunity to be given a second chance to rectify an error of commission which shortened a patient's life? But an operation like any biological experiment is performed only once. Why not prepare well for it? Death is so final!

Yet, we see surgeons hurrying through operations as though their time were more important than the safety of the patient. Has not the fallacy of the 'get in quick and out quicker' approach to surgical problems been exposed sufficiently? No amount of best care before and after operation can undo the harm of an operation badly performed.

Wise surgical planning limits the surgeon's range of activity. The Army Medical Corps in World War II had a record of accomplishment in the management of difficult surgical problems which was unique in the annals of medi-



cine. The success of that undertaking was the result of planning organization and the selection of individuals with satisfactory training to do a given job. In our own work, we are left largely to our own devices in these matters. The product of our endeavors is dependent in large measure upon how well we have planned and the care with which organizational detail has been carried out. The range of operations which any one surgeon may perform is also a matter of personal choice. This latter item is a matter which demands some standardization among surgeons, just as much as particulars of planning and organization. There are still a few surgeons who affect to believe that they can take all of surgery for their province. They know as well as anyone that their performance in such a wide category of operative procedure is substandard in some of these areas, when judged in the critical light of what constitutes good practice. If a surgeon has not the moral courage to say to himself occasionally "The interests of this patient are served better by having someone more intimately acquainted with the problem undertake this task than I," when will society or medicine set up an advisory group with authority to decide for us that which we have been unable to decide for ourselves?

Even among teachers of surgery who have a better opportunity for continued self-improvement than the rank and file of surgeons, there are still a few who essay to embrace a large portion of all of surgery. In our time, we have seen the province of the general surgeon shrink so much so that occasionally we wonder what areas of surgery are embraced in the designation general surgery. Yet, this is as it should be. If a teacher of surgery were so ardent a student of his art that he wished to encompass the entire field, an aspiration more ambitious than praiseworthy, he would remain all his days a learner and would thereby lose the important opportunity to give directional growth to a smaller sphere of surgery. Teachers of surgery must prove themselves in the next generation as well as in this. The teacher who leaves no pupils or intellectual progeny has not been fully alive to his responsibilities or wholly faithful to his trust

*The passing of the all-around surgical specialist.* The sprouting of many surgical specialties from the parent stem of general surgery affords some indication of how surgery has grown. Moreover sharper lines of distinction between the various surgical specialties are being drawn. The specialty boards are playing an important role in lending acceleration to this transition. In some clinics not so long ago one could see a surgeon, in a single day's work, do a stomach operation or two, a few operations upon the biliary tract, as well as the colon and rectum, and perhaps a few goniometers and a breast operation or two in addition and then extend himself into the province of the urologist, gynecologist, and orthopedist. Let us be thankful that the day of the all-around surgical specialist is done! Surgery is not advanced by that type of activity and no matter how talented the surgeon he cannot do equally as good work in all these provinces.

The background of training of the surgeon should be broad. But having acquired orientation and competence, a surgeon must of necessity give selective direction to his activity instead of trying to grow in all directions simultaneously. The public has the right to demand a high standard of performance from us. Moreover we are all debtors to our profession and from those of us who have enjoyed opportunities above the ordinary society reasonably may expect that we should strive to add something to the sum total of knowledge rather than continue to be parasites upon our common heritage.

*The responsibility of higher institutions of learning to surgery.* Surgery has been enriched from many sources. Our institutions of higher learning have a responsibility for leadership in surgical education in this country—not alone to train students for the practice of surgery and to help them meet the requirements of the Specialty Boards, but also for the great task of improving surgery. Recognition of the tremendous importance of research in lending accelerated momentum to the slow growth of knowledge is a part of that responsibility. Knowledge can come to have new meaning with synthesis of well known

facts and much of surgery's progress in the past decade has been compounded out of well known facts becoming known to the right persons. It is to the discovery of new fact however that we look hopefully to the future for significant changes and improvements in surgery that will have the same impact upon our lives as did the discovery of anesthesia and asepsis.

*The acquisition of surgical techniques* The acquisition of skills is an interesting study. Those of us who have been privileged to be teachers of surgery and who have nurtured young surgical plants have had a unique opportunity to observe how such seedlings grow. Given a good brand of 'plant' with a high native intelligence and a real capacity for application accompanied by an intense and unflagging interest in surgery together with a sympathetic understanding of the frailties of man the capacity for growth of such an individual is almost limitless. And if in addition he is possessed of an inextinguishable yearning to add his bit, whether large or small, to the sum total of surgical knowledge there is no telling how far he may go. That he will surpass his teacher in accomplishment is self-evident. There is a certain inertia or lag in the learning process when progress is made slowly if not almost imperceptibly. But all of a sudden the man who just yesterday seemed almost a novice becomes an accomplished technical surgeon. The circumstances which bring about this accelerated spurt of growth are difficult of assessment and are not readily defined. It is not a process that can be hurried but a development which must come naturally through a certain sequence of events which by no means is the same for all individuals. This development has to do with the surgical neophyte becoming steeped in the practices, techniques and procedures as well as the general approach of a surgical service to problems. In this learning process, acquaintance and an increasing familiarity with the numerous facets of individual surgical problems as they relate themselves to physiology, biochemistry or bacteriology are very important. This period of training constitutes essentially an apprenticeship. For the finished surgeon it is a *sine*

*qua non*. The surgeon who is self taught is distinguished readily from the person who has pursued this more rigorous and orthodox scheme of training. And how quickly the surgeon of ability who has traveled this devious and stony path learns to master the technical phases of difficult operations is always a source of amazement and gratification to me. It is a metamorphosis in which the co-ordination of eye, mind and hand are important. The man who can grasp the problem and transmit to his hand what the eye sees and exact from this eye to mind to hand relationship a high standard of performance—that man is the superior surgeon. Before this co-ordination is effected the surgeon seemed but a fledgling but when that time comes almost overnight he becomes an accomplished surgeon whose work reflects confidence in his own performance. Only the surgeon who has trod this steep and winding path can know the cost! Is it worth the effort? Ask any of these men and examine the product critically! Truly there is no royal road to learning.

This circumstance of how quickly the trained surgeon masters operative techniques augurs well for the future of surgery. It suggests how we see further than our predecessors because we stand on their shoulders in turn our students stand on ours. It is a promising prospect for surgery the continued growth of which is assured in the hands of the present keen generation of surgeons who are beginning to make their mark. As Leonardo da Vinci remarked: It is a poor pupil who does not surpass his master.

*Motivation of the surgeon* One need not gossip long in the medical sewing-circle the confessional in which the sins of our neighbors are confessed more adequately than one's own to learn that surgeons are not generally held in that high esteem by our medical colleagues to which we would aspire. There are those who look upon the surgeon as a manual laborer in a Greek dress. There are even those in our own midst who affect to believe there is less science than art in surgery. And many of our medical colleagues who are not as accustomed or as adept as we in employing their hands in the service of their brains are bold to suggest that surgery is only a trade para

sitic upon the generous gifts of medicine. Take away the petty skills from most surgeons they say and see what empty sacks remain. Are these critics unmindful of the tremendous impetus given greater medicine by the discovery of anesthesia and antiseptics? Have they forgotten how the ministrations of the surgeon make an important contribution to the daily enjoyment of and in many instances to the extension of life?

It seems to me that trained surgeons schooled in the scientific method hold in their hands important tools by which to push back the boundaries of medical ignorance. A disciplined imagination lies at the bottom of every great discovery. The most important requisite of any promising research project is an idea. Surgeons who aspire to make contributions to the patrimony of knowledge would do well to school themselves in the techniques of one of the biological sciences, such as bacteriology, biochemistry, or physiology. I hold strongly to the belief that for the surgeon who aspires to a career in academic surgery that 2 years spent in acquiring the technique of one of these provinces of knowledge will pay usurious dividends not alone to the individual but to surgery and greater medicine as well.

The author of a recent thought-provoking and deservedly popular book<sup>1</sup> writes, 'The surgeon's skill sometimes is a splendid example of the sublimation of an early childhood urge to cut. A well known psychiatrist<sup>2</sup> wrote a few years back 'Leaving aside all secondary conscious motives for operating other than those provided by reality we realize that much surgery betrays evidences of being undisguised sadism. I resent such implied or expressed innuendos concerning the motivations of the surgeon. I associate daily with surgeons who give no evidence of such sadistic repressions. If the truth were known the reasons generally are probably far simpler and find their likely explanation in why men become grocers, lawyers, or engineers. You see before you a boy grown to manhood whose consuming ambition was to continue

his activities on the farm that he loved so much. His discerning father suggested that ministering to the physical ills of man would prove even more satisfying than lavishing care on cows, horses and pigs. This was difficult for a growing farm boy to believe. Inasmuch as the spirit of compromise resolves most differences, I suggested veterinary medicine as a substitute. My father far wiser than I continued to insist that medicine was a better outlet, and so I came rather unwillingly into medicine and surgery pushed in through the back door. "Contented industry and the late Wm. J. Mayo, is the mainspring of human happiness. And when that labor has to do with making the lot of man more endurable what employment could give greater happiness? I feel certain that the services of a psychoanalyst need not be enlisted to ferret out the compelling reasons that urged many of you to become surgeons.

It is, however, probably not out of place to suggest that envy because of the relatively larger incomes earned by surgeons and especially by surgical specialists, lies at the root of much of the criticism directed at surgeons by their medical colleagues. On this score I shall only say that for the years that lie ahead surgeons and other medical specialists paid out of proportion to their contributions to the advancement of medical knowledge, as judged from the critical viewpoint of the true scientist, would do well to consider receiving part of their emolument as increased opportunity. Society rewards us generously for our responsible labors in the relief of suffering and the betterment of man's lot. If however, we value even more the approbation of our colleagues with scientific leanings—a consideration which is not unimportant—some thought might well be lent to utilizing partially the potential earning capacity of surgeons as well as that of other highly paid medical specialists to afford ourselves better conditions of work, thereby improving the product of our labors, and at the same time lending a helpful stimulus to surgery. No doubt, many of you already have resolved this problem in some such manner. Satisfactory conditions of work and an opportunity for creative effort are valued by the thoughtful surgeon as among the best

J. L. Lieberman. *Peace of Mind*, p. 28. New York: Simon Schuster, 1946.  
Karl Menninger. *Psychoanal. Quart.*, 23:4, 3, 1972.

of paymasters. No one fears that the successful surgeon will starve! The tissues of the rich and the poor patient present the same problem to the surgeon. And the inarticulate but touching gratitude of a patient who can not pay in the coin of our realm, is nonetheless among the best of all rewards of the surgeon.

The surgeon and particularly the older surgeon will do well to contemplate occasionally his motivations and incentives and revalue anew his rewards. Let him also reaffirm periodically the Hippocratic Oath! When long years ago this writer was confirmed in the faith of his fathers the preacher employed on the occasion a text from the prophet Jeremiah: 'Stand ye in the ways and see, and ask for the old paths, where is the good way and walk therein and ye shall find rest for your souls an instruction equally as important for surgeons as well as for Sunday school communicants. Can there be greater rewards than the satisfaction and the peace of mind which come from having served his fellow man well? Our yoke of duty and responsibility may be heavy but whose opportunity and privilege to bring happiness to others is greater?

*The Federated Surgical Society of America* The Regents of the American College of Surgeons provisioned the avid curiosity and thirst for new found knowledge on the part of the practicing surgeon, when they instituted the Forum on Fundamental Surgical Problems. The continued interest in this type of program by the general surgeon in practice affords ample demonstration of the wisdom of that decision. And as more of America's best young surgeons who went to war return and manifest renewed zeal to contribute to the advancement of surgical knowledge an even more critical selection of papers for presentation can be assured. The time is now ripe for the formation of the Federated Surgical Society of America embracing all the ancillary surgical specialties much in the manner of the Federated Biological Societies in the pre-clinical divisions of medicine. That society serves medicine in a unique manner. A similar organization of surgery and its various surgical specialties employing the prototype of the Surgical Forum as its pattern would lend renewed emphasis to the importance of re-

search in surgery. At the same time, it would constitute an important agency in giving better integration to the many now somewhat distinct, branches of surgery. Is not the American College of Surgeons the parent society which should foster this development?

Have surgical meetings had any influence on your intellectual growth and development? They have on mine. Man cannot lift himself up by his bootstraps neither can surgical societies increase surgical knowledge save in so far as they encourage an interchange of ideas between surgeons at the best possible level. Surgical specialists in the same field are not long the best company for one another. There is not enough stimulating sustenance in that type of association for continued growth and development no matter how interesting the interlude provided by such exchanges. The life-giving spirit and vitalizing influence derived from close association with fellow colleagues in the broad domain of medicine is indispensable for the surgeon.

Surgery is on the move. We respect the traditions of the past but the empiricism of surgeons of generations just past is being displaced by the appreciation of and more frequent employment of the scientific method. The touchstone of the scientific method lies in the universal validity of its results. It affords a finality which sets aside all room for continued speculative rationalization. While we are debating and airing our respective opinions on a controversial subject some enterprising individual constructs and carries out the crucial experiment which reveals the truth in the matter. How sterile and unprofitable are discussions based solely on impressions no matter who the authority. Not even the experienced investigator makes a ten strike each time he sets up an experiment. No the progress of research is slow. Yet fact correlated with fact builds a structure which will stand against the winds of time.

It is from the lips of men who are engaged in the exciting pursuit of fact finding that we may expect that stimulating refreshment which makes us better surgeons for the experience. The acquisition of knowledge is not a passive process. List - ing to the recital of the train of events which led up to an im-

portant discovery does not make us better surgeons. It does however make us want to be better and serves to reorient us with reference to the great superiority of the experimental method over empiricism. When all surgeons learn to ask What is the evidence rather than who employs a certain procedure, then the absorptive capacity of surgeons for new found information will have been enhanced considerably. Surgery will profit immensely by having all surgeons listen to expositions in which the experimental method is employed. Moreover young men prosecuting original researches have a right to be heard. And is it not a bit wearisome to have to listen to parrots of other men's thinking?

*Unnecessary surgery.* Some of my colleagues who are not surgeons tell me that some surgeons perform unnecessary operations and undertake necessary operations which they are not trained to do for pecuniary gain. This is difficult for me to believe. If there be such men in our profession who call themselves surgeons, God have mercy on their souls! Is not the path of the well trained surgeon intent on doing the very best of which he is capable beset with difficulties enough? Can a surgeon take his tasks so lightly that he would submit patients, who seek his counsel to unnecessary or ill advised operations? God forbid! If this be true every man in the profession every hospital in the land should leave no stone unturned to expose such practice. We who enjoy the greatest confidences of patients who place their trust and lives in our hands have a sacred duty to perform. If we knowingly set aside that trust, we are not entitled to the protection which our medical license gives us.

If I forget thee O Jerusalem let my right hand forget her cunning. Steadfastness of purpose and consecrated devotion to his tasks should characterize the resolution of the surgeon in his outlook upon his work.

*Surgery is a stern discipline.* Surgery is an exacting and stern discipline. Let no man who aspires to be a surgeon be unmindful of this admonition. A realistic, critical attitude of self-analysis by the surgeon with reference to accountability for operative failures and postoperative complications is a *sine qua non* for continued growth and development of the

surgeon and betterment of his accomplishment. The irrepressible optimism of the Pollyannish surgeon denies him the improvement and cultivation which comes from a critical review of every failure. At the base of most disappointments lie errors in judgment or execution some neglect that might have been prevented with adequate forethought and preparation. Only when surgeons have succeeded in eliminating all avoidable causes of death after operation can they be satisfied with their own accomplishment—a laudable but unattainable objective. Yet, the struggle of striving to achieve that which lies beyond our reach makes us better surgeons for the effort. Any record, in which only *unavoidable* deaths account solely for the mortality, suggests that the surgeon and his associates have done their work well.

*Improving the surgical mortality score.* A consideration which must be always uppermost in a surgeon's mind is how to reduce the mortality score and at the same time extend the favors of surgery to those patients, who because of age or physical infirmity are not satisfactory operative risks. Familiarity with all the facets of the problem and a sustained effort to eliminate or reduce to a minimum all the *avoidable* causes of death after operation are the items that make for an improved mortality record. In this endeavor the surgeon must exact a high standard of performance from himself as well as from his associates. The day of the one-man operation is over. It takes a trained team of surgeons and nurses, accustomed to working together and alert to the complexities and vagaries of a group of interrelated surgical problems to make a creditable showing. Limitless concern for every detail and precise execution of carefully planned procedures are items out of which success and improvement of the mortality score are compounded.

*Preoccupation of mind of the surgeon.* Because of the very nature of the cares and heavy responsibilities shared by surgeons, they come to have a certain preoccupation of mind. Try as we may it is not easy to disguise completely our feelings when vexed with anxieties over ill patients. Those who know us best seem to be able to divine our true state of mind. The

cares of patients weigh heavily upon the mind of the surgeon and it is understandable that his spirits may exhibit some of the fluctuations of a barometer contingent upon how the patients under his care are getting on. Who among us has not felt a certain buoyancy of spirit when a very ill postoperative patient takes a turn for the better?

*Static character of surgery made dynamic by synthesis of well known facts into new knowledge* This year marks the centenary of the first public demonstration of the employment of anesthesia for operations, one of the most beneficent and welcome gifts to mankind in the history of the world. Antisepsis and asepsis recreated surgery and opened up new and undreamed of avenues for the surgeon's skill. The exclusion of infections from clean wounds gave an impetus to surgery and the entire field of medicine such as it has not experienced since. Surgery bounded forward with a terrific surge. Yet after some years, surgery appeared to have reached an impasse such that, surgeons like the late Lord Moyni had been saying again as surgeons of the preanesthetic and preantiseptic era had said that surgery had reached the acme of its development along technical lines. Yet lesser innovations and a better understanding of the derangements in bodily economy attending operation have remade surgery again. The improvements that have come about in the last decade or more are not the startling variety that marked the swift progress which came with anesthesia and asepsis. Nevertheless, real improvement in many areas of surgery is readily discernible. The greatest forward strides probably have been made in intrathoracic surgery. Improved techniques in this province of surgery have permitted performance of operative procedures with low mortality rates for conditions which surgeons looked upon with hopeless discouragement and despair a generation ago. Vascular surgery of the thorax is a new chapter in operations being written by the surgeon of today who has schooled himself in the stern discipline of preparing nice dissections of the large blood vessels of the thorax.

The gauge of a surgeon's accomplishment must be measured against the achievement

for that period. It is unfair to compare the performance of a surgeon of one generation with that of another. There were good surgeons 25 years ago but surgical organization in well appointed hospitals is much better today. Anesthesia is considerably better, our understanding of the nutritional requirements of surgical patients is far better and our knowledge of care of patients before, during and after operation is better. Nursing care also is considerably better than it was a generation ago. We know more about shock and replace blood loss more adequately. We have learned that it takes time and patience to do operations well and that maintenance of a steady state of the patient throughout the operative procedure has done away with the necessity for hurry a circumstance which condemned many an operation to failure although the advocates of the method continued to insist it was the chief determinant in deciding whether a patient would survive.

In other chapters of surgery there has been less conspicuous but nevertheless noticeable improvement. Gastrointestinal surgery has been quite static for a generation. Yet, with similar improvements in technique which gave such accelerated momentum to the surgery of intrathoracic conditions, the last few years also have witnessed the extension of operations upon the gastrointestinal canal to older age groups and substandard risk patients with a constantly declining mortality rate. Apart from the items listed above which played so important a rôle in the flowering of intrathoracic surgery an additional factor which has been of particular significance for the improvement of results in abdominal surgery has been increasing appreciation of the importance of suction applied to duodenal tubes to obviate the occurrence of intestinal distention following operation. Moreover prevention of gastric retention precludes regurgitation into the lungs a former frequent cause of postoperative pneumonia.

The discovery of the sulfonamides and penicillin has lent a great impetus to surgery as it has to medicine as a whole. The discovery of a new fact can change the whole complexion of a problem. But how plodding a process is the discovery of a single new fact!

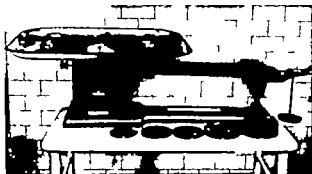


Fig. 1. Weighing scale employed in the general surgical operating rooms at the University of Minnesota Hospitals. Such a scale weighs to an accuracy of 1 gram. The use of dry sponges (save on exposed viscera such as small bowel or lung) serves to inform the surgeon of the blood loss at any juncture of the operation.

Little wonder that a new fact is a priceless possession and that we immortalize the names of men who have added a single important fact to knowledge. Keener appreciation of previously known facts lends its stimulus to a branch of knowledge the impact of a new fact, however gives impetus and momentum that is felt over a tremendous range a new fact is like a ferment in changing a static state into a dynamic one. It breathes new life into an undertaking.

#### FORTUNES OF SURGERY

There is no equation or formula which can give a complete answer to the important question of what may be expected of an operation.



Fig. 3. Use of the Red-cross lifter on platform for patients who can not stand. This scheme of weighing needs the help of nurses and an orderly to lift the patient, with least discomfort to him, onto the litter. (Surg. Gyn. Obst., 94 Feb. 2A)

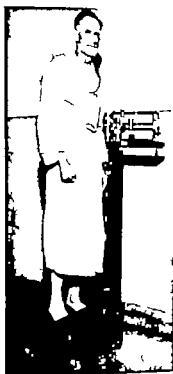
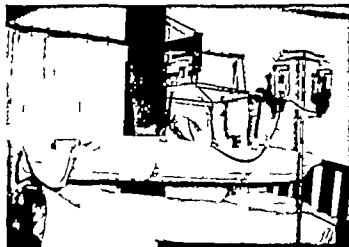


Fig. 2. Patients undergoing difficult operations on stand on a bedside weighing scale the day following operation. Patients are weighed in the morning before rounds, the gain or loss in weight from the prospective weight helps to determine the water and sodium chloride requirements for the next 24 hour period.

The planning of the procedure, the nature of the organization in which the surgeon works, his training and his general outlook on his responsibilities, the character of the dissection he performs, the breadth of his comprehension of what constitutes satisfactory preoperative preparation and postoperative care and the vigilance with which the anesthetist, the surgeon and his staff and the nursing staff watch over the patient—these are the determinants of the outcome of an operation. And yet even in this enumeration some things are left to chance. On this latter score, may I say that the surgeon who leaves the care of a number of items to chance is an unsafe surgeon. No matter how well we have standardized the performance of a certain operative procedure, they are not all performed alike. The hemostasis in one operation may not be as satisfactory as we may have wished it or the somewhat irregular placement of a single suture may have angulated an anastomosis whether gastrointestinal or vascular such is



Fig. 4. a. A new bedside weighing scale built for me by Mr. John A. Phelan of the scientific apparatus shop. This scale, with an electrically driven motor to hoist the patient up and let him down permits weighing the patient in bed.



b. The scale in use. The hoisting device lifts the patient a few inches off the bed. There is no interruption of the administration of intravenously administered fluids.

to affect its function unfavorably. The performance of surgery demands a high level of concentration together with a harmonious co-ordination of eye, hand and mind. Perhaps it was this circumstance that Thomas Fuller had in mind when he said the surgeon stands in need of an eagle's eye, a lady's hand and a lion's heart. For the difficult surgery of today a sturdy pair of legs is also an indispensable necessity!

*Fatigue undermines the surgeon's efficiency.* There is no effective antidote for the fatigue and weariness which beset the surgeon in long and strenuous operative ordeals. Intentness of purpose urges him on to the performance of his best effort, though it cannot drive away the subjective feeling of fatigue and the physical impairment of efficiency which comes with long sustained application under trying circumstances. There are operations being performed now of such magnitude that the surgeon occasionally stands in greater need of postoperative treatment than the patient on completion of the operation! It is my feeling that an impetus may be lent to the safe conduct of patients through some of the more difficult and tedious operations, when university clinics come to attach greater importance

to some of the techniques employed by industry and football coaches in combating the inefficiency of fatigue by sending in a fresh team. No surgeon of experience will deny the deterioration of accomplishment which attends fatigue. The interests of the patient which should be the paramount concern in any operation would be served better by such an expedient.

*The great need of more precision techniques.* Surgery and surgeons generally stand in serious need of greater precision techniques in the gauging of patients as satisfactory risks for operation in the assessment of whether the preoperative preparation is adequate in the intricacies of the operation as well as in post-operative management. There is a mortality and morbidity of treatment as well as of disease! Let no surgeon mistake this. We are prone to say the patient died despite all our efforts. How often the converse is true, the patient died because of what was done. Are we so blind or dull that we cannot see this? It is in the critical analysis of the events leading to unhappy outcomes that surgeons have the opportunity to improve themselves and to improve surgery.

We can all point out in our own experiences the repercussive effects of ill advised treatment. In this connection I like to tell under graduate students of an experience in which I was in a manner a participant. My family has a summer home not far from the Twin Cities. One of my neighbors is a veterinarian.



One summer before the long war years, we both had young dogs. My good friend the veterinarian said to me his dog had manifested a few signs of distemper and he was in the process of vaccinating him for it. Being a good neighbor he volunteered to do as much for mine. I decided to let my dog take his chances with the distemper. He did contract it and was ill for a week or so but made a complete and satisfactory recovery. A short time following our initial conversation I asked the veterinarian how his dog was getting on. He said he feared he had overdone the vaccination of his dog and in consequence the dog's appetite was poor. As a stimulus to appetite, he was giving the dog some strychnine and the dog was showing signs of improvement. A week later our paths crossed again and I asked the doctor how the dog was getting along. He said that the dog had been overtreated with strychnine causing him to have convulsions. In an effort to control the convulsions, he had anesthetized the dog with ether and had given him too much ether and had killed him! We too are guilty of occasionally shortening lives when we are striving to make them longer and happier. And often that rôle is not as self-evident as it was in this story.

How many patients lose their lives each year because of mismanagement of the water and electrolyte requirement of patients? To say many is an understatement. Is it happening in your clinic? It has in ours. I believe that when surgeons generally become more alert to the factors of safety in this intricate problem they will have taken an important step forward in improving their own accomplishments. I shall not say very much about our general plan of management of this problem here for I have discussed the problem at length elsewhere (2, 3, 4). I have the feeling however that when surgeons lend a more attentive ear to assessing such needs of patients in a more quantitative manner they will be agreeably surprised to observe what great help such guides afford them.

Routine use of dry sponges in operations affords an opportunity to assess the gain in weight, thus informing the surgeon of the extent of the blood loss at any juncture of the

procedure. To replace fluids in kind and in amount with that lost is obviously the best treatment. And to weigh patients before and immediately after operation as well as in the convalescent period is the best of all guides in helping the surgeon orient himself with reference to the electrolyte and fluid requirements of his patient. Moreover the weighing scale is far more sensitive in the detection of minor changes in body hydration than are changes in hemoglobin. Obviously such routine weighing of patients undergoing major surgery is often unnecessary for the problem of hydration seems to resolve itself by employment of simpler means involving less trouble constituting therefore needless effort. But who counts the cost of labor when lives are at stake? Do we not read almost daily in the newspapers of the heroic sacrifices of men with no view to cost or personal danger, assuming large risks in the effort to save a life? In the hospital in which you work have lives not been lost because the surgeon and his staff were not alert to the changes occurring in hydration and electrolyte balance of the patients? We have lost patients needlessly through this agency while professing an interest in the problem of water and electrolyte requirements of postoperative patients, at the same time, enlisting the helpful co-operation of the best talent that a University Clinic has to offer in the solution of such problems. It is in just such situations that the weighing scale has its chief virtue, in affording a provision of what will happen if abnormal contractions or increases in body weight continue uncorrected. Thus I may also say: since the expedient of weighing patients undergoing major surgery has become routine practice on the writer's surgical service, loss of life through disorientation of the surgical staff with reference to the important problem of hydration of patients has been more than decimated. I must confess we still go astray occasionally but usually recognize the error of our ways before disaster overtakes us. It is in the surgery of elderly substandard risk patients, who tolerate abuses poorly and especially in the surgery of gastrointestinal conditions necessitating the presence of intubated duodenal tubes, that the weighing scale is a

*sine qua non* if the surgeon aspires to do such operations with risks not far out of line with those assumed by younger standard risk patients. Reducing the mortality score as I stated previously consists essentially in the recognition of error and its correction. If a patient's weight in the early postoperative phase can be maintained within 2 to 3 per cent of the preoperative value (plus or minus) the surgeon is assured that the water and electrolyte requirements of his patient are being met satisfactorily. Pneumonia and cardiac failure as a consequence of overhydration owing largely to the administration of too much sodium chloride we saw not infrequently postoperatively among older patients undergoing extensive and complicated surgery before routine employment of the weighing scale. Routine weighing of such patients to detect deviations from the preoperative normal is at least as important as taking the patient's temperature. When surgeons learn to deal satisfactorily with the difficult problem of hydration of postoperative surgical patients, one of the most formidable of hazards to safe conduct of the patient through operation will have been surmounted. It is a barrier to recovery from operation that the surgeon must learn to hurdle.

Mr. Albert Sullivan Jr.<sup>1</sup> in studying the case records of 151 consecutive patients undergoing major surgery upon the gastrointestinal canal, during the first 6 months of 1946 observed that in this group slight losses of weight were far more common than gains of weight. Only 11 patients (7.3 per cent) showed a weight gain of 2.5 per cent of their total body weight, whereas 76.8 per cent exhibited weight losses of 2.5 per cent or more. The greater number of this group lost weight during the first 5 days after operation. Only 1 patient lost more than 6 per cent of the body weight. The average age in this group of patients was 58.9 years. These findings suggest that our surgical staff is more sensitive to weight gains than losses in weight. All of the patients in this group had inlying duodenal tubes, presenting therefore essentially the most difficult problems of maintenance of

water and electrolyte equilibrium. Obviously the cause of the weight loss in most instances was administration of too little sodium chloride accompanied by employment of moderately generous quantities of 10 per cent glucose solution. The effect of such therapy is to promote diuresis a circumstance that is pleasing to surgeons especially when dealing with a group of patients whose mean age is high. Needless to say it is important to take careful note of small deviations from the operative weight in order to keep fluctuations in weight at a minimum. Of the total measurable output of body fluid 70 per cent was urine the remainder being constituted largely by the fluid aspirated by the inlying duodenal tube. The average daily administration of sodium chloride was 6.5 grams in the early convalescence of those patients losing 2.5 per cent or more of their body weight. These observations suggest that the daily administration of 6.5 grams of sodium chloride is probably slightly less than enough for patients with inlying duodenal tubes undergoing major surgery upon the gastrointestinal canal.

Acquaintance with and employment of precision techniques by the surgeon and his staff in the various items that hedge about an operation afford the patient the best promise of a favorable outcome. It is the operation without mishap and a convalescence without complication that spells success. Such a procedure also permits early ambulation and early dismissal from the hospital. The convalescence punctuated by complication is synonymous with increased morbidity as well as mortality. The circumstances which characterize success and failure are often 'minor differences' but it is out of infinite and alert attention to detail that success is compounded. By very dint of relentless perseverance in his attack upon the factors that constitute the 'minor differences' between success and failure the surgeon can gradually overcome the hazards that are undermining his efforts. Recognition of error when accompanied by a resolute determination shared by the surgeon's staff to avoid the repetition of such mistakes, is the best assurance against failure. It is a source of ever recurring wonder to me how well patients get on after serious operations un

<sup>1</sup>Medical student from Tulane, doing a voluntary externship in the surgical wards during the summer of 1946.

attended by complication. And when surgeons succeed in making the unpleasant trials of the waking and recovery periods following operation more agreeable, patients will be less likely to regard an operation as a journey through the valley of the shadow of death.'

#### SUMMARY AND CONCLUSIONS

Order is heaven's first law. It also must rank among the most important of guiding principles in the surgeon's code. Without order the results of operation are unpredictable. A surgeon who has regulated his activity in accord with semblance of good order comes well prepared for operation. Preparation has to do with readiness as well as fitness. He does not undertake operations for which he is not prepared. Nor does he perform unnecessary operations. The surgeon's trust is as sacred as life itself and must not be profaned. The surgeon who has schooled himself in the preparation of nice and precise anatomical dissections does not permit himself to be hurried. He places the safety of his patient above every other consideration. And the security of the patient demands not alone that, the surgeon watch over him with tender and observant care during operation but that the surgeon has seen to it that no detail is overlooked in the preoperative preparation, and that alertness and vigilance characterize the care of the patient after operation.

The success of operations depends upon a harmonious blend of many things. The practical wisdom garnered from experience is in

essence an issue resulting from detection, a knowledge, and correction of error. Though we falter. If we are in earnest in our determination not to fail, success is inevitable. We soon learn to count the cost less and value the result more. The surgeon's objective should be the elimination of all avoidable causes of death after operation. The safe conduct of the patient through operation is a matter upon which an instruction can be given more readily than consistently followed. Portia's prudent counsel in the Merchant of Venice<sup>2</sup> on this score is well known to you. She said, "If to do were as easy as to know what were good to do, chapels had been churches and poor men's cottages princes' palaces. It is a good divine that follows his own instructions. I can easily teach twenty what were good to be done; but be one of the twenty to follow mine own teaching. The fortunes of our patients are determined by the manner in which the formalities of surgery are heeded by the surgeon. The functions of surgery and its future growth as a benevolent and helpful aid to man suggest that improvement in accomplishment demands that the surgeon be mindful and observant of the stern disciplines of his handcraft.

#### REFERENCES

1. SULLIVAN JR., ALBERT. Studies on 51 patients at the University of Minnesota Hospitals in relation to their daily weight fluctuations. Unpublished manuscript.
2. WASHINGTON, OWEN H. Intestinal Obstruction. 2d ed. Springfield, Illinois: Charles C Thomas, 1914.
3. Idem. Minnesota M., 1914, 25: 783-80.
4. Idem. N. England J. M., 1917, 23: 717-129.

## CLINICAL USES OF STREPTOMYCIN IN MEDICINE AND SURGERY

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**A**LTHOUGH streptomycin was first described by Schatz, Bugie and Waksman less than 3 years ago the drug is already in full commercial production and distribution and has proved to be a useful antibacterial agent in medical and surgical practice. The full possibilities and limitations of streptomycin treatment in several important diseases remain to be determined but progress has been extremely rapid in the last 2 years and should continue at an accelerated rate.

The usefulness of streptomycin is dependent on the fact that this antibiotic agent is effective against several pathogenic bacteria which are not susceptible to the action of other anti-bacterial substances. These bacteria include some frequently encountered gram negative bacilli and above all the bacillus of tuberculosis.

The treatment of infections of the urinary tract due to bacteria sensitive to streptomycin has been extensively studied (7-9) and it is uniformly agreed that streptomycin is of value in such treatment although its potentialities are limited. These bacteria frequently acquire a resistance to the action of streptomycin within a few days hence if permanent results are to be realized, it is extremely important that conditions favorable to persistence or recurrence of infection be corrected promptly if possible. Strains resistant to streptomycin are more likely to be developed if there is obstruction to flow of urine or if calculi or other anatomic defects permitting survival of bacteria are present. The importance of proper timing of treatment in relation to surgical intervention becomes obvious.

Bacteremia due to gram negative bacilli sometimes occurs, especially in association with severe infections of the urinary tract and

as a postoperative complication following operation on the infected urinary tract. Streptomycin therapy frequently is effective in treatment of such bacteremia (7-9) when due to organisms sensitive to this antibiotic agent (9).

Meningitis due to sensitive micro-organisms especially gram negative bacilli should be treated with streptomycin utilizing both parenteral and intrathecal routes of administration. My associates and others (7-9, 10) have reported favorable results in influenzal meningitis treated with streptomycin.

Since acute peritonitis is frequently of such serious portent and due to such an admixture of pathogenic micro-organisms I would recommend the simultaneous use of all available antibacterial agents in medical treatment. The combination of streptomycin with penicillin appears to be thoroughly logical under these circumstances, especially if the peritoneal cavity is soiled with intestinal contents.

Wound infections due to mixed bacterial flora should frequently be treated with both penicillin and streptomycin especially if bacteriologic examination proves the presence of sensitive micro-organisms. Fully adequate débridement should first be carried out to minimize the possibility of a recurrence of the infection due to bacteria which have acquired a resistance to the action of streptomycin.

Streptomycin is of real value in some cases of chronic suppurative pulmonary disease such as bronchiectasis (11) and especially as a preoperative measure preparatory to pulmonary resection. Here again it should usually be used in conjunction with penicillin and administered as an aerosol. The duration of treatment will vary from 1 to 2 weeks or more the treatment being continued until sputum is reduced in amount, changed in character and rendered bacteriologically sterile or nearly so. Cases of bronchiectasis suitable for streptomycin therapy may be selected by merely ex-

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aming smears of the sputum stained by Gram's method. If numerous gram-negative bacilli are present, streptomycin is likely to be a useful adjuvant to penicillin therapy.

Acute and chronic infections of the respiratory tract due to organisms of the *Hemophilus* and *Klebsiella* groups may be treated successfully with streptomycin (7-9).

The treatment of tularemia with streptomycin has yielded spectacular and promptly curative results (5). Streptomycin may be considered a specific remedy for tularemia; hence the accurate diagnosis of tularemia becomes of greatly increased importance.

Brucellosis and typhoid fever are caused by organisms which are only moderately sensitive to streptomycin. The latest available reports of streptomycin therapy in these diseases are not encouraging (9) except possibly during the most acute phases with demonstrable bacteremia.

When streptomycin is administered orally it is not absorbed from the alimentary tract in significant amounts; hence its oral administration is useless for treatment of systemic infections. However, the antibiotic agent is not destroyed but remains within the lumen of the bowel to exert its antibacterial effect on the intestinal flora (6). The possibilities of orally administered streptomycin have not been fully studied for preoperative preparation of patients prior to intestinal operation, either as a substitute for sulfonamides or in combination with sulfonamides. My surgical colleagues have made sufficient use of streptomycin in this manner to indicate that it does have practical possibilities.

The action of streptomycin on cultures of *Mycobacterium tuberculosis* was noted early (13) but this is a property which had been described previously for a number of other substances of microbial origin (4) and many synthetic chemical compounds (14). When streptomycin proved to be extremely effective against experimental tuberculosis of guinea pigs (2-3) its clinical possibilities were recognized and quickly explored.

The greatest potentialities for streptomycin therapy appear to exist in treatment of tuberculosis (8) including some surgical types of tuberculous infection. This is due to the fact

that no other practical and effective antibacterial therapy is available against the bacilli of tuberculosis and to the fact that this bacillus is much more sensitive to streptomycin than are the other common pathogenic bacteria. Furthermore, the tubercle bacillus remains sensitive to streptomycin for at least a few months before becoming drug resistant (15) and this permits realization of satisfactory therapeutic effects, especially in lesions of recent origin. It also has been found that even rather poor candidates for radical surgical treatment of pulmonary tuberculosis may be rendered excellent candidates after a few months of treatment with streptomycin. Likewise postoperative tuberculous complications may be amenable to streptomycin therapy or may be prevented by use of the drug.

Many types of tuberculous infection ultimately produce destructive changes which no drug can directly benefit. Antibacterial therapy is only suppressive in this and other diseases and will yield permanent benefits only if natural mechanisms of healing can achieve supremacy during the limited period of a few months during which the bacilli are sensitive to the action of streptomycin. Selection of tuberculous patients for streptomycin treatment must be undertaken with the greatest care. During the past 2 years my colleagues and I have followed a few simple rules, based on our concept of the action of streptomycin. These rules may be enumerated as follows: (1) Patients who are making satisfactory progress on conventional forms of treatment for pulmonary tuberculosis or who are likely to do so should not receive streptomycin. (2) Patients who have terminal types of pulmonary tuberculosis, especially when bilateral destructive changes are present, and who could not become candidates for surgical treatment are not regarded as good subjects for streptomycin treatment. (3) Patients who have old chronic nonprogressive fibrocavous and cavernous types of pulmonary tuberculosis are not likely to experience satisfactory results and hence should not be treated. (4) Priority in treatment has been given to more acute, progressive pulmonary tuberculosis of recent origin. In general, patients with most severe constitutional symptoms and with least destructive

pulmonary changes have obtained the best results from streptomycin treatment. These are individuals with naturally low resistance or with depleted resistance, and hence those most in need of assistance from antibacterial therapy. It should be repeated that such treatment should be given before the disease has wrought changes in the lung such as cannot be repaired within a few months. All patients with pulmonary tuberculosis chosen for streptomycin treatment should have a component of exudative disease and the larger the proportion of exudative to proliferative tuberculosis the better.

The clinical results of treatment of such patients often are realized promptly. Within the first few weeks fever declines, cough and expectoration decrease, appetite and a sense of well being return and the patient begins to regain lost weight. Later, after 6 to 8 weeks of treatment, roentgenographic evidences of improvement of exudative lesions are first noted. Usually within 3 to 5 months maximal clinical and roentgenographic improvement has been attained. This would appear to be the time for surgical treatment of remaining disease and especially for closure of any remaining cavities, such as might serve as sources for subsequent bronchogenic dissemination of the disease.

Ulcerating tuberculous lesions of the larynx, the hypopharynx and the tracheobronchial tree have healed rapidly and so far without exception in our small series of 10 cases. These patients have received combined treatment with intramuscularly administered streptomycin and streptomycin aerosol.

Some types of extrapulmonary tuberculosis have responded to streptomycin treatment with remarkable uniformity. This is especially true of chronic long standing draining sinus tracts, which usually close within a few weeks, but these will remain closed only if treatment is continued for several weeks after apparent healing. In renal tuberculosis and tuberculous cystitis temporary and palliative effects have been observed frequently but actual healing of small lesions has been observed rarely possibly because the kidney lacks the power to heal tuberculosis readily. In only a few cases of tuberculosis of bones and joints has strepto-

mycin been used but results have been encouraging. Much remains to be learned about streptomycin in relation to orthopedic surgery in the treatment of tuberculosis of the skeletal system.

Until the advent of streptomycin there was no way in which the course of tuberculous meningitis and miliary tuberculosis could be modified. Even with streptomycin treatment there is an extremely high mortality rate. However in most cases of early tuberculous meningitis the patients respond promptly to adequate intramuscular and intrathecal streptomycin treatment but all too frequently these gains are not permanently sustained. At least temporary clinical remission is almost the rule following streptomycin treatment of early but acute and severe tuberculous meningitis. Consciousness is regained often within a few days, fever declines within a few weeks, a sense of well being returns and frequently patients appear to be essentially normal, even for several months. Subsequent exacerbations of the disease are likely to recur and not to respond to treatment. However this may not always be true for in 3 cases of proved tuberculous meningitis arrest of the disease continued for 6-month course of intensive treatment. One patient has no residual neurologic signs, one is normal except for deafness and the third has apparently received severe damage to the central nervous system, especially the cerebellum. Although nearly a year has passed since the onset of illness in these 3 cases it is too early to classify the patients as cured. Five patients who had tuberculous meningitis have died despite treatment but 3 of these did not receive what is now regarded as adequate treatment and the remaining two were first seen at a late stage of the disease.

Disseminated hematogenous tuberculosis of miliary type has not responded previously to any form of treatment and spontaneous recoveries have been extremely rare. With streptomycin treatment it is possible to bring about a complete clinical and roentgenographic remission in a large proportion of cases but unfortunately the recurrence rate has been very high thus far and three of our four treated patients have eventually died. The remaining

patient has remained well for 6 months but cannot yet be classified as cured.

Tuberculosis of the alimentary tract and tuberculous peritonitis have not been studied adequately but symptomatic improvement of the 5 patients who have been treated at the Mayo Clinic has been striking.

Although clinical effectiveness of streptomycin is readily demonstrated in many types of tuberculous infection the results are often not permanent and frequently do not compare with results achieved in acute diseases treated with other antibacterial agents such as penicillin. The limitations of streptomycin treatment in tuberculosis must be emphasized constantly in this day of miracle drugs and the emphasis must still be placed on the known effective methods of treating tuberculosis, especially care in a sanatorium and collapse therapy. The place of streptomycin in tuberculosis therapy has not been determined but this agent is much more likely to supplement than to supplant the proved effective standard methods of treatment.

Streptomycin usually is administered by intramuscular injection doses being given every 3 to 4 hours and totaling from 1 to 3 grams per day. The lower limits of effective dosage have not been fully explored nor can final statements be made concerning the upper limits of safe dosage. Streptomycin is more toxic than penicillin but very little difficulty is experienced in treatment of more acute diseases which require only a week or two of treatment. When treatment is continued beyond 2 to 4 weeks nearly all patients will experience some disturbance of equilibrium (1) occasionally to a severe degree. Fortunately compensation is achieved in all or nearly all instances more promptly in younger than in older patients and no permanent disability is likely to result. Sluggish response to caloric stimulation of the vestibular apparatus is usually noted for many months and perhaps permanently even when there is no residual functional disability. The cause and significance of these changes have not been determined fully and are in need of complete investigation. Deafness has been noted occasionally but hearing is ordinarily regained if treatment is discontinued promptly. In this respect, strep-

tomyacin resembles such drugs as quinine and salicylates. Evidence of renal limitation has been noted occasionally but serious renal damage is not nearly so likely to occur as is true with administration of sulfadiazine. Streptomycin should be used with caution when there is reason to fear pre-existing impaired renal function because the drug may not be readily excreted under these conditions.

#### SUMMARY

Streptomycin is an effective antibacterial remedy of value in treatment of several infectious diseases not amenable to treatment with other antibacterial substances.

Streptomycin may be used in combination with penicillin for treatment of mixed infections such as are likely to occur in the presence of acute peritonitis, chronic suppurative pulmonary disease and contaminated wounds.

Streptomycin has value in treatment of infections due to gram-negative bacteria occurring in the blood stream, in the meninges, or in the urinary tract.

Streptomycin is highly specific in treatment of tularemia. It has but little value in treatment of brucellosis and typhoid fever.

Streptomycin is the only practical antibacterial substance which is useful in treatment of tuberculosis. Limitations of streptomycin therapy in this disease appear to be imposed by the destructive and granulomatous changes produced in tuberculous tissue and by the fact that the drug cannot be depended on to destroy tubercle bacilli in the human body.

#### REFERENCES

1. BROWN, H. A., and HENDERSON H. C. *Proc. Mayo Clin.* 1946, 2: 347-352.
2. FREIDMAN, W. H., and HENDERSON H. C. *Proc. Mayo Clin.*, 1944, 0: 593-599.
3. FREIDMAN, W. H., HENDERSON H. C., and MURPHY, F. C. *Am. Rev. Tuberc.*, 1945, 52: 269-298.
4. FLOREY, H. W. *Brit. M. J.* 1945, 2: 633-643.
5. FOSTER, L., and PASTERNAK, A. R. *J. Am. M. Ass.* 1946, 130: 393-398.
6. HENDERSON, DOROTHY H., FREIDMAN, F. R., HENDERSON, H. C., NICHOLS, D. R., and HERRICK, W. L. *Am. J. M. Sc.*, 1945, 210: 576-584.
7. HERRICK, W. E., and NICHOLS, D. R. *Proc. Mayo Clin.*, 1945, 10: 449-462.
8. HENDERSON H. C., and FREIDMAN, W. H. *J. Am. M. Ass.*, 1945, 132: 778-782.
9. KRIEGER, C. S., BLAKE, F. G., LOCKWOOD, J. S., LEA, P. H., MARSHALL, E. K., JR. and WOOD, W. R., JR. *J. Am. M. Ass.*, 1946, 32: 47-70-77.

10. LOGAN, G. B., and HERRELL, W. E. *Proc. Mayo Clin.*, 1946, 21, 393-400.
11. OLSEN, A. M. *Proc. Mayo Clin.*, 1946, 21, 53-54.
12. SCHATZ, A., BOGUE, ELIZABETH, and WAKEMAN, S. A. *Proc. Soc. Exp. Biol. N. Y.*, 1944, 55, 66-69.
13. WAKEMAN, S. A., BOGUE, ELIZABETH, and SCHATZ, A. *Proc. Mayo Clin.*, 1944, 19, 537-548.
14. WELLS, H. G. *Yale J. Biol.*, 1931-1932, 4, 611-626.
15. YOUNG, G. P., WILKINSON, ELIZABETH H., FELDMAN, W. H., and HEDENHAW, H. C. *Proc. Mayo Clin.*, 1946, 21, 126-127.

## THIOURACIL AND IODINE

## The Preoperative Management of the Thyrotoxic Patient

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FROM the reported experiences in the collected literature, 3 salient characteristics of thiouracil therapy have been emphasized. These have been the prompt clinical response to the drug, the standardization of the dosage at 0.6 gram daily by which the basal metabolic rate is reduced 1 per cent each day and most important, that thiouracil toxicity has appeared in about 14 per cent of all patients so treated. Since so much value yet so much danger has been found in the treatment of the thyrotoxic patient with thiouracil, some safer method of management should be sought to obtain the maximal therapeutic effect of the drug with the greatest margin of safety. This has been the objective of the present study in admittedly small series since from a total experience of 527 thyroidectomies only 20 recent hospital cases were considered suitable for this form of therapy.

There were 16 females and 4 males varying in age from 23 to 76 years. The average age of 45.1 years was equivalent to that of 190 thiouracil treated patients reported by Lahey. In the series were 9 nodular and 9 diffuse goiters and 1 recurrent goiter in each group. The tissue submitted from the recurrent diffuse goiter was reported by the pathologist as adenocarcinoma. All admission basal metabolic tests were made after at least one day of rest in bed. The highest was plus 72.4 per cent and the lowest plus 25.1 per cent. The average plus 43.57 per cent. This approximated Lahey's average of plus 49 per cent. Admission leucocyte counts ranged from 10,050 to 41,500 with an average of 7,135. All other clinical laboratory determinations and radiological examinations were performed routinely on admission but have been omitted from this report. Medication was withheld until the laboratory findings were charted. Bed rest except for 2 hours daily was the rule. In addition ice caps were applied to the head and precordium intravenous fluids were administered as indicated and sedation obtained by the generous use of phenobarbital. The average daily dose of phenobarbital was 4 grains. This included the larger doses of 3 grains to 9 grains given the night before operation. While the Bartlett's have advocated larger amounts to produce narcosis and semi-anesthesia these patients were easily managed on the smaller dosages since avertin was used as a basal anesthetic 45 minutes before the scheduled operating time. All patients received 0.6 gram of thiouracil daily divided into 3 doses each of 0.2 gram. The longest period of administration was 21 days the shortest 6 days and the average 11.9 days. There were 4 exceptions to this dosage. In 3 patients it was necessary to increase the amount and in 1 to decrease it. In Case 8 patient previously iodine resistant, required 0.6 gram daily for 8 days 0.8

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62 days Thyroidectomy was performed without incident and without postoperative storm in all cases. In Case 5 a large nodular intrathoracic goiter in a patient aged 65, the admission basal rate was plus 31.3 per cent and grave myocardial damage without heart failure was present. The rate was reduced to plus 14.2 per cent by thiouracil and patient was then iodinated. Death occurred less than 30 minutes after the incision was made as the right lobe and isthmus were removed. This was a cardiac death in the thyrocardiac group which is known to carry the highest mortality rate.

Since end results and the time spent in a hospital have always been pertinent factors in this form of management should be compared with present methods of combined ambulatory and hospital care. Thiouracil was used an average of 11.9 days plus Lugol's solution 6.2 days or a total preoperative time of 18.1 days. Case 5, the operative death and Case 20 in which patient refused operation have been deducted from these figures. The average postoperative time was 6.8 days or an average total hospitalization of 24.9 days. During all of this time each patient was under medical control while receiving a known toxic drug. This control cannot be exercised over out patients having at their personal disposal 1 or 2 weeks supply of thiouracil. Until thyroid disease can be cured medically, the thyrotoxic patient must eventually come to operation. While the standard 0.6 gram daily dose of thiouracil effectively reduced the basal metabolic rate this small series of 527 thyroidectomies and the thousands re-

ported elsewhere have clearly pointed out that Lugol's solution, bed rest and sedation as well as thiouracil are still factors essential to the successful management of the thyrotoxic patient.

#### SUMMARY AND CONCLUSIONS

1 Thiouracil has a field of usefulness and should be limited to the preoperative preparation of the thyrotoxic patient.

2 The dangers which have been previously reported appear to be due to the prolonged use of a potent drug.

3 These dangers can be minimized in the hospital by careful observation, study and the individualizing of treatment to the needs of each patient.

4. It would seem unwise to place in the hands of an out patient a dangerous drug and allow such a patient to be removed from regular and controlled observation.

5 The use of iodine in conjunction with thiouracil is a sound and safe practice since it eliminates uncontrollable operative hemorrhage and thus ensures safe hemostasis.

6 Reduction of the basal metabolic rate to limits between plus 15 per cent and plus 30 per cent by thiouracil followed by the administration of large doses of iodine reduces the preoperative preparation time to the economic advantage of the patient without materially increasing the surgical risk.

#### REFERENCES

- 1 ASTWOOD E. B. J. Clin. Endocr., 1944, 4, 229.
- 2 BARTLETT W. and W. Jr. Surg. Gyn. Obst., 1930, 51: 217-223 1930, 51: 775-777
- 3 LARLEY F. H. Labey Clin. Bull. 1944.
- 4 Idem. Surg. Gyn. Obst., 1945, 81: 425-439.



TABLE II.—CLASSIFICATION OF CLINICAL DISORDERS OF FLUID AND ELECTROLYTE BALANCE\*

Water disequilibrium	Salt disequilibrium
1. Acute water deficit.	1. Extracellular salt water deficit.
2. Chronic water deficit.	2. Extracellular salt water deficit with water deficit.
3. Absolute water excess.	3. Extracellular salt water deficit with relative water excess.
	4. Extracellular salt water excess.
	5. Extracellular salt water excess with relative water deficit.
	6. Extracellular salt water distributional shifts.
	7. Any of above (1-6) with changes in base-bicarbonate (alkalosis or acidosis)

\*Intracellular salt disequilibrium states are not considered in constructing this table.

gresses at a rate rapid enough to prevent the kidney from excreting salt in sufficient amounts to maintain the solute concentration of the body fluids at a normal level. This state is accompanied by intense thirst if the individual is conscious. The clinical signs that accompany acute water deficit are oliguria, dryness of mucous membranes, elevation of body temperature (rectal), and hallucinations, disorientation, mania, and coma in order of progression of the deficit. The laboratory signs are a high urine specific gravity (if renal function is good), high blood urea, and concentration of red blood cells, plasma proteins, chloride and sodium in the blood.<sup>1</sup> The correlatives necessary for making the diagnosis are the physical signs of water deficit, a high urine specific gravity and the absence of signs of an extracellular salt water volume deficit (see extracellular salt water volume deficit).

**Chronic water deficit.** (Primary water deficit with a normal solute concentration of body fluids, Fig. 2.) Chronic water deficit is the most frequently encountered disturbance of fluid equilibrium in psychiatric institutions. It differs from acute water deficit because a compensatory renal excretion of salts (Na and



Fig. 2. At left, normal extracellular fluid; at right, chronic water deficit.

K) occurs as the body content of water falls (4). This tends to maintain the solute concentration of body fluids within normal limits. However, salt concentrations finally rise when the deficit of water becomes so great that in sufficient water is provided to the kidney to excrete the salt necessary to keep solute concentrations normal.

In the treatment of chronic water deficit one must remember that salt deficit is associated with the water deficit even though no obvious loss of salt by vomiting, diarrhea, or sweating has occurred.

The cause of chronic water deficit is a decrease in the rate of water accretion of such a degree that the rate of total water gain is less than the rate of minimal water loss. However, the discrepancy between the gain and the loss of water is not so great as to prevent the kidney from holding the solute concentrations of body fluids within the ranges compatible with health.

The most frequent cause of the disorder is a reduction in the sensorium that under conditions of health keeps the water content of the body within a relatively narrow range of variation. Its frequency of occurrence is high in psychopathic states, organic brain disease (senile alcoholic, luetic, postapoplectic), drug addiction, chronic febrile illnesses, geographic limitation of water intake, and chronic painful states (peripheral vascular disease, causalgia, chronic infection, arthritis and neoplasia).

The clinical signs of chronic water deficit are predominantly those of an extracellular salt water (base) deficit provided that the development of the deficit proceeds slowly enough for the kidney to keep the solute concentration of the body fluids constant. However the signs of acute water deficit may be added to those of extracellular salt water defi-

<sup>1</sup>It is especially that diminished elasticity of the skin, softening of the eyeballs, and longitudinal wrinkling of the tongue are not listed as signs of acute water deficit.



erally associated with states of water deficit or excess, or states of alkalosis or acidosis. A continued excretion of sodium in excess of that taken into the body is its cause. The excretion may be extrarenal (vomiting, diarrhea, fistulae) or renal. The renal excretion may be compensatory as in chronic water deficit or pathologic as in renal tubular hypofunction (hydro-nephrotic atrophy). The associated presence of water equilibrium disturbances will depend upon the concomitant rate of water accretion. If less water is drunk during the development of the extracellular salt water deficit than was lost through kidney, skin and lung, an associated deficit will be present. The development of changes in composition alkalosis or acidosis, are mainly dependent upon the composition of the fluid lost from the body. Polyuric obstruction with vomiting of an acid solution tends to be associated with an alkalosis. Loss of pancreatic juice, an alkaline solution (pancreatic fistula), produces acidosis.

The signs and symptoms of an extracellular salt water deficit are variable. They depend in part upon the rate of formation of the deficit<sup>1</sup> upon the water content of the body other than that in the extracellular fluid, upon the concomitant rate of potassium loss, and upon the degree of the "uncompensated" compositional changes that may be associated with the deficit. The signs and symptoms of a relatively uncomplicated deficit are as follows:

1 Usually there are no definite signs or symptoms associated with a salt water deficit of 0 to 2 per cent B in a healthy adult.<sup>2</sup> However, in the aged in winter and in the chronically ill, a reduction of the extracellular salt water volume of this degree may be attended by severe symptoms and signs.

2 An extracellular salt water volume decrease of 2 to 4 per cent B is accompanied by apathy, weakness, somnolence, anorexia, brief periods of nausea, reduced affective responses,<sup>3</sup> transient vertigo on assuming the erect posture, a soft pulse with insignificant

and variable changes in systolic blood pressure and pulse rate, and a slightly sticky skin. This stage has been called the "early barbituric acid-depressive phase of salt deficiency."

3 An extracellular salt water volume decrease of 4 to 6 per cent B ( $1\frac{1}{3}$  to  $1\frac{1}{2}$ ) of the extracellular fluid volume is associated with an increase in severity of the above signs and symptoms and in addition occasional unproductive retching, syncope on attempting to stand, a lowered blood pressure—frequently to "shock" levels, a variable pulse rate—usually tachycardia, a subnormal temperature if ambient temperature is below 85°F,<sup>4</sup> a wrinkled tongue, sticky skin, "putty" muscles, and soft eyeballs.

4 Coma finally supervenes and death occurs with reductions of the extracellular salt water volume of  $\frac{1}{3}$  to  $\frac{1}{2}$  of the "normal."

The laboratory signs are variable and are in part dependent upon the amount of the deficit (little change of solute concentration with small deficits regardless of rate of water ingestion) (11) upon the composition of the salt solution excreted (plasma chloride falls faster if stomach contents are lost than if small bowel contents are) upon the rate of water accretion in deficits of salt water volume greater than 2 to 3 per cent B (see chronic water deficit and extracellular salt water deficit with "relative water excess") and upon the rate of development of the deficit.

The finding of "normal" blood solute or red blood cell concentrations does not rule out the presence of an extracellular salt deficit. However, a diminution of the solute concentration (Na and Cl) with an increase in the concentration of red blood cells (high hematocrit) is positive evidence that a relatively severe and rapidly developed extracellular salt water deficit exists. The relationship of the changes in the solute and red blood cell concentrations to the salt water deficit are qualitative but usually not quantitative. Therefore the history and the physical examination constitute the best bases for ascertainment of the existence of salt water deficit.

B<sub>0</sub>—original body weight.

<sup>1</sup>When extracellular salt water volume deficits are associated with a proportionately greater water deficit, when they are very great and the individual is near death, when it occurs in infancy or when it is incurred in hot climates, an elevated temperature is usually found.

<sup>2</sup>The more rapidly the deficit develops, the more severe are the symptoms and signs that accompany a given deficit.

<sup>3</sup>Author's observations on C. L. M. Three trials, fasting state for 14 hours, volume deficit induced by continuous duodenal drainage for 50 hours excepting for eight  $\frac{1}{2}$ -hour periods with the tube clamped to permit the drinking of water to allay severe thirst.

<sup>4</sup>No desire to smoke, read the paper or talk to anyone.



Theoretically the actual water content of the body in this state, although it is usually in deficit, may actually be in excess of the individual's usual content in health even though extracellular fluid volume is below normal in spite of its dilution with water. To have this particular condition readily obtain it is necessary that the loss of extracellular sodium proceed without much reduction of intracellular base and with a rate of water accretion that is faster than its rate of loss.

A full blown picture of an extracellular salt water deficit with water intoxication does not occur often with environmental temperatures below 85 degrees F. However, at low environmental temperatures it may complicate the course of recovery from trauma (operative, 20 thermal 22, crush) provided that too much water is given too soon or that too little sodium is given too late. The rate of excretion of positive loads of water by the kidney is reduced and may approach zero with severe salt water deficits. In oliguric or anuric states associated with an extracellular salt water deficit, the restoration of the solute volume and the concentration of the extracellular fluids by the administration of an appropriate interstitial salt solution is of primary importance in the re-establishment of kidney function. If an attempt be made to force urine flow by the administration of water before the extracellular fluid volume deficit is corrected, severe water intoxication may be induced, and an oliguria converted to anuria.

Extracellular salt water deficit with water excess (miner's cramps) occurs fairly frequently in hot environments if a sodium deficit is incurred while the drinking or the administration of water is not limited (21). Heavy work by an untrained, unacclimatized person (high rate of Na loss through sweating) and a reduction of sodium intake below minimal rate of loss in a person at rest (alcoholism, febrile illnesses, etc.) are the usual immediate causes of the sodium deficit.

through fistulous tracts (duodenal, choledochal, pancreatic and external) with the chronic loss of extracellular fluid from granulating wounds; and with inattention to details in the care of people with large wounds (placing individuals with large open wounds or granulating surfaces in tube of water rather than saline, the covering of large wounds with wet dressings that are wet with water or hypotonic salt solutions as boric acid).

The physical signs and symptoms of an extracellular salt water deficit with relative water excess are those of an extracellular salt water deficit, those of an absolute water excess, and those of uncompensated compositional changes if they are present. Obviously large individual variations in signs and symptoms will be present. The laboratory signs of an extracellular salt water deficit with relative water excess are as follows: a low sum of the plasma chloride and bicarbonate (below 115 to 120 mEq per liter) in the absence of acetoneuria, a low urine chloride concentration and a normal or an increased concentration of red blood cells. These are the most essential correlates to be considered in formulating a diagnosis of an extracellular salt water deficit with relative water excess.

*Extracellular salt water excess* (Fig. 7) The symptoms and signs of a rapidly induced relatively small excess are listed in Table III. The sensible loads at the end of the period of loading varied from 2.8 to 4.1 percent of body weight because of the excretion of the salt water (renal and intestinal) that occurred during the loading period. The volume of

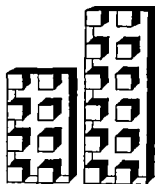


Fig. 7. At left, normal extracellular fluid; at right, extracellular salt water excess.

fluid given always amounted to 5 per cent body weight in 5 hours.

The signs and symptoms vary and seem to be partially dependent upon the composition and tonicity of the solution that was administered, especially by the oral route. Haldane and Priestley described this relationship earlier. The salt solution drunk "was meant to approximate to the salt content of human serum and was found to be much more palatable than 6 p.c. sodium chloride solution—a point of some practical importance because it



TABLE III.—SYMPTOMS AND SIGNS OF EXTRA-CELLULAR SALT WATER EXCESS IN MAN

Symptoms	Group			
			3	4
limb sensation	100%	100%	0%	40%
nausea	100	80		0
looseness	100	100	100	100
abdominal cramps	83	30		
orthury	66	40	100	40
heavy eyelids	77	100	00	100
headache	44			
anorexia	44	0	80	
thirst	66	100	00	
Urea				
Personality changes (Irritability or depression)	77		40	0
frequent repeated watery stools	66			
Edematous edema of legs	44	60	80	
Edematous edema of hands and legs	11	30	30	
muscle incoordination	44		60	0
Diaphoresis with acid excretion			80	
emthex				

Group. Nine healthy fasting men, loaded with 5 per cent  $B_u$  of .85 per cent NaCl solution at rate of per cent  $B_u$  per hour by mouth.

Group 3. Five healthy fasting men, loaded with 5 per cent  $B_u$  of .85 per cent intrasternal salt solution (NaCl, 14 mEq. per liter plus  $NaHCO_3$ , 30 mEq. per liter in water) at rate of per cent  $B_u$  per hour by mouth.

Group 4. Five healthy fasting men, loaded intravenously with per cent  $B_u$  of .85 per cent NaCl solution at rate of per cent  $B_u$  per hour ( .85% N Cl is 5% glucose solution produced more severe post administration muscular incoordination).

Group 5. Five healthy fasting men, loaded with 5 per cent  $B_u$  of .06 per cent NaCl solution at rate of per cent  $B_u$  per hour by mouth.

was found to be almost impossible to drink rapidly two or three litres of sodium chloride solution without producing vomiting' (17)

Hoarseness and a sensation of 'heavy eyelids' are the only constant symptoms associated with a sensible load of 2.8 to 4.1 per cent body weight of the above solutions. Greater positive loads of salt solutions are associated with the gross collection of fluid in subcutaneous tissue, in body cavities and in some organs. Therefore gross overloads of 15 to 25 per cent body weight are associated with variable signs and symptoms that have an intimate relationship to the degree and rate of impairment of breathing, circulation and renal function

Extracellular salt water excess rarely exists without a disturbance in the content of water in the body in relation to total solutes. A relative water deficit is commonly associated with it. This state is described below

*Extracellular salt water excess with relative water deficit* (Fig. 8) This syndrome may be readily induced during the postoperative period and after trauma by the exclusive use of an isotonic salt solution to provide for the water and salt needs of a person who cannot

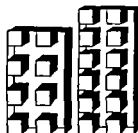


Fig. 8. At left, normal extracellular fluid; at right, extracellular salt water excess with water deficit.

eat or drink. It is physiologically analogous to the illness induced by drinking sea water to satisfy thirst.

If 0.9 per cent sodium chloride solution (159 mEq sodium per liter) is the only fluid infused into healthy fasting men the urine excreted during the first 24 hours does not contain much more sodium than the infusate per unit volume. Consequently the amount of water made available to the body from the saline solution is smaller than the insensible loss of water and the concentration of salt in body fluids increases.

If the intravenous injection of 0.9 per cent sodium chloride in water or 0.9 per cent sodium chloride in 5 per cent glucose into a healthy man is continued at a constant rate during the next 24 hours so that an amount of solution roughly in excess of 3 per cent of body weight is administered in 24 hours, a new equilibrium state tends to be established. This state is characterized by the excretion of the salt given that day and by a concentration of sodium chloride in the urine sufficiently greater than its concentration in the infusate so that enough water is thereby provided to balance the insensible loss, and the concentration of salt in the body remains at the level reached

the previous day or it decreases. If the above solutions are given as the sole source of water during renal insufficiency states or during the immediate postoperative period when the kidneys' ability to excrete sodium in high concentrations in the urine is limited, a much greater excess of sodium chloride and a greater deficit of water in relation to total body solutes will exist before the new equilibrium state is reached. Indirect evidence indicates that under certain circumstances the relative water deficit may reach such proportions as to be associated with anuria in the presence of edema. The syndrome of "acute salt intolerance" is now thought to be due to salt excess with a relative water deficit.

The symptoms and signs are as follows: disorientation, anorexia, nausea, vomiting, a diminishing rate of urinary flow in relation to the amount of fluid retained, hoarseness, and the collection of fluid subcutaneously, in the lungs, and in body cavities. The plasma sodium concentration tends to be elevated, and the red blood cell count and plasma protein concentration tend to be reduced. If oliguria is present, the nonprotein nitrogen of blood increases.

*Changes in composition of extracellular fluid* (Departure from the normal electrolytic pattern of extracellular salt water.) Changes in the composition of extracellular fluid can be of many types. A few of them are hypoproteinemia, hyperproteinemia, hypocalcemia, hypercalcemia, hyponatremia, hypernatremia, and acidosis alkalosis. Only two of them, acidosis and alkalosis of nonrespiratory origin, will be considered.

The degree of acidosis or alkalosis present should be looked upon as a measure of the organism's inability to compensate for a change in the relationship of the bicarbonate ion to the anions of stronger acids ( $\text{SO}_4$ ,  $\text{HPO}_4$ ,  $\text{Cl}$ , lactate) in the extracellular salt water. In other words the actual change in the hydron concentration (acidosis or alkalosis) is a measure of the ineffectiveness of the respiration the renal function, and the buffer systems to compensate for an alteration in the relationship of acid ( $\text{H}_2\text{CO}_3$ ) to base bicarbonate ( $\text{BHCO}_3$ )—HA/BA. This change in relation ship in the type of acidosis or alkalosis con-

sidered here is due to a shift in the proportion of  $\text{HCO}_3$  to the sum of the other anions of stronger acids than  $\text{H}_2\text{CO}_3$  in the extracellular fluid ( $\text{Cl}$ ,  $\text{HPO}_4$ ,  $\text{SO}_4$ , lactic and other organic acids).

The signs and symptoms of a relatively un complicated<sup>1</sup> base-bicarbonate deficit ("acidosis") and of a base-bicarbonate excess ("alkalosis") are relatively mild. The reduction by one-half<sup>2</sup> of the base bicarbonate (to 10–14 mEq per liter) by drinking hydrochloric acid is attended by moderate dyspnea and hyperpnea with mild exercise, such as walking at one's usual rate on level ground and severe dyspnea after rapidly climbing three flights of stairs similar to that which may be experienced during the last 50 yards of the "440". There is no appreciable dyspnea or sense of fatigue at rest, but recovery of a feeling of well being after exercise is long delayed with the above base-bicarbonate deficit. No great change in the mental reactivity was noted at the above level of base bicarbonate deficit. Greater noncompensatory deficits of base bicarbonate to one-quarter of normal (7–8 mEq per liter) in adults (13) and to less than one-fifth of normal (4–5 mEq per liter) in children (13) may not be attended by any grossly detectable signs or symptoms indicating an impairment of the function of the central nervous system.

Similarly the elevation of base bicarbonate to 40 to 52 milliequivalents per liter of plasma ( $\text{CO}_2$  combining capacity 90 to 120 volumes per cent) may not be associated with any detectable mental or physical signs of illness, even the tendency to the development of muscular cramps and hyperexcitability of tendon reflexes may not be apparent. Hypopnea is difficult of detection without actual measurement of the minute volume of respiration. Therefore it appears that most of the symptoms usually ascribed to "acidosis" (base-bicarbonate deficit)<sup>3</sup> and "alkalosis" (base-bicarbonate excess) are the result of the concomit-

<sup>1</sup> Acidosis—rapidly induced by drinking N/100 hydrochloric acid.

<sup>2</sup> Alkalosis—rapidly induced by drinking 35 per cent  $\text{NaHCO}_3$  in water.

<sup>3</sup> Disorientation, anorexia, nausea, vomiting, weakness, apathy, pain in muscles, paralytic ileus, hypotension, fast pulse.

ant disturbances in physiologic components other than base bicarbonate. Fagge in 1874 (9) first called attention to the apparent rôle played by dehydration (salt water deficit) in the clinical picture of diabetic coma and to the partial efficacy of the injection of a saline solution into the blood. However following Stadelmann's implication of acid poisoning as the cause of diabetic coma, the rôle of the salt water volume deficit in the picture of diabetic coma was largely forgotten for a time.

Within the last two decades Fagge's original ideas have been rediscovered, and it is now realized that salt water deficits (extracellular

( $\text{Na}^+ \text{Cl}^- \text{HCO}_3^-$ ) and intracellular ( $\text{K}^+ \text{HPO}_4^{--}$ ) may quite frequently accompany nonrespiratory base bicarbonate deficits and base bicarbonate excesses. Consequently as more experience is gained in treating individuals suffering from disturbances in body fluid equilibrium, it is realized that the symptoms and signs of severe alkalosis or acidosis, with their ubiquitous physiologic effects, may be minimal and that it should be more generally realized that the direction of one's efforts toward their correction without taking cognizance of the relatively large neutral salt water deficits that are associated with them will occasionally result in inadequate salt water replacement. Then the signs and symptoms ordinarily ascribed to the alkalosis or acidosis, excepting those related to respiration and in the case of alkalosis those relating to ionized calcium deficit, may persist though to a lesser degree after the carbon dioxide combining capacity has been returned to normal. Therefore, in the treatment of a base-bicarbonate excess or deficit the replacement of the attendant neutral salt water deficit should always be kept in mind. See Table IV for the treatment of acidosis and alkalosis.

*Extracellular salt water distributional shifts* (Fig. 9) (Reciprocal variations in the extracellular salt water volume of various tissues, with the total extracellular salt water volume of the body remaining constant.) This type of disturbance in fluid equilibrium is frequently seen by the surgeon. Varying degrees thereof universally accompany all trauma. The experiments of Underhill, Kapsinow and Flske

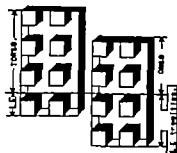


Fig. 9. Extracellular distributional shift from torso to lower extremities.

(23) demonstrated that the rate of shift of fluid into an injured area is rapid and that after the fluid has entered the injured area, it does not leave it in appreciable amounts for 50 to 70 hours. The increment of fluid in the injured area actually constitutes a functional loss of salt water and plasma proteins from the body (the uninjured part). Red blood cells also collect in the injured tissue largely because of the capillary dilatation and the stasis of flow of blood in it. This constitutes a functional hemorrhage although the total red cell volume remains within normal limits as determined indirectly from the hematocrit and plasma volume determinations or directly using carbon monoxide.

A distributional shift of body fluids following trauma is similar to an uncomplicated extracellular salt water deficit or a chronic water deficit. Clinically significant distributional shifts of body fluids are associated with trauma (mechanical, e.g. crushing injuries, fractures of the pelvis and femora; major operative procedures; thermal, e.g. scald and burn; and chemical, e.g. peritonitis following perforation of the duodenum or gall bladder) with thrombophlebitis with infections such as gas gangrene, typhus fever and trichinosis and with toxic dermatoses. This list is not complete.

Salt water (see Table IV, distributional shift) blood and plasma protein constitute the basic therapeutic elements in the treatment of distributional shifts of body fluids.

More detailed and specific directions for the treatment of disturbances in the equilibrium of body fluids than those included in this paper can be found in the *Journal of the American Medical Association* (3) and in the *New England Journal of Medicine* (1).

# MOYER FLUID AND ELECTROLYTE BALANCE

TABLE IV—TREATMENT OUTLINE

Fluid volume state	Repair solution	Concentration of solute in repair solution	Composition of repair solutions		
			Compositional change in extracellular fluid		
			Alkali normal	Alkali deficit (Minimal—moderate)	Alkali excess (Minimal—moderate)
Acute water deficit	Glucose in water	5, 10, or 15%	Sodium chloride plus sodium bicarbonate (or lactate) plus potassium chloride. Ratio $\text{Na}^+/\text{Cl}^-/\text{NaHCO}_3/\text{KCl}/\text{mEq}$ 1.0 0.66 4		
Chronic water deficit	Sodium salts	100 mEq/Liter*	Sodium chloride plus sodium bicarbonate (or lactate) plus potassium chloride. Ratio $\text{Na}^+/\text{Cl}^-/\text{NaHCO}_3/\text{KCl}/\text{mEq}$ 1.0 1.0 0.66 4		
Extracellular salt water deficit with water deficit	Sodium salts	150 to 300 mEq/Liter	Sodium chloride plus sodium bicarbonate (or lactate) plus potassium chloride. Ratio $\text{Na}^+/\text{Cl}^-/\text{NaHCO}_3/\text{KCl}/\text{mEq}$ 1.0 1.0 0.66 4		
Water excess	Sodium salts	160 to 250 mEq/Liter	Sodium chloride plus sodium bicarbonate (or lactate) plus potassium chloride. Ratio $\text{Na}^+/\text{Cl}^-/\text{NaHCO}_3/\text{KCl}/\text{mEq}$ 1.0 1.0 0.66 4		
Extracellular salt water deficit with relative wet excess	Sodium salts	100 to 160 mEq/Liter	Sodium chloride plus sodium bicarbonate (or lactate) plus potassium chloride. Ratio $\text{Na}^+/\text{Cl}^-/\text{NaHCO}_3/\text{KCl}/\text{mEq}$ 1.0 1.0 0.66 4		
Extracellular salt water distributional shifts	Glucose in water	5 to 15%			

\*Salt dissolved in water or in 5 per cent glucose solution.

When disturbed fluid volume states coexist with severe compositional disturbances, the initial treatment should be directed toward the correction of the alkalosis or acidosis. In the treatment of alkalosis, 1M/100 HCl or a 0.9 per cent solution of  $\text{NH}_4\text{Cl}$  are effective. In the treatment of severe acidosis, sodium bicarbonate (1.5% solution) or sodium lactate (1M/100 solution) may be used. When the signs of shock or liver damage are present, sodium bicarbonate is to be preferred to sodium lactate because the latter may not be split by the liver of a person who is very ill and it is not well. The amount of acid or alkali to be employed in the initial treatment of base-bicarbonate deficit or excess may be determined as follows: (1) Is the treatment of acidosis, use 60 mgms. of sodium bicarbonate per kilogram of body weight as a 1.5 per cent solution for each mEq the base bicarbonate is to be replaced to calculate the base bicarbonate needed to correct given base-bicarbonate deficit will provide enough  $\text{Na}^+$ . (2) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (3) If the necessary laboratory data are not available, changes in physical signs may be used in reestablishing the amount of sodium bicarbonate or base bicarbonate is below 35 mEq. The amount can also be obtained with calculation by the use of Van Slyke's nomogram. (4) The employment of this formula and extracellular deficits (15). (5) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (6) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (7) If the necessary laboratory data are not available, changes in physical signs may be used in reestablishing the amount of sodium bicarbonate or base bicarbonate is below 35 mEq. The amount can also be obtained with calculation by the use of Van Slyke's nomogram. (8) The employment of this formula and extracellular deficits (15). (9) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (10) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (11) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (12) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (13) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (14) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears. (15) For the initial treatment of alkalosis, employ the following rule: Take 0.06 cubic centimeters of concentrated HCl (36 per cent) per kilogram of body weight for each mEq the base bicarbonate is above 300 cubic centimeters of saline; then give it slowly and stop the injection if dyspnea appears.

**Therapy** The conduct of parenteral fluid therapy should be primarily determined from an evaluation of the history, the symptoms, the physical signs, and laboratory data. Laboratory data are valuable but should not be used as the primary determinants of diagnosis or procedure. Some of the reasons for the above statement follow

a. The quantitative correlation of the departure from normal values of the hemoglobin and the hematocrit with changes in the extracellular salt water volume in experimental sodium deficiency states is poor and is negative occasionally. This is the more especially true the more slowly the salt water deficit is contracted and the longer it exists (14, 15). If hematocrit and hemoglobin changes are used

as bases for the calculation of the fluid need, an underestimation will usually be made.

b. The concentration of plasma proteins is also a "poor" constant. In many instances of known sodium salt deficit, the total circulating protein diminishes at approximately the same rate as the volumes of the plasma and the extravascular extracellular fluid do (8). Consequently, the plasma protein concentration may not be above normal even though a dangerous degree of extracellular salt water depletion may be present.

c. The plasma chloride level does not constitute a valid basis for ascertaining either the presence or the degree of change in the extracellular salt water volume. The plasma chloride concentration may not fall and may act

usually increase as an extracellular salt water volume deficit occurs as a result of pancreatic or biliary drainage, and it may be below normal when the extracellular fluid volume is normal (hypochloremia secondary to a primary carbon dioxide excess as in emphysema, asthma, depression of breathing by opiates) or when the extracellular salt water volume is even greater than normal (hypochloremia secondary to an excess of water as in water intoxication).

The weight of the body from day to day is not an universally sound physiologic basis for the determination of the salt and water needs of the individual. Distributional shifts of extracellular salt water into the subcutaneous tissues or into serous cavities occasionally occur rapidly and as a result thereof the rest of the body suffers from the depletion of its extracellular salt water—there is need for salt water even though the individual's weight has not changed. Conversely an individual who has been given salt water or plasma in the treatment of injury (burns) usually begins to lose weight rapidly between the fourth and seventh days as the edema of the burned area subsides. Salt water should not then be given to the patient even though he is losing weight because he is excreting the salt that was given to him while the edema was forming and now that the edema is subsiding the salt constitutes an excess. If one assumes that except for the above types of illnesses, weight change is a sound basis for controlling fluid administration he assumes that the ideal water and salt contents of the body are constant. This is likely not true though only a small amount of exploratory research work has been done on the possible changes in the "ideal" body content of water and salt associated with various ills. Under certain circumstances the "ideal" water and salt contents of the body may be larger and under others smaller than they are in the healthy individual.

When determinations of the volumes of plasma and extracellular salt water can be made easily and repeatedly they may become valuable aids in the diagnosis and treatment of disturbances in body fluid equilibrium.

\*Ideal contents may be defined as those most conducive to the rapid recovery of health.

Changes in the concentration of plasma solutes and red blood cells are most valuable as checks of the appropriateness of the diagnosis and treatment.

Because there are no simple dependable means of detecting small extracellular salt water deficits, the daily parenteral administration of salt to those who cannot eat or drink is presumably an expedient that should be employed even though no salt is being lost through extrarenal channels or sequestered in diverse regions of the body. How much salt should be given under these circumstances?

Because healthy nonfasting men habitually eat 2 to 10 grams of salt daily it has been felt that a sick man who cannot eat should receive parenterally at least 5 grams a day in order to maintain his salt balance.\* However men suffer no apparent harm if their salt intakes are reduced to 1 gram daily. The Tlascalan Indians forgot the taste and the use of salt after they had been cut off from salt for centuries (16). Infants sustain their most rapid period of growth on about a gram of sodium chloride per diem.

It appears likely that the salt that man ingests daily is dictated by taste and habit rather than by actual need, and that healthy men in general have within their bodies more salt than is actually necessary for the maintenance of health. Quantitative salt excretion studies lend support to this idea. The question of the optimal salt intake, during a fast, is still unanswered. From a surgical standpoint, the routine parenteral administration of 5 to 9 grams of salt daily when there is no abnormal functional loss thereof is in certain instances capable of delaying recovery. In fact, a slight deficit of extracellular salt water may be preferable to any excess (even 5 to 9 grams daily) especially during the immediate postoperative period. This belief is supported by a number of reasons.

1. For 2 to 4 days after any injury injected salt solutions tend to collect most rapidly and to a relatively greater extent in the area of injury (19). This phenomenon is very easily demonstrated in anyone upon whom a colostomy has been performed. If no saline is given the transudation from the surface of the loop will be relatively small and it swells

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relatively little, if then 2,000 cubic centimeters of 0.9 per cent saline solution are administered, the transudation and swelling increase rapidly. An enteric anastomosis behaves in the same way, the edema that occurs about the region of the anastomosis is greater if saline is given. Therefore, the resumption of the functional continuity of the intestine following an enterostomy or enterocolostomy will tend to be longer delayed as the amount of salt injected is increased. On one occasion an edematous occlusion of a gastrojejunostomy stoma was found to be the cause of a complete gastrojejunal obstruction 24 days after a subtotal gastric resection. The mass of salt given daily was 4 grams over that lost as gastric drainage. No subcutaneous edema was present. Following the second operation, although no corrective operative procedure was carried out, the functional patency of the anastomosis was established after 4 days of zero intake of salt. The rate of healing of wounds tends to be related inversely to the local edema; the greater the edema, the slower is the rate of healing. This is most clearly demonstrated in the experiments performed by Glen, Gilbert and Drinker.

2 The incidence of postoperative pulmonary complications after upper abdominal operations is higher especially in the aged when maintenance doses (5 to 9 grams daily) are infused than when no salt is given unless specific signs of need appear (Unpublished data.)

3 A deficit of extracellular salt water is more easily corrected than an excess.

The adoption of the policy of withholding salt during the immediate postoperative period until signs of its need appear shifts the responsibility for the maintenance of a physiologically adequate extracellular salt water volume from the kidneys of the patient to his physician. This responsibility is big. If signs of illness are present or appear after an operation or injury that are attributable to a functional extracellular salt water deficit contracted by an external loss or an internal shift thereof vigorous saline therapy must be instituted and the consequences of local edema forgotten.

If there are indications for the parenteral administration of fluids, what solution or solutions should be employed? In general the

solution used should be so composed as to effect the return to normal of the various formations of the body's fluids without producing other deformations that may be more difficult of accommodation by the organism than the original ones were. Obviously, if the kidneys of all sick individuals would perform as do those of healthy men the manufacture of a universally applicable repair solution would be feasible, in fact 0.9 per cent sodium chloride in water or in 5 per cent glucose (glucose-saline) could serve in that capacity.

If a water deficit existed, it could be corrected by the administration of 0.9 per cent sodium chloride in amounts in excess of 3,000 cubic centimeters daily, should the kidney excrete urine that contained 1.8 per cent salt, for then all the salt injected could be excreted in one-half the volume of water that was injected as 0.9 per cent salt, thus making available to the body a volume of water equal to the volume of urine.

If a water excess existed and the kidney excreted the sodium chloride in 0.9 per cent concentration or lower the water content of the body would decrease by an amount equal to, or greater than the insensible loss of water.

If alkalosis existed, the excess of chloride relative to sodium in the 0.9 per cent sodium chloride solution, compared to the concentration of chloride relative to sodium in plasma would serve to reduce the alkalosis (the concentration of alkali) even should the kidneys put out no urine. If acidosis was present, the administration of 0.9 per cent sodium chloride would permit its correction if the kidneys were capable of excreting sufficiently greater amounts of chloride than sodium.

However, the kidneys of men and women who have been injured or operated upon are relatively unable to excrete a urine having a higher concentration of sodium chloride, than is present in 0.9 per cent sodium chloride, and consequently water deficits tend to be increased rather than alleviated by the administration of 0.9 per cent sodium chloride solution. In addition, the kidney's ability to excrete chloride in excess of sodium is reduced following trauma or an operation, and therefore the correction of an acidosis with sodium chloride may be impossible.

In other words, solutions of 0.9 per cent sodium chloride in water or in 5 per cent glucose (glucose-saline) are not universally applicable repair solutions because the renal function tends to be depressed following operations and trauma. Therefore, the solutions employed in the correction of fluid disequilibrium states should be so constituted as to effect the correction without depending upon the kidneys.

The solutions that fit the physiologic requirement for the correction of the fluid disequilibrium states described herein are listed in Table IV.

The volume of fluid administered and the rate of administration depend largely upon the response of the individual and the constitutional severity of the depletion.<sup>1</sup> Usually the volume of salt solution given in 24 hours should not exceed 6 per cent of the weight of the body unless the rate of functional loss of extracellular salt water continues at a rapid rate, either as a result of the continuance of distributional shifts (burns, trauma, peritonitis, gas gangrene) or as a result of continued high rates of external loss (ileostomy colostomy or other fistulous drainage). Under these latter conditions the infusion of salt water may have to be continued to 10 to 15 per cent of the weight of the body per 24 hours. When a rapid rate of infusion is employed or a large volume of fluid is given repeated auscultation of the chest and gross determination of venous pressure should be performed. If rales appear or if the veins of the neck become distended and tense the infusion should be temporarily discontinued.

After the correction of deficits has been effected, the amount of salt water given daily will depend upon the continued existence of the cause of the deficit. If the cause of the deficit is a distributional shift due to an injury the movement of extracellular fluid into the injured part will tend to decrease rapidly so that after 36 hours there will be little further shift. After 72 to 100 (23) hours have elapsed after the injury the extracellular fluid in the injured part will begin moving back

into the rest of the body and no more salt should be given because a functional excess of extracellular salt water then exists. If the loss of extracellular salt water continues (because of hyposthenuric nephropathy fistulous drainage, diarrhea, vomiting gastroduodenal drainage) the loss of salt should be made up, as it occurs, by the injection of a saline solution that has the salt compositional pattern of the body fluid lost.<sup>2</sup> (See Gamble for the composition of various body fluids.) If no salt is lost after the correction of the deficit, very little if any need be given.

Another general physiologic principle that should be kept in mind when one prescribes parenteral fluids is. A primary change in the body's content of one substance is associated with changes in the organism's content of other substances consequently the restitution to normal of the primary change in content does not insure the restitution to normal of the secondary changes upon which the ultimate recovery of the person may rest. For example a man who excretes large amounts of hydrochloric acid into his stomach, develops pyloric obstruction and vomits a large amount of chloride and a smaller amount of sodium are lost in the vomitus. This increases the concentration of base-bicarbonate in the body and the pH of the extracellular fluid increases respiration slows and the amount of carbon dioxide in the body increases, base-bicarbonate is excreted through the kidney and the body's content of base and consequently of extracellular salt water are thereby diminished. Sodium enters the cells of the body (6) and potassium leaves them to be excreted. A deficit of potassium is incurred thereby. The volumes of plasma and of extravascular extracellular salt water decrease plasma protein leaves the blood stream (8) and the total circulating protein falls although none is lost externally. The red cell mass actually declines although the hematocrit may rise (14).

Now let the extracellular salt water volume deficit be replaced by the infusion of 0.9 per

<sup>1</sup>Men with extracellular salt water depletion associated with signs of "shock" receive more solution at a faster rate than those having extracellular salt water depletion without signs of "shock."

<sup>2</sup>Sweat, give NaCl 45 to 66 per cent, gastric drainage with free hydrochloric acid to it, give NaCl 45 to 66 per cent; hyposthenuric nephropathy and enterostomy drainage (ileostomy or long-tube section) give NaCl plus NaHCO<sub>3</sub> plus KCl (see Table IV), pancreatic fistula, give osmotically equivalent means of NaCl plus NaHCO<sub>3</sub> (5 grams NaCl plus 4 grams NaHCO<sub>3</sub> per liter).

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cent sodium chloride solution the chloride and sodium deficits and a part of the carbon dioxide and base-bicarbonate excesses are relieved. There still exists a deficit of plasma protein, a deficit of red blood cells, and an intracellular potassium deficit and sodium excess. (The chemical signs of an intracellular potassium deficit are a persistently high carbon dioxide combining capacity, a high blood urea (or non protein nitrogen), and a low chloride concentration in plasma [4].) If an attempt is made to "correct" the high carbon dioxide combining power and the "hypochloremia" by further administration of sodium chloride, the deficit of potassium tends to be aggravated regardless of whether the sodium chloride is retained or excreted and the chloride concentration of plasma remains low and the carbon dioxide combining power high.

Therefore, it is obvious that the infusion of sodium salts alone will not satisfy the physiologic demands of the organism after reconstitution of the extracellular salt water volume and that the transfusion of whole blood and the administration of potassium salts should be considered as integral parts of the treatment of a large salt water deficit (7) especially if it has developed slowly and is associated with pronounced physical signs such as great weakness, atonic muscles and hypotension. Upon theoretical (10) and clinical grounds the transfusion of blood should be withheld until partial reconstitution of the extracellular volume has been effected in order to minimize the tendency for the intravascular agglutination of red blood cells and clotting. Darrow (4 to 7) has demonstrated recently that a deficit of potassium frequently accompanies disturbances of extracellular fluid equilibrium and that it has great physiologic and clinical significance.

## SUMMARY

A clinical plan is presented for the recognition of disturbances in the equilibrium of body fluids.

The disturbances in equilibrium considered are (1) acute water deficit (2) chronic water deficit (3) absolute water excess (4) extracellular salt water deficit, uncomplicated (5) extracellular salt water deficit with water defi-

cit (6) extracellular salt water deficit with water excess (7) extracellular salt water excess (8) extracellular salt water excess with water deficit, (9) changes in composition of extracellular fluids (electrolytic pattern) (10) distributional shifts of extracellular salt water.

The general principles of therapy involved are

1. It is better to treat the man than it is to treat his "blood chemistry," plasma proteins, hematocrit, or weight. A presumptive clinical understanding of the types of disturbances in the equilibrium of body fluids may be gained from a correlation of the history and the physical examination of the patient. The laboratory data are valuable as checks of the diagnosis and treatment, but they should not be used as primary bases for either.

2. Sodium salts should be given when they are needed and should be withheld when they are not.

3. A primary change in one physiologic variable, such as the sodium content of the body is attended by secondary changes in other physiologic variables, consequently, the reconstitution of the primary variable to "normal" content does not insure the return to normal of the secondary variables upon which ultimate recovery may rest. Decreases in the volume of circulating red blood cells and plasma proteins and in the mass of intracellular potassium are important secondary variables associated with sodium deficiency, especially if the sodium deficit has developed slowly.

4. The kidneys of patients treated by the surgeon are often not "alert" enough to alter a 0.9 per cent solution of sodium chloride to fit the need of the organism; therefore, appropriately balanced salt solutions should be used.

## REFERENCES

1. BUTLER, A. M., and TALBOT N. B. *N. England J. Med.* 1944, 211: 585-621.
2. CULLER, E. E. *Ohio State M. J.* 1936 32 509.
3. DARRROW, D. C. *J. Am. M. Ass.* 1940, 114 555.
4. Idem. *Ann. Rev. Physiol.* 1944, 6 113.
5. Idem. *Ann. Rev. Physiol.* 1945 233 97.
6. Idem. *J. Clin. Invest.* 1946, 25 334.
7. Idem. *J. Pediatr.* 1946, 28 515.
8. ELKINGTON, J. R., DARRROW, T. S., and WINKLER, A. W. *J. Clin. Invest.* 1946, 25 190.
9. FADGE, C. H. *Guy's Hosp. Rep., Lond.*, 1874, 19 173.
10. FARRAR, R. *Physiol. Rev.* 1929, 9 241.





# USE OF BLOOD AND BLOOD SUBSTITUTES

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IN recent years much new information regarding the nature origin and function of different elements of the blood has become available through the researches of biochemists physiologists and clinicians. In many instances the clinical applicability of such information has been obvious and the patient has derived immediate benefit. In this field as elsewhere in medicine progress in the care of the sick depends not only on the fundamental contributions from laboratories of basic science but on the clinician's alert and intelligent appraisal of new facts and on his skilful application of these new facts in the clinic.

Whipple and his collaborators have done much to define the facts of protein metabolism and the conditions governing the regeneration of the plasma proteins and hemoglobin (10 14 15). The quality and quantity of protein ingested the state of the liver the presence or absence of infection or intoxications the factor of individual organismal variation and the availability of iron to the body have been shown to be critical conditions in the maintenance of normal hemoglobin and plasma protein concentrations and blood volume. They have shown that the healthy animal for example can replace all its circulating plasma protein in 3 days under the stimulus of plasma withdrawal while taking a protein rich diet. Hemoglobin which contributes six times as much protein to the blood as does plasma protein takes about six times as long for replacement. Body protein accretion (both new hemoglobin and tissue protein) is believed to go through the transition stage of plasma protein. The protein of the plasma thus constitutes a pool which is drawn upon by the cells throughout the body and which is in constant interchange with cell protein. The studies of

Schoenheimer and others using tagged elements supports the conception of continual and rapid movement of amino acids through out the proteins of the body. The blood then must be regarded as a tissue which is in dynamic equilibrium with the other tissues of the body and its composition and volume are maintained relatively constant only through a set of remarkably complex and continuous reactions.

Of particular interest to surgeons also is the work of Cohn and his group in the fractionation and characterization of the plasma proteins (3 4 9). As methods have been developed for the separation of the different proteins of the plasma it has become possible to prepare them for tests of their function with a consequent better understanding of the physiological rôle of the individual proteins. The properties of the different fractions are of great clinical import, and must be considered in the intelligent use of blood and blood substitutes. For example the colloid osmotic force of plasma protein is essential to the maintenance of the volume of the circulating blood and when the plasma protein concentration falls below a so-called critical level in the neighborhood of 5 grams per 100 cubic centimeters reduction in blood volume and dangerous tissue edema may occur. It must be remembered however that the albumin fraction is much more important than the globulin fraction in this respect, for although the albumin molecule comprises only about 60 per cent of the plasma protein it is a much smaller molecule than globulin and provides about 80 per cent of the colloid osmotic pressure of the plasma. It has been shown that the antibody properties of the plasma reside in the globulin component and reduction in this fraction by malnutrition prolonged abnormal loss or impairment of the body's power to form globulin lowers resistance to infection (2). The clotting power of the blood depends particularly on two components of the plasma protein namely, fibrin

11. GAMBLE, J. L. *Physiology and Pathology of Extracellular Fluid. A Lecture Syllabus.* Cambridge, Mass. Harvard University Press, 1942.
12. GIBSON W. W. L., GILBERT H. H., and DRIDGER, C. K. *J. Clin. Invest.*, 1943, 22: 609.
13. KIRK, E. *Acidosis.* P. 18. Copenhagen and London. Eldar Munksgaard and William Heinemann, 1946.
14. MARRIOTT W. McK. *Physiol. Rev.* 1923, 3: 251.
15. MILLIGAN, R. C., MUNTWYLER, E., MAUTZ, F. R., and ABBOTT, W. E. *J. Biol. Chem.*, 1942, 144: 785.
16. PETERS, J. P. and VAN SLYKE, D. D. *Quantitative Clinical Chemistry* P. 766 1st ed. Baltimore Williams and Wilkins, 1932.
17. PRIESTLEY, J. S. *J. Physiol.*, 1916, 50: 509
18. ROWNTREE, L. G. *Arch. Int. M.* 1923, 32: 157
19. SOLLMAN, T. *Manual of Pharmacology* P. 847 6th ed. Philadelphia and London. W. B. Saunders 1943.
20. STEWART J. D. and ROUTER, G. M. *J. Clin. Invest.*, 1942, 21: 97
21. TALBOT J. H. and MITCHELLSON J. *J. Clin. Invest.*, 1933, 12: 533
22. TRUNKER, H. M., EGBERT H. L., and WILLIAMS, H. S. *J. Am. M. Ass.*, 1939, 13: 2907
23. UNDERHILL, F. P., KAPROW, R., and FINE, M. E. *Am. J. Physiol.*, 1930, 95: 302.
24. VAN SLYKE, D. D. *Bull. N. York Acad. M.*, 1934, 1: 3.
25. WEIR, J. F., LARROW, E. E., and ROWNTREE, L. G. *Arch. Int. M.* 1922, 29: 306.

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ogen and the globulin prothrombin. In addition, an antihemophilic globulin has been isolated and this element, missing in hemophilia, can be supplied from normal plasma to control the bleeding of hemophilia. Largely through the work of Cohn and his group under the stimulus of war time needs, these various derivatives of the plasma proteins have been put to practical test for the benefit of the sick and the wounded.

These remarks serve as a reminder that in the use of blood and blood substitutes in surgical practice one is dealing with fundamental physiological considerations. The better the understanding of the need of the patient, the clearer the objectives and the less empirical the practice, the better the result.

The rest of this discussion will be concerned with two common surgical problems, namely hemorrhage and secondary shock. These conditions will be considered in relation to therapy by the intravenous administration of whole blood plasma, albumin solution and protein hydrolysates. By the latter term is meant the mixture of polypeptides and amino acids formed by the enzymatic breakdown of a high quality protein such as casein or lactalbumin. Such hydrolysates in 5 or 10 per cent solution are nonallergenic and nonpyrogenic when properly prepared. They may be regarded as a blood substitute in that they provide the essential amino acids for the construction of plasma protein and hemoglobin when given intravenously.

**Hemorrhage.** In the healthy adult the volume of the blood comprises about 8 per cent of body weight, but variations of from 6 to 10 per cent have been found in different individuals (8-18). The blood volume tends to remain constant in the same individual and is probably more closely related to surface area and height than to weight. The healthy person can withstand a sudden loss of one third the blood or even more (up to 1.5 or 2 liters) but this is not true of many of the patients the surgeon must treat. Malnutrition, previous hemorrhage, infection, trauma, disease of cardiovascular system, liver or kidneys, reduce the power of the organism to make the life-saving adjustments required in overcoming critical blood loss.

As previously noted the blood volume is not to be regarded as a fixed entity as if contained in a rigid walled vessel. Not only may the size of the vascular bed vary rapidly through vasodilatation or vasoconstriction and ischemic shunts, but the blood is in diffusion equilibrium with the larger reservoirs of interstitial and intracellular fluid. With loss of blood an immediate inflow of fluid from outside the capillary bed begins, a process which is detectable by fall in red cell count and hematocrit. Furthermore in hemorrhage protein is mobilized from parenchymatous organs such as the liver and red cells are drawn into circulation from the spleen and bone marrow. The more rapid the loss of blood, the less the time for successful compensation and the lower the physiological reserve of the patient the smaller his capacity to endure hemorrhage. It has been shown by studies of hemorrhagic shock in animals that the longer hemorrhagic hypotension and tissue anoxia are allowed to go uncorrected the less the likelihood of survival. After a certain point damage to such organs as the liver and brain becomes progressive. The urgent need for correction of blood loss is thus emphasized. Ideally the loss of blood should be made good as it takes place.

A great service has been done practicing surgeons by Coller and his co-workers, as well as others, in providing evidence that the amount of blood lost during common operations in good hands may be large (1.5, 6, 7, 12, 20). Many surgeons unquestionably had failed to appreciate that operative and post-operative shock commonly stemmed from uncorrected hemorrhage. Further proof is convincingly available in the major teaching clinics of the country today where by the free use of blood transfusion during and after operation surgical procedures of hitherto impossible magnitude are being successfully performed (13). As Coller has pointed out, (a) the amount of bleeding at operation is almost always greater than the surgeon suspects, (b) there is no practicable method of measuring the extent to which bleeding has occurred at any given time during operation and (c) replacement is most effective when whole blood is given as the loss occurs (5). Every

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surgeon undertaking major surgical procedures should familiarize himself with the range of values for blood loss at various operations and ideally he should measure the losses at his own hands in a series of cases.

The replacement therapy for massive hemorrhage seems obvious though from time to time the obvious has been held suspect. Whole blood has been lost in the operative field into body cavities into tissue planes or to the surface and whole blood should be given in treatment (11-19). The blood must be carefully matched it must be given in large enough quantity it must be given without delay. The acutely depleted blood volume lowered cardiac output and tissue anoxia urgently require relief. In acute hemorrhage plasma or albumin injected intravenously will increase blood volume but further dilution of hemoglobin and crippling of the mechanism for oxygen-carriage results. Under these circumstances the systolic blood pressure may temporarily rise and produce a false sense of security while the patient's condition is actually worse.

Following a severe nonfatal hemorrhage unless the loss has been completely corrected by blood transfusion a period ensues during which anemia, hypoproteinemia and reduced blood volume are common findings. Unless the patient is receiving large amounts of iron the anemia is apt to be of the hypochromic microcytic type and the hypoproteinemia may be associated with a relatively greater reduction of albumin than of globulin. During the convalescence from severe hemorrhage further blood transfusions may be administered but protein requirements may be advantageously contributed to by infusions of plasma and albumin. A better source however of amino acids is protein hydrolysate in 5 or 10 per cent solution.

**Secondary shock.** In the state of secondary shock as distinct from neurogenic transitory hypotension there are present reduction in cardiac output and blood flow fall in blood pressure and usually evidence of peripheral arteriolar constriction. As a rule there is lowered basal metabolic rate and body temperature rapid pulse shallow respiration and sweating. Secondary shock may be seen in

medical as well as surgical conditions and the syndrome may be classified on an etiological basis as follows:

- 1 Loss of propulsive force, or cardiogenic shock as seen in coronary occlusion and severe cardiac arrhythmias.

- 2 Dilatation of the vascular bed as seen in overwhelming invasive infections or in transection of the spinal cord.

- 3 Mechanical interference with blood flow as in volvulus of the intestine cardiac tamponade tension pneumothorax pulmonary embolism or mesenteric thrombosis.

- 4 Primary reduction in blood volume as in wound shock hemorrhage, burns war gas poisoning and severe dehydration.

The classification of secondary shock in this manner is of value in that it emphasizes the varied nature of forces which may produce the same clinical picture though in many cases more than one of these major causes may be at work. It follows that treatment will vary likewise.

It is probably a fair assumption that reduction in cardiac output is present in secondary shock due to any of the above causes and that lowered blood volume is present in most instances. However, blood transfusion may be dangerous rather than beneficial in cardiogenic shock or pulmonary embolism and though blood transfusion is helpful in intestinal strangulation it is equally important to correct the mechanical defect by early surgical operation. In the state of secondary shock due to fulminating infections restoration of blood volume by infusions of plasma and by blood transfusions is in order but of greater urgency perhaps is treatment of the infection itself as by surgical operation antibiotics and sulfonamides depending on the case (17). The uncritical use of blood transfusion in secondary shock without analysis of its cause is therefore to be condemned.

In the state of secondary shock due to losses from the circulation or in other words in primary oligemic shock, successful treatment must be based on knowledge of the nature of the losses. In wound shock, including the shock incident to surgical operation oligemia is due to loss of whole blood and the treatment that is needed is blood transfusion in suf-

ficient volume. Furthermore the treatment of such cases of hemorrhagic oligemia does not end with recovery from the hypotension as was pointed out above. Incomplete restoration of lost blood, the presence of complicating infection, the wasting effect of the reaction of injury raise the need for protein. The intravenous route must often be employed in meeting this need, and 5 or 10 per cent amino acids solutions, plasma, albumin and whole blood must be given.

To illustrate the need for discrimination further, the parenteral fluid requirements in wound shock and in burn shock may be compared. In both conditions there is severe reduction in the volume of circulating blood. In wound shock however whole blood has been lost, and the hematocrit and red cell count are normal or low, the plasma protein concentration is normal or low. In burn shock, plasma has been lost in large amounts and albumin frequently to a greater extent than globulin, the hematocrit and red cell count are sharply elevated. Correction of blood composition here is important as well as restoration of blood volume and the immediate intravenous therapy of choice is infusion of plasma or albumin solution. In both wound shock and burn shock blood and protein hydrolysates and to a less extent plasma and albumin solution may be required intravenously in later convalescence.

#### CONCLUSIONS

In conclusion certain general principles involved in the use of blood and blood substitutes in the treatment of hemorrhage and shock are listed.

1. Careful matching of blood before transfusion is essential in minimizing reactions and renal damage; plasma for infusion should be of the pooled mixed variety, or it should be typed.

2. Deficiency of hemoglobin and deficiency of plasma protein often occur together, whether the lack is acute or chronic.

3. In the restoration of depleted blood volume by intravenous injections normal blood

composition as well as normal volume should be the aim.

4. Acute losses of hemoglobin are less easily repaired by the body than are losses of plasma protein.

5. In infections, toxic states and trauma regeneration of hemoglobin and plasma protein may be greatly impaired.

6. The longer tissue anoxia due to hemorrhage and shock is allowed to go uncorrected the less the likelihood that the patient will recover.

7. In hemorrhage and shock as seen in surgical patients the need for blood transfusion and for infusions of protein and the protein derivatives often continues during convalescence.

#### REFERENCES

- BUDINGTON, W. T. and T. FLOW, G. W. A. England J. M. 1938, 3: 8, 185.
- CANNON, P. R., WHEELER, R. W., WOOLDRIDGE, R. L., and BENDIS, E. P. Ann. Surg., 1944, 120: 544.
- COMB, E. J. Science, 1945, 5.
- COMB, E. J., OXLEY, J. L., STROUD, L. L., HUGHES, W. L. J., ANDERSTROM, S. H., J. Clin. Invest. 1944, 23: 417.
- COLLIER, F. A. and CROOK, C. F. J. Am. M. Ass. 1944, 36: 1.
- CROOK, C. F., and COLLIER, F. A. Surg. Gy. Obst., 1946, 8: 47.
- GATCH, W. D. and LITTLE, W. D. J. Am. M. Ass. 1944, 83: 1075.
- GIBSON, J. O. H. and EVANS, W. A., J. J. Clin. Invest., 1937, 6: 37.
- JANEWAY, C. A., HERNIMBERG, W. and H. THURN, G. Med. Clin. N. America, 1945, 29: 669.
- MILLER, L. L., ROBERTS, R. S., MILLER, L. L., WHITFIELD, G. H. J. Exp. M. 1945, 8: 405.
- NORRIS, R. P. and GREGORY, M. I. J. Clin. Invest. 1946, 25: 72.
- Personal data unpublished.
- PHILLIPS, D. H. J. Am. M. Ass. 1945, 127: 109.
- ROBERTS, R. S., MILLER, L. L., WHITFIELD, G. H. J. Exp. M. 1945, 8: 3.
- Ibid. 1946, 83: 493.
- SCHONBERGER, R. The Dynamic State of Body Constituents. Cambridge, Mass. Harvard University Press, 1942.
- STEWART, J. D. Surgery 1941, 9: 304.
- STEWART, J. D. and ROBERT, G. M. J. Lab. Clin. M. 1941, 20: 1383.
- STEWART, J. D. and WARTER, F. Ann. Surg. 1945, 20: 20.
- WHITE, M. L., JR., and BUXTON, R. W. J. Thorac. Surg. 1941, 10: 5.

# LIGATION OF THE INFERIOR VENA CAVA IN THROMBOSIS OF THE DEEP VEINS OF THE LOWER EXTREMITIES

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**L**IGATION of the major veins to limit propagation of blood clots and prevent pulmonary embolism has become a standard procedure. The point of ligation of the involved vein depends upon the level of the blood clot and the extent of disease of the vein. The only safe rule to follow is to ligate above the clot through a normal segment of vein just below a main tributary. The majority of cases of thrombosis of the veins of the lower extremity can be detected while the clot is still below the inguinal ligament. In these, ligation of the femoral vein for the deep venous thrombosis, and the same phlegmonous vein for superficial thrombosis usually terminates the process. However in some cases the disease has extended to such a level that ligation of the inferior vena cava becomes necessary. Ligation of the inferior vena cava is not a new procedure. It has been quite widely used in pelvic thrombophlebitis. However it has only recently been used to any extent in the treatment of thrombosis of the deep veins of the lower extremities. We have performed ligation of the inferior vena cava in 30 cases of ascending thrombosis of the deep veins of the lower extremities. A report of these cases forms the basis for this communication.

## INDICATIONS FOR LIGATION OF INFERIOR VENA CAVA

Although the indications for ligation of the inferior vena cava were essentially the same in all of our cases, the basic venous pathology was quite varied (Chart 1). In this series there were 3 types of venous thrombosis, namely phlebothrombosis, acute femorotibial thrombophlebitis, and thrombophlebitis in varicose

veins (Table I). The relative dangers of pulmonary embolism in the various types and the necessity for ligation of the inferior vena cava in the cases we are reporting can best be shown by description of the pathology and clinical course of each type.

## PHLEBOTHROMBOSIS

Phlebothrombosis usually begins in the small veins of the legs or feet. The clot is attached at first only at its origin. Propagation is the characteristic quality of this type of venous thrombosis. As the original mass of clot begins to organize the vein wall at this level becomes thickened edematous, and inflamed. As new clot is added it extends steadily upward floating freely in the blood stream. The clot gradually fills the involved veins and eventually becomes organized and fixed to the vein wall. This process may require many weeks. Until there is complete organization and fixation of the thrombus it may be dislodged at any time and produce pulmonary embolism. Phlebothrombosis is particularly dangerous because at first there may be no local symptoms. Its existence often becomes known only after the patient has suffered one or more episodes of pulmonary embolism. As the clot extends upward more venous channels become occluded and local signs and symptoms develop. In all of the cases in this series there were local signs and symptoms of venous thrombosis. The common signs are edema of the foot, ankle, and leg, dilated superficial veins, cyanosis of the nail beds, and often a fall in local temperature. Pain in the calf is the most important symptom. This may be constant but is more often noted on motion of the foot or leg or on pressure over the veins. Fever is frequently absent and when present is quite mild. Leucocytosis is usually absent. Phlebothrombosis of the deep veins of the legs accounted for 25 of the cases in this series.





pathetic blocks were performed over a 3 day period before there was relief of symptoms. The deep veins became thrombosed and superficial collaterals developed rapidly.

The remaining 4 unilateral cases all developed thrombosis of the deep veins of the normal side with massive edema of that limb. The process was gradual and at no time was there any disturbance of the arterial circulation. In all of our 30 cases there has been some degree of postoperative edema of both legs. This has been controlled by properly fitted elastic stockings. We have used a series of leg exercises in order to expand the collateral circulation gradually (Chart 3). The legs are elevated on 4 soft pillows immediately after operation. Walking motion exercises of the feet and legs are given frequently. As the edema subsides or if negligible throughout the pillows are gradually lowered. About 10 days following operation the patients are allowed to dangle legs over the side of the bed—still using the exercises. About 14 days after the operation the patients are allowed to walk. Elastic stockings are then fitted and are worn at all times except while in bed. The patient gradually resumes free activity. All of the patients that survived have been rehabilitated to the point of resuming full time occupations. There has been no ulceration of the legs. There is a marked difference in the rapidity of development of collaterals in the males and females. In the males the superficial collaterals have predominated in the females the deep collaterals, and often there is no dilatation of the superficial veins.

#### VENOUS COLLATERAL PATHWAYS FOLLOWING LIGATION OF THE INFERIOR VENA CAVA

When the inferior vena cava is ligated many collateral pathways develop. Some of these carry blood back to the inferior vena cava above the point of ligation; others communicate with the portal vein or the superior vena cava system. Among the most important deep collateral routes is the communication of the hypogastric vein with the inferior mesenteric vein through the hemorrhoidal plexus. Another major route is from the external iliac vein through the inferior epigastric vein to the superior mesenteric vein and thence to the

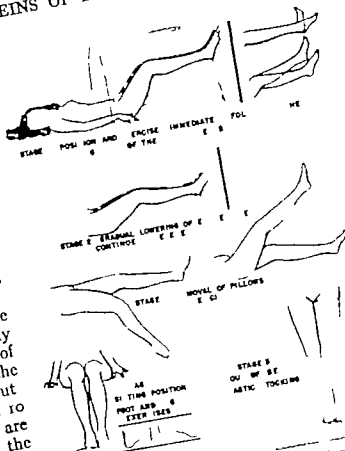


Chart 3 Postoperative measures to restore venous circulation

superior vena caval system. In women an additional important deep pathway is found in the ovarian veins which have access to blood from the hypogastric veins through the pelvic and uterine plexuses and deliver it to the inferior vena cava directly or via the renal vein. In men the homologous pathway through the spermatic veins is considerably less efficient, which probably explains the clinical observation that the superficial abdominal veins usually are more prominent in men than in women after ligation of the inferior vena cava. The main superficial collateral circulation is from the femoral vein through the superficial epigastric vein to reach the superior vena cava system by communication with the lateral thoracic vein. Other veins which contribute to the collateral circulation include the vertebral venous system (communication through pelvic plexuses), the lumbar veins (communication through the deep iliac circumflex vein and ilio-lumbar vein) and the superficial iliac circumflex and superficial internal circumflex branches of the femoral vein.



# NUTRITIONAL PREPARATION FOR SUBSTANDARD RISK PATIENTS

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THE number of publications which have appeared during the war years and since attest to the current interest among investigators and clinicians, in nutritional problems. As a consequence of these efforts it is now possible to list better methods for solving the dilemma of the surgeon contemplating a major operation on a patient who is a substandard risk as a result of a chronic dietary deficiency. When from unhappy personal experiences, surgeons had learned to calculate the added risks these individuals suffered often in the past, a number were denied benefits obtainable through surgery or if accepted after a genuine appraisal of the increased hazard the necessary surgical manipulations were found to be poorly tolerated. The patient seemed to react unfavorably from the outset with an instability of blood pressure out of proportion to the actual blood loss. Blood transfusions would often produce only a transient and unsatisfactory response. Frequently the convalescence was protracted, complications developed to jeopardize the patient's life. In a considerable number a vitality sufficient to meet all the requirements for convalescence was so lacking that death occurred despite recourse to a variety of therapeutic measures. The usual autopsy findings of some incipient heart failure and bronchopneumonia, a fatty liver or a failure of wound healing, were hardly an operation but rather confirmed the impression that malnourished individuals presented a substandard risk. Too frequently if surgeons will continue to be settled tragically if surgery persists merely in restoring to normal the hydration, electrolyte status, and hemoglobin content. The statement has facetiously been offered that some modern surgeons find it necessary to operate by the calendar while others can 'work by the clock.' However a measure of wisdom may well be with the former when dealing with chronically starved patients because an increased experience with the preoperative phase of dietary preparation indicates that the success of an operation may hinge on the effectiveness of such nutritional care and makes unnecessary the completion of a hasty dissection before the patient's condition deteriorates. Such a statement implies that the pathologic biochemical states resulting from starvation are reversible after an appropriate dietary regimen. In nearly all except pre-mortem instances this is possible. The rate at which the lost body protein can be replaced is much slower though than when balanced anew the body electrolytes or fluids. Sudden dramatic results which capture the attention are not the rule. The processes of nutritional restitution frequently require days, may even take weeks, and therefore demand of the surgeon patience. In this regard there is a real need as yet unanswered how serious accurate methods of determining how seriously starved the patient actually is, how much nourishment and how long, should he be fed before an operation can be undertaken without an added risk. Fortunately however a partial restoration of the bodily stores usually suffices to permit performance of the necessary operative procedure. That is to say all the fat need not be forced from the liver nor all depleted tissues refabricated nor the hypoproteinemia completely corrected or the immune globulins and phagocytic values restored to normalcy. Even though short of this goal, after a reasonable period of satisfactory preoperative food intake the surgeon can then anticipate a convalescence virtually as free of complications as that encountered among the standard risk group. A discussion of the meth-

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ods and nutrients employed upon the surgical service at the University of Minnesota Hospitals for realizing this represents the subject matter of this paper. It is hoped that the therapeutic outline offered will prove to have a broad practical application to the several nutritional problems faced by surgeons and by virtue of its relative inexpensiveness, simplicity of preparation and apparent effectiveness, merit trial in the preoperative dietary preparation of surgical patients.

#### FACTORS RELATED TO LIQUID DIETS FORTIFIED WITH PROTEIN AND CARBOHYDRATES

During semistarvation or starvation periods, man just as any experimental animal becomes autocannibalistic while deriving his energy from body fat and protein. This means that his diet necessarily is low in calories, carbohydrates, and protein but relatively high in fat. From this one might predict that a diet of opposite qualities, namely high in protein carbohydrates and caloric content, would be best suited to correcting those abnormalities ascribable to this starvation regimen. The results of numerous investigations and clinical experience have confirmed this impression.

Of these several constituents experience and experimentation have demonstrated that protein plays a chief rôle. The principal sources of protein in natural foods are meat, fish, eggs, certain dairy products and cereals. Yet, in each of these, the protein contributes but a fraction of the total bulk. It therefore becomes necessary to consume relatively enormous quantities of food when very high protein diets are desired. For example, to realize an intake of 300 grams of protein from beef a pot roast between 3 and 4 pounds would have to be eaten. This is a feat usually beyond the capacity of any individual weakened and apathetic from prolonged starvation and is an impossibility in the case of those patients with stenosis or obstruction due to a lesion at the pyloric outlet. Desirable as it may be to foster the consumption of a high protein diet by pleasant appearing tastily prepared menus, the physical factors indicated above limit the accomplishments possible by this means. In order to pyramid the intake from such means,

liquid dietary supplements fortified with a protein concentrate and ordinarily also a carbohydrate can be used. A variety of protein concentrates are at present available, and among these is skim milk powder with the following composition:

Components	Per cent
Protein	37.8
Casein	3
Lactalbumin	5.2
Lactoglobulin	3
Carbohydrate (lactose)	49.7
Fat	1
Water	3.0
Ash	3.5

An experience has been acquired with use of this fortifying substance in diets prepared for treating several hundred malnourished surgical patients on the surgical service of the University of Minnesota Hospitals. Skim milk powder has a low cost, is readily and widely available in quantity stores well in the bulk, and can be fairly well disguised in a variety of palatable mixtures. The proteins present are complete, possess a medium capacity to induce plasma protein regeneration under experimental conditions, and are rich in the liver protecting amino acid methionine. In addition much of our biologic information on nutrition has been acquired using those proteins present in skim milk powder. They have repeatedly proved excellent sources when fed in quantity.

The use of a liquid diet either as a supplement to the hospital fare or as the sole source of calories finds frequent and valuable application in the care of patients with surgical lesions of the esophagus, stomach, and duodenum. A tale of recent weight loss can usually be found written in their admission history. This is particularly true when mild or serious degrees of obstruction are an associated complication of the disease process. Here not uncommonly the oft repeated acceptance of an incompletely masticated bolus of solid food leads to an insoluble problem in aboral transport and results in an even greater degree of obstruction and retention. Yet, it has not been unusual to note that when the lumen has been freed of these chunks by repeated washings, very satisfactory volumes of a liquid diet are accepted daily with little or no retention.

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The fluid character of these liquid mixtures has an appeal for the dietetic staff burdened by a number of requests for special trays. Untrained workers can be easily instructed to perform the simple compoundings involved in the preparation of these formulas. Too the use of liquid diets with a fixed caloric value has made relatively easy and practical the measurement calculation and charting of the daily caloric intake on the same sheet with temperature pulse and respiration. Nutrition is thus brought into focus at the bedside whenever chart rounds are being held. This method of day to day contact with the problem and an accounting of the progress made consistently satisfactory care of those classified as substandard risks have been tried but the following with some variations, has appeared most adaptable



Fig 1 Drip feeding apparatus.

tubing and flow rates are thus visualized and regulated by a thumb screw attachment. Most patients however are able to drink the mixture and as it is the taste is similar to that of an eggnog. It can of course be flavored to suit the individual desire with chocolate cocoa vanilla or other disguising substances. Some such variation is frequently employed by out patients undergoing dietary preparation. These patients can obtain skim milk powder by prescription from the bulk stock in the drug room. Simple mimeographed directions about preparation volume to be consumed daily, and the refrigeration requirements are given to them during the course of the out patient workup. A brief explanation to this group of the importance to them of this dietary preparation usually suffices to insure their co-operation. Preparation from the out patient approach is frequently possible except in the case of the very debilitated and hence reduces the actual period of hospitalization in many instances to about that for the more standard risk group. Whenever this liquid diet constitutes the sole source of food for the patient, he is urged to take if possible about 5000 calories, i.e. 3 liters daily. In the absence of obstruction this is no great problem and the consumption of quantities greater than this is not unusual. If the diet is used as a supplement, the acceptance of even a liter adds materially to the protein and caloric intake for that day. Diarrhea has been a problem sporadically. It usually can be avoided

## DIET II

Carbohydrates  
Protein  
Fat  
Calories  
Volume  
Caloric equivalent

6 whole eggs  
3 egg whites  
4 oz. skimmed milk powder  
300 gm. lactose  
1000 gm. skim milk  
5 gr. salt (may be added when indicated)

		408.8 gm.	
		130.4 gm.	
		37 gm.	
		2,446 c.	
		1,500 c.c.	
		16	
about	P	F	
about	36 0	36 0	
CHO	8 0		
	40 4	1 2	
	58 8		
	300 0	36 0	
	50 0		
	408 8	130 4	37 2

Best, cane sugar or cerelose can be substituted.

This mixture passes readily through an indwelling nasal tube. It can therefore be employed as a drip feeding mixture in an apparatus similar to that in Figure 1. This is employed when caring for persons so enfeebled by their disease and starvation that it is impossible for them to make the efforts necessary to get adequate amounts of food from bedside trays. For this setup it has proved advantageous to use an intravenous flask with a dependent air vent. This permits the entering bubbles as they rise to agitate gently the mixture and hence reduces the tendency to plugging through sedimentation. A Murphy drip apparatus is inserted into the connecting

TABLE 1 PREOPERATIVE NITROGEN BALANCE STUDY

L. E., Uni Hosp. No. 704968, aged 50 years, diagnosis, carcinoma of stomach—5 pounds eight loss

Date	GRIND										STOOL		INTAKE				BLOOD													
	Vol	Wt	Total	Urea	Amino	Cre-	Lactose	Sugar	Total	Carbo-	N	Fibrous	H <sub>2</sub> O	H <sub>2</sub> O	H <sub>2</sub> O	H <sub>2</sub> O	H <sub>2</sub> O	H <sub>2</sub> O	H <sub>2</sub> O	H <sub>2</sub> O										
	cc	gr	gm	gm	gm	gm	gm	gm	gm	gm											gm	gm	gm	gm	gm	gm	gm	gm	gm	gm
	cc	gr	gm	gm	gm	gm	gm	gm	gm	gm											gm	gm	gm	gm	gm	gm	gm	gm	gm	gm
4-2-40	660	02	56	0.8	47		30	7.3		1002			300	85.9																
4-3-40	1640	01	7.3	3.0		7	35	8		0.30			5500	9	80.8	4.15	1	3	4.5											
4-14-40	40	01	7.6	5		7.7	47	7.0		0.30			3400																	
4-5-40	3260	005	0.7		5	0.3	5			0.30			3430			4.3	30		3.4											
	Total 3400			Total 78			Total 44			Total 11			Total 50 gm																	
4-10-40	2170	040	4.3	0.6	304	8.4	34	1		507			4330																	
4-7-40	870	047	8	7.3	27	8.5	30	4		3060			4000	94	36.8															
4-8-40	150	013	5.13	5.0	8	8	36	1		460			3100	03	27.7	04	4	3.35												
4-18-40	880	018	4.60	0	30	7.7	40	3.7		3060			4000	104	25.6															
4-20-40	990	030	7.0	7	30	7.0	5	5		3060			4000	97	80.5															
4-4-40	490	030	6	5.7	30	7	97	3		465			4000																	
	Total 6871			Total 601			Total 601			Total 601			Total 601																	
4-2-40	390	030	8.6	5		6.14	13	7		360			2400	800	90.0	03	3	4.1												
4-3-40	1015	01	7	5		4.28	15			360			2600	303	93.3															
	Total 6			Total 6			Total 6			Total 6			Total 6																	

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NEOPERATIVE NITROGEN BALANCE STUDY—Continued

# ARCO NUTRITIONAL PREPARATION FOR RISK

TABLE 1 PREOPERATIVE NITROGEN BALANCE, CARBON DIOXIDE, AND STOMACH-INTAKE

Date	Vol. C	URINE	STOOL			Weight		Total Nitrogen from food		Urea Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food		Total Nitrogen from food	
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through the maintenance of appropriate refrigeration of all portions of the diet other than the patient's immediate requirements and by the routine use of thoroughly cleansed or sterilized dispensing equipment. Should it occur despite attention to these precautions modest doses of paregoric and amphogel will ordinarily correct the situation. Patients with ulcerative colitis or regional enteritis are rather consistent exceptions to this, however and may develop an aggravatingly persistent diarrhea. The use of this mixture therefore is best avoided or limited to small quantities while testing the patient's tolerance.

As indicated earlier satisfactory objective measurements of the accomplishments of a refeeding regimen are virtually nonexistent. By trial and error methods it has been possible to arrive at estimates of how long a patient should receive a caloric intake augmented to about 4000 or more calories daily. From experiences with several hundred nutritional problems the conclusion has been reached that if 5 to 7 days are devoted to such dietary preparation for each 10 per cent of the body weight lost, the individual will consistently be able to tolerate extensive surgical procedures. These values are admittedly empirical and probably maximal rather than minimal. Until more critical tests are available however the present method offers a reasonably reliable means for calculating the duration of the special dietary regimen.

#### REASONS FOR DIETARY PREPARATION PREOPERATIVELY

It will be noted that emphasis has been placed upon preparation being preoperative. This appears to be an important consideration because the weight of evidence at this time indicates a greater retention of nitrogen ingested during this phase rather than after an operation. Data from a number of laboratories (2, 4, 7, 10) as well as ours (11) confirm the accelerated loss and difficulty of securing a favorable balance of nitrogen in the recovery phase after surgery. In addition such difficulties are pyramided when the patient after an intestinal operation is unable to take nourishment for several days because of ileus, nausea or vomiting.

#### OTHER SOURCES OF PROTEIN AVAILABLE FOR SUPPLEMENTING DIETS

Besides skim milk powder various substances are available as fortifying materials. The data of Madden and Whipple (6) suggest a number of possibilities. Two of these homogenized raw pork liver and powdered bovine plasma protein have been tested and each demonstrated (12, 13) to be definitely superior to skim milk powder for the production of protein. Unfortunately the possibility of controlling brucellosis appears too real to permit routine use of the former. The latter so far has been obtainable only in quantities sufficient for investigational purposes despite the fact that countless tons are potentially available in the blood now sold as fertilizer or stock feed. Whereas, estimates of manufacturing costs are high when calculated on the amounts available from a few pilot plants, the application of modern production methods on a larger scale would likely result in price reductions sufficient to permit its less restricted usage. The incentive to develop the manufacturing of this product by the packing industry necessarily will await a more generalized medical recognition of and demand for just such a superior dietary protein. In a similar fashion a large portion of the protein of fresh caught tuna, mackerel and sardines is lost to human consumption (3). This, under current commercial practices, inedible fraction can be separated from its unpalatable characteristics and in this purified form possesses high biological value for hemoglobin and plasma protein formation. These tests limited to date to small animals, might profitably be extended to clinical material. Yeast has received somewhat limited attention as a source of protein for humans due to its rather low content of sulphur containing amino acids and because of an objectionable odor and taste which are quite difficult to disguise. These several drawbacks have been virtually eliminated in products recently developed from new strains (9). The result is a powder virtually free of unpleasant aromatic or gustatory characteristics, with as much as a 70 to 80 per cent protein content. Its effectiveness as a dietary supplement for man remains unmeasured. These to mention but a few con-

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tributions of biochemists to general nutritional problems offer a partial solution of the search for more, better and cheaper proteins with high biological activity. Their trial in the management of clinical dietary problems assuredly seems warranted if the progress of our knowledge in this field is to parallel that in the laboratory. From the selection of materials now available for fortifying diets broad scope is offered to the investigator in developing those combinations achieving the greatest effectiveness with the least cost and with the best palatability.

METHODS FOR PARENTERAL NUTRITIONAL PREPARATION

METHODS FOR PARENTERAL  
PREPARATION

In certain nutritional problem cases, for-  
tunately a rather small percentage the oral  
route is not available for protein and caloric  
repletion. On a surgical service this most  
often results from an obstructive lesion of the  
esophagus stomach or duodenum which will  
ultimately require a surgical procedure of  
magnitude. In this situation the surgeon has  
essentially two alternatives for alimentation  
elect to make a jejunostomy with this operation  
My personal experience with this operation  
has been a limited but rather consistently un-  
satisfactory one. Despite the employment of  
a wide variety of mixtures, severe diarrhea has  
invariably appeared before the quantity of  
material being fed reached a desirable level.  
The attainment of a substantial nitrogen and  
caloric balance under these circumstances is of  
course unlikely. Even when this complication  
has been less troublesome convalescence has  
lagged. This may be related to the well docu-  
mented temporary inability to anabolize pro-  
tein that exists after a traumatic episode and  
which has been carefully studied by several  
workers *vide supra*. The other alternative is  
the establishment of a parenteral feeding pro-  
gram for the dual purpose of meeting the pa-  
tient's current caloric needs, and securing the  
maximal nitrogen retention possible under the  
circumstances. To this end a daily carbo-  
hydrate intake of 200 to 250 grams is realized  
through the use of 10 to 20 per cent glucose  
solutions intravenously and isotonic glucose  
solutions subcutaneously. Unless this much  
sugar is available to the body for energy re-

requirements quantities either of the body proteins or of infused nitrogenous compounds continue to be catabolized for fuel. The magnitude of the carbohydrate intake therefore bears an indirect but quite essential relation ship to the state of the nitrogen balance. Direct control of the state of the nitrogen balance however is regulated by the kind and amount of nitrogenous compounds injected. Some of these requirements can be provided by the use of pure amino acids or pure amino acid salts or pure amino acid esters.

control of the body is regulated by injected casein, however is required by the amount of nitrogenous compounds can be provided by these requirements can be provided by protein hydrolysates or pure amino acid mixtures (5). The latter has not been available so far in this clinic. Several definite limitations exist with the use of the former. Between 15 and 20 hours are required to complete the infusion of six thousand cubic centimeters of 5 per cent each of the protein hydrolysate amigen and of glucose. This is about the maximum quantity acceptable in each 24 hours. If this casein hydrolysate is injected at rates much faster than this or in greater concentrations, unpleasant systemic manifestations in our experience become more frequent. The nitrogen content of this considerable volume of fluid is theoretically equivalent to 225 grams of protein. In some cases with a long history of extreme privation and continuing rapid loss of protein (burns, massive ulceration etc.) this quantity of nitrogen would scarcely suffice if the entire amount were available for useful metabolic activity. Actually however in several experiments it has been demonstrated that the total nitrogen content of a 24 hour urine collection after venoclysis of this type contains considerably more waste nitrogen than that obtained with feeding equivalent amounts of skim milk powder or powdered bovine plasma protein. There are at least two reasonable explanations for these findings. Since differences in biological activity have been demonstrated for proteins from various sources to casein (i.e. superior in all animal qualities to casein) the bovine plasma protein might provide a more utilizable hydrolysate if it were tried as the substrate. Or the hydrolysis by other than intestinal mechanisms, of these substances might lead to a decrease in the acceptability of the end products, perhaps through an incompleteness of processing. The salt content of amigen is of little consequence when only small

through the maintenance of appropriate refrigeration of all portions of the diet other than the patient's immediate requirements and by the routine use of thoroughly cleansed or sterilized dispensing equipment. Should it occur despite attention to these precautions, modest doses of paregoric and amphogel will ordinarily correct the situation. Patients with ulcerative colitis or regional enteritis are rather consistent exceptions to this however and may develop an aggravatingly persistent diarrhea. The use of this mixture therefore is best avoided or limited to small quantities while testing the patient's tolerance.

As indicated earlier satisfactory objective measurements of the accomplishments of a refeeding regimen are virtually nonexistent. By trial and error methods, it has been possible to arrive at estimates of how long a patient should receive a caloric intake augmented to about 4000 or more calories daily. From experiences with several hundred nutritional problems the conclusion has been reached that if 5 to 7 days are devoted to such dietary preparation for each 10 per cent of the body weight lost the individual will consistently be able to tolerate extensive surgical procedures. These values are admittedly empirical and probably maximal rather than minimal. Until more critical tests are available however the present method offers a reasonably reliable means for calculating the duration of the special dietary regimen.

#### REASONS FOR DIETARY PREPARATION PREOPERATIVELY

It will be noted that emphasis has been placed upon preparation being preoperative. This appears to be an important consideration, because the weight of evidence at this time indicates a greater retention of nitrogen ingested during this phase rather than after an operation. Data from a number of laboratories (2, 4, 7, 10) as well as ours (11) confirm the accelerated loss and difficulty of securing a favorable balance of nitrogen in the recovery phase after surgery. In addition such difficulties are pyramided when the patient, after an intestinal operation is unable to take nourishment for several days because of ileus, nausea or vomiting.

#### OTHER SOURCES OF PROTEIN AVAILABLE FOR SUPPLEMENTING DIETS

Besides skim milk powder various substances are available as fortifying materials. The data of Madden and Whipple (6) suggest a number of possibilities. Two of these homogenized raw pork liver and powdered bovine plasma protein have been tested and each demonstrated (12, 13) to be definitely superior to skim milk powder for the production of protein. Unfortunately the possibility of controlling brucellosis appears too real to permit routine use of the former. The latter so far has been obtainable only in quantities sufficient for investigational purposes despite the fact that countless tons are potentially available in the blood now sold as fertilizer or stock feed. Whereas, estimates of manufacturing costs are high when calculated on the amounts available from a few pilot plants, the application of modern production methods on a larger scale would likely result in price reductions sufficient to permit its less restricted usage. The incentive to develop the manufacturing of this product by the packing industry necessarily will await a more generalized medical recognition of and demand for just such a superior dietary protein. In a similar fashion a large portion of the protein of fresh caught tuna, mackerel, and sardines, is lost to human consumption (3). Thus, under current commercial practices, inedible fraction can be separated from its unpalatable characteristics and in this purified form possesses high biological value for hemoglobin and plasma protein formation. These tests, limited to date to small animals, might profitably be extended to clinical material. Yeast has received somewhat limited attention as a source of protein for humans due to its rather low content of sulphur containing amino acids and because of an objectionable odor and taste which are quite difficult to disguise. These several drawbacks have been virtually eliminated in products recently developed from new strains (9). The result is a powder virtually free of unpleasant aromatic or gustatory characteristics, with as much as a 70 to 80 per cent protein content. Its effectiveness as a dietary supplement for man remains unmeasured. These, to mention but a few con-

## VARCO NUTRITIONAL PREPARATION FOR RISK PATIENTS

contributions of biochemists to general nutritional problems offer a partial solution of the search for more, better and cheaper proteins with high biological activity. Their trial in the management of clinical dietary problems as surely seems warranted if the progress of our knowledge in this field is to parallel that in the laboratory. From the selection of materials now available for fortifying diets broad scope is offered to the investigator in developing those combinations achieving the greatest effectiveness, with the least cost and with the best palatability.

### METHODS FOR PARENTERAL NUTRITIONAL PREPARATION

In certain nutritional problem cases forunately a rather small percentage the oral route is not available for protein and caloric repletion. On a surgical service this most often results from an obstructive lesion of the esophagus stomach or duodenum which will ultimately require a surgical procedure of magnitude. In this situation the surgeon has essentially two alternatives. For one he can elect to make a jejunostomy for alimentation. My personal experience with this operation has been a limited but rather consistently unsatisfactory one. Despite the employment of a wide variety of mixtures severe diarrhea has invariably appeared before the quantity of material being fed reached a desirable level. The attainment of a substantial nitrogen and caloric balance under these circumstances is of course unlikely. Even when this complication has been less troublesome convalescence has been less troubled. This may be related to the well documented temporary inability to anabolize protein that exists after a traumatic episode and which has been carefully studied by several workers *vide supra*. The other alternative is the establishment of a parenteral feeding program for the dual purpose of meeting the patient's current caloric needs and securing the maximal nitrogen retention possible under the circumstances. To this end a daily carbohydrate intake of 200 to 250 grams is realized through the use of 10 to 20 per cent glucose solutions intravenously and isotonic glucose solutions subcutaneously. Unless this much sugar is available to the body for energy re-

quirements, quantities either of the body proteins or of infused nitrogenous compounds continue to be catabolized for fuel. The magnitude of the carbohydrate intake therefore bears an indirect but quite essential relationship to the state of the nitrogen balance. Direct control of the state of the nitrogen balance however is regulated by the kind and amount of nitrogenous compounds injected. A portion of these requirements can be provided by protein hydrolysates or pure amino acid mixtures (5). The latter has not been available so far in this clinic. Several definite limitations exist with the use of the former. Between 15 and 20 hours are required to complete the infusion of six thousand cubic centimeters of 5 per cent each of the protein hydrolysate amigen and of glucose. This is about the maximum quantity acceptable in each 24 hours. If this casein hydrolysate is injected at rates much faster than this or in greater concentrations, unpleasant systemic manifestations in our experience become more frequent. The nitrogen content of this considerable volume of fluid is theoretically equivalent to 225 grams of protein. In some cases with a long history of extreme privation and continuing rapid loss of protein (burns, massive ulceration, etc.) this quantity of nitrogen would scarcely suffice if the entire amount were available for useful metabolic activity. Actually however in several experiments it has been demonstrated that the total nitrogen content of a 24 hour urine collection after a venoclysis of this type contains considerably more waste nitrogen than that obtained while feeding equivalent amounts of skim milk powder or powdered bovine plasma protein. There are at least two reasonable explanations for these findings. Since differences in biological activity have been demonstrated for proteins from various sources, a material superior in all around qualities to casein (i.e. bovine plasma protein) might provide a more utilizable hydrolysate, if it were tried as the substrate. Or the hydrolysis by other than intestinal mechanisms of these substances might lead to a decrease in the acceptability of the end products, perhaps through an incompleteness of processing. The salt content of amigen is of little consequence when only small

volumes are being employed but attains real significance (9 grams in 6000 cubic centimeters of 5 per cent solution) when large volumes are in use. This item becomes even more important in the presence of the hypoalbuminemia frequently present in just this type of patient. States of overhydration due to such liberal administrations of salt and serious enough to require temporary cessation of this therapy have been noted.

This listing of these limitations should not be construed to mean that the intravenous administration of protein hydrolysates is fruitless for no one can seriously contend but that it has an important rôle in nitrogen replacement therapy. Rather it is hoped that the recapitulation of such inherent defects will bring their existence to the attention of those who have not so far appreciated them. Fortunately the number of cases wholly dependent on parenteral feeding is in a minority. Such patients must be blessed with the services of conscientious house officer or interne because they demand of him and themselves an abundant patience and tact during the tedious hours of prolonged intravenous therapy. Without actually achieving the goal of large scale plasma protein regeneration those benefits which result from the employment of hydrolysates are certainly real and definitely worthwhile. Through their agency it is possible to halt or retard the steady protein losses from starvation and allied depleting mechanisms (*ulceration infection hemorrhage*). The nitrogen intake can also be augmented considerably by daily transfusions of plasma or whole blood. Although the total amount of nitrogen in a plasma or whole blood transfusion would be relatively small considered as dietary or hydrolysate nitrogen it is proportionately more valuable because a significantly smaller fraction is lost in the urine the 24 hours after administration. This situation is particularly true when comparison is made with hydrolysate nitrogen. In this connection it appears only fair when calculating the cost of such replacement therapy to base one's ultimate conclusions on the amount of nitrogen the body actually retains and has available for functional purposes, rather than consider ing solely the price of each intravenous flask

and its contents. The use of whole blood and plasma, particularly when the latter is from a pooled source, is assuredly not an unmixed blessing. The possibility of inoculating the recipient with the virus of infectious hepatitis has been emphasized recently (18) and attention called to this serious hazard.

A nitrogen balance study by my associate, Dr. Arnold Kremen and myself yields data illustrating some of the problems and limitations of parenteral alimentation discussed earlier. The final 5 day period of this study is probably a significant example of the body's greater inclination to accept and retain nitrogen when supplied orally rather than intravenously. As has been indicated, the surgeon will find a knowledge of nutrition a means of improving his care of those patients suffering from a recent serious weight loss. Failure to recognize this obligation and meet the augmented nutritional requirements of this group will be followed by an increase in the morbidity and mortality statistics. To avoid these complications, liquid diets augmented with protein rich materials are recommended whenever the oral route is available. For those patients requiring parenteral feeding a specific program albeit a less satisfactory one, is offered.

#### REFERENCES

1. BARNES, P. B. *J. Am. M. Ass.* 1943, 337: 334.  
CO. TUI WRIGHT, A. M., MULHOLLAND, J. H.  
CARABBA, V. B. ECHAN, I. and VANCE, V. J. *Ann. Surg.* 1944, 120: 99-122.
2. DUELL, HARRY J. JR. HUBERT, M. C., JOHNSON, CORNELIA H., WINKLER, RICHARD J., GEDDES, ERNEST and SCHWABENBERG, G. J. *Nutrit.*, 1945, 3: 73-85.
3. HOWARD, J. E., PARSONS, W., STEIN, K. E., EISENBERG, H. and REID, V. *Bull. Johns Hopkins Hosp.*, 1944, 75: 56-68.
4. MADSEN, S. C., BARRETT, S. H., REMINGTON, J. H., MARTIN, F. J. C., WOOD, R. R., and SWELL, F. W. *Surg. Gyn. Obst.* 1945, 81: 5-143.
5. MADSEN, S. C., and WHITFIELD, C. H. *Physiol. Rev.* 1945, 25: 100.
6. MCDONALD, H. N. and CUTHBERTSON, D. P. *Biochem. J.* 1945, 37: 2.
7. NEEFT, J. R., STOKES, JOHN, JR., REICHHOLD, J. R., and LUDEN, F. D. W. *J. Clin. Invest.* 1944, 23: 836-855.
8. Personal communication.
9. PETER, J. P. *Physiology Federation Proc.*, 1944, 3: 97-101.  
Unpublished personal data.
10. VARECO, R. L. *Proc. Soc. Exp. Biol.*, 1945, 58: 60-63.
11. *Idem. Surgery* 1945, 9: 393-378.

# COMPLETE OCCLUSION OF THE ABDOMINAL AORTA

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**I**N 2 patients with complete aortic block just below the origin of the renal arteries diagnoses were made during life by direct translumbar aortic injection of radiopaque medium. In 1 patient, the diagnosis was confirmed by 2 subsequent aortograms, while the other was proved at necropsy. The technique used has been described (8-10)

## CASE REPORTS

**Case 1.** T. H., a white man aged 45 years was admitted to Jefferson Hospital on February 8, 1945 with the chief complaint of pain in both ankles. He had been well until October, 1944, at which time he began to experience progressively increasing weakness of both legs with easy fatigability and pain behind the knees on effort.

On December 7, 1944 while eating supper he had a violent periumbilical pain so severe that he became doubled up and broke out in a cold sweat. The pain remained localized to the periumbilical area lasted for 1 hour and was followed by a dull ache which persisted for several days. He was admitted to another hospital. The gastric analysis was normal and x-ray study of the upper gastrointestinal tract revealed a small deformity at pyloric end of stomach suggestive but not conclusive of a small ulcer.

While in the hospital 5 days after the first acute episode of pain he experienced a sudden attack of excruciating pain which first involved his right foot and thigh then spread upward to the lower abdomen and finally down the other leg. The attack which lasted about 30 minutes, was accompanied by numbness, paralysis and extreme pallor of both lower extremities. The severe pain then subsided to a dull ache and localized in both ankles. Sensation and motor power returned promptly.

Following discharge from a hospital the patient experienced an almost constant ache in both ankles. The pain usually prevented sleep and necessitated sitting on the edge of the bed with his feet resting on a chair. At the time of admission to Jefferson Hospital he could not take more than 20 steps without experiencing pain in the calves.

From the Department of Medicine and the Samuel D. Gross Surgical Division, Jefferson Medical College Hospital. Presented at the Forum on Translumbar Aortic Problems, before the Clinical Courses of the American College of Surgeons, Cleveland, Oct. 2, December 6, 20, 21, 1945.

One feature of the occupational history of possible importance was his employment in a cold storage room from 1941 to 1943 during which time he was intermittently exposed to low temperatures.

The patient was thin, weighed 135 pounds and appeared 50 years old. Blood pressure was normal. Respirations were normal. The temperature pulse and obtainable in the lower extremities, but in the left arm was 170/120 and in the right arm 160/120. Eyegrounds showed diffuse arteriolar constriction with increased tortuosity several pinpoint hemorrhages and one large hemorrhage in the extreme periphery of the left eye ground. The remainder of the examination of the head as well as the neck and chest, was essentially normal. The abdomen was normal except for the fact that aortic pulsations could not be palpated. Arterial pulsations including the femoral popliteal posterior tibial and dorsalis pedis, were not palpable in either lower extremity. Both feet were cold the left colder than right. The erythrocyte count was 4,400,000 hemoglobin 87 per cent and platelets 194,000. The blood sedimentation rate was normal. Results of repeated urine tests were negative. The blood sugar urea Kahn reactions and serum proteins were normal.

The blood urea nitrogen test was 105 per cent and tests of the urea clearance test in both arms and both legs prothrombin time in both arms and both legs revealed hypercoagulability of the blood. Venous pressure in the upper extremities as well as the calcium gluconate pressure in the upper extremities showed a normal time performed. The electrocardiogram showed a prominent Q-wave in leads II and III suggesting a prominent coronary artery disease posterior in type. Roentgenograms of the chest abdomen and spine were essentially normal. Soft tissue examination of the lower extremities failed to show any evidence of calcification in the blood vessels. Study of the upper gastrointestinal tract with barium revealed thickened mucosal folds and slight distortion of the duodenal bulb suggestive of an old healed duodenal ulcer and the barium enema was normal.

Circulatory function tests in the lower extremities all indicated markedly impaired function. Skin surface temperature studies failed to show an appreciable rise after paravertebral lumbar sympathectomy. Peritoneoscopy revealed no evidence of an abdominal mass as a source of extrinsic aortic pressure. The left internal iliac artery and vein were

volumes are being employed but attains real significance (9 grams in 6000 cubic centimeters of 5 per cent solution) when large volumes are in use. This item becomes even more important in the presence of the hypoalbuminemia frequently present in just this type of patient. States of overhydration due to such liberal administrations of salt, and serious enough to require temporary cessation of this therapy have been noted.

This listing of these limitations should not be construed to mean that the intravenous administration of protein hydrolysates is fruitless, for no one can seriously contend but that it has an important rôle in nitrogen replacement therapy. Rather it is hoped that the recapitulation of such inherent defects will bring their existence to the attention of those who have not so far appreciated them. Fortunately the number of cases wholly dependent on parenteral feeding is in a minority. Such patients must be blessed with the services of conscientious house officer or interne because they demand of him and themselves an abundant patience and tact during the tedious hours of prolonged intravenous therapy. Without actually achieving the goal of large scale plasma protein regeneration those benefits which result from the employment of hydrolysates are certainly real and definitely worthwhile. Through their agency it is possible to halt or retard the steady protein losses from starvation and allied depleting mechanisms (ulceration infection hemorrhage). The nitrogen intake can also be augmented considerably by daily transfusions of plasma or whole blood. Although the total amount of nitrogen in a plasma or whole blood transfusion would be relatively small considered as dietary or hydrolysate nitrogen it is proportionately more valuable because a significantly smaller fraction is lost in the urine the 24 hours after administration. This situation is particularly true when comparison is made with hydrolysate nitrogen. In this connection it appears only fair when calculating the cost of such replacement therapy to base one's ultimate conclusions on the amount of nitrogen the body actually retains and has available for functional purposes, rather than considering solely the price of each intravenous flask

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#### REFERENCES

- BAERON, P. B. *J. Am. M. Ass.* 143, 337-344.
- CO. TUI, WRIGHT, A. M., McHOLLAND, J. H., CARABBA, V., BARTMAN, I. and VINCI, V. *J. Am. Surg.* 1944, 20: 90-9.
- DUELL, H. A. BY J. J. HIRSHBY, M. C. JORDON, CORNELIA, H., WENZLER, RICHARD J., GERBER, ERNEST and SCHWABENBERG, G. *J. Nutrit.* 1945, 3: 175-85.
- HOW, R. D., J. L., PARSON, W., STEIN, K. E., EMMERICH, H. and REIDT, V. *Bull. Johns Hopkins Hosp.* 1944, 75: 56-68.
- MADDER, S. C., BARNETT, S. H., RUMINGTON, J. H., MARTIN, F. J. C., WOODS, R. R., and SWELL, F. W. *Surg. Gyn. Obst.* 1945, 82: 3: 43.
- MADDER, S. C., and WHIPPLE, G. H. *Physiol. Rev.* 1945, 20: 100.
- MCNABO, H. N. and CUTHBERTSON, D. P. *Biochem. J.* 1943, 37.
- N. EFR, J. R. STOKES, JON. JR. REINHOLD, J. R., and LAKENS, F. D. W. *J. Clin. Invest.* 1944, 23: 836-845.
- Personal communication.
- PETERS, J. P. *Physiology Federation Proc.* 1944, 3: 97-100.  
Unpublished personal data.
- VARCO, R. L. *Proc. Soc. Exp. Biol.*, 1945, 58: 60-62.
- Idem. *Surgery* 1946, 19: 303-378.

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One feature of the occupational history of possible importance was his employment in a cold storage room from 1941 to 1943 during which time he was intermittently exposed to low temperatures.

The patient was thin, weighed 135 pounds and appeared 50 years old. The temperature was unobtainable in the lower extremities but in the left arm was 170/120 and in the right arm 160/120. Eye grounds showed diffuse arteriolar constriction with increased tortuosity several pinpoint hemorrhages and one large hemorrhage in the extreme periphery of the left eye ground. The remainder of the examination of the head as well as the neck and chest was essentially normal. The abdomen was normal except for the fact that aortic pulsation could not be palpated. Arterial pulsations including the femoral, popliteal, posterior tibial and dorsalis pedis were not palpable in either lower extremity. Both feet were cold, the left colder than right.

The erythrocyte count was 4,400,000, hemoglobin 87 per cent, leucocytes 7,400 with normal differential count and platelets 194,000. The blood sedimentation rate was normal. Results of repeated urine tests were normal. The blood sugar, urea, Kahn reactions and serum proteins were normal. The urea clearance test was 105 per cent. The prothrombin time was 100 per cent and both legs revealed hypercoagulability of the blood. Venous pressure in the upper extremities as well as circulatory time performed by the calcium gluconate method were normal. The electrocardiogram showed a prominent Q-wave in leads II and III suggesting coronary artery disease posterior in type.

Röntgenograms of the chest, abdomen and spine were essentially normal. Soft tissue examination of the lower extremities failed to show any evidence of calcification in the blood vessels. Study of the upper gastrointestinal tract with barium revealed thickened mucosal folds and slight distortion of the duodenal bulb suggestive of an old healed duodenal ulcer and the barium enema was normal.

Circulatory function tests in the lower extremities all indicated markedly impaired function. Skin surface temperature studies failed to show an appreciable rise after paravertebral lumbar sympathetic nerve block. Pentotoneoscopy revealed no evidence of an abdominal mass as a source of extrinsic aortic pressure. The left internal iliac artery and vein were





Fig. 1 First aortogram in Case 1 showing complete transverse block of abdominal aorta at level of middle of second lumbar vertebra.

clearly visualized but no arterial pulsation was noted. A neurosurgical consultant reported normal neurologic findings and advised that lumbar sympathectomy would be of questionable value.

Vascular obstruction in the iliac arteries and the aorta itself was thought the most likely possibility but coarctation of the aorta was also considered. It was felt that aortography might definitely prove the diagnosis. Accordingly this procedure was first performed on February 24, 1945, with aortic puncture at the level of the upper border of the first lumbar vertebra. The arteriogram revealed a complete transverse block of the aorta at the level of the middle of the second lumbar vertebra immediately below the origin of both renal arteries (Fig. 1). The renal arteries and their tributaries were well visualized and appeared normal. In order to rule out any error in technique repeat aortography was performed on April 30, 1945, puncture being made one vertebral level lower, at the upper border of the second lumbar vertebra. On this aortogram (Fig. 2) practically all of the radiopaque medium was visualized within the superior mesenteric artery and its branches and no portion of the aorta itself was definitely delineated. Anastomosis of the middle colic branch of the superior mesenteric artery with the left colic branch of the inferior mesenteric was well demonstrated on this examination. Since the second



Fig. 2 Second aortogram in Case 1 2 months later showing opaque medium within superior mesenteric artery and its branches. Arrow indicates large anastomotic communication between middle colic artery of the superior mesenteric and left colic branch of inferior mesenteric artery.

aortogram merely confirmed the findings of the first one by inference rather than actual demonstration of the block, the study was performed for the third time on June 4, 1945. The needle was introduced at the level of the second lumbar vertebra just above the area of anticipated block. This aortogram (Fig. 3) left no doubt as to the existence of the block, which was sharply delineated at precisely the same level as on the first examination. The large anastomotic channel between the superior and inferior mesenteric arteries was again visualized as well as an extensive paravertebral anastomosis.

*Treatment and subsequent course.* Anticoagulation therapy with dicoumarol, vasodilator drugs (papaverine and niacinamide, sodium citrate and sodium tetrathionate intravenously, and mecbol by iontophoresis) and the oscillating bed were employed during his 6½ months in the hospital. One month after admission the patient developed an ischemic ulcer on the lateral aspect of the right leg just above the external malleolus (Fig. 4a). Despite the use of penicillin systemically, various local applications including blood ointment and the measures already mentioned to improve the arterial circulation in his lower extremities, the ulcer remained refractory throughout his hospital stay. He



Fig 3 Third aortogram in Case 1, 3 months after first aortography showing sharp delineation of the block just below the origin of the renal arteries. An extensive para vertebral anastomosis is demonstrated

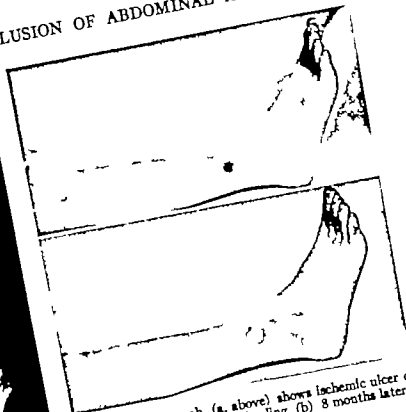


Fig 4 Photograph (a, above) shows ischemic ulcer of leg in Case 1 with complete healing (b) 8 months later

was discharged on August 22, 1945. At this time he could walk about 50 steps before experiencing pain in the calves and he was also able to sleep most of the night without pain in the ankles.

Three months after the patient left the hospital his leg ulcer healed (Fig 4b) after examination was last performed on November 26, 1946, a year and 3 months after discharge. At this time the patient stated he felt well could walk three city blocks with out having to stop because of pain and could do light work. Blood pressure in the left arm was 210/150 in the right arm 200/150 but unobtainable in the lower extremities. Aortic pulsation could not be detected and arterial pulsations in the lower extremities were still not palpable.

CASE 2 J. D. a white man aged 52 years was admitted to Jefferson Hospital on February 19, 1945 with the chief complaint of frontal headaches. These headaches which first started in December 1942, occurred when the patient arose in the morning and became progressively worse during the day. They could be relieved by rest and salicylate medication. In January 1943 he was informed by a physician that he had albuminuria and a systolic blood pressure of 260. Despite treatment by doctor he had almost daily frontal headaches with occasional dizziness.

During the preceding 10 years the patient had experienced numbness, tingling and weakness of the lower extremities particularly after prolonged effort but never any pain. He was treated for pneumococcal pneumonia in February 1943 in another hospital. The family history was not significant. The patient was a middle-aged thin man weighing 118 pounds, lying comfortably in bed. The temperature pulse and respirations were normal. Blood pressure in the left arm was 250/130 right arm 210/150 left thigh 124/100 and right thigh 130/108. Ophthalmoscopic examination revealed diffuse hypertensive retinitis with arteriosclerosis grade 3. The remainder of the examination of the head as well as the neck and lung fields were essentially normal. The heart was regular in rate and rhythm slightly enlarged to the left and there were low grade systolic murmurs at the aortic and aortic aortic valve.

There was a palpable aortic impulse in the epigastrium over which a systolic murmur was audible but no pulsations could be detected below this area. The remainder of the abdominal examination was normal. Examination of the extremities revealed a full strong radial pulse but arterial pulsations, including femoral, in the lower extremities were almost imperceptible.

The blood count revealed the hemoglobin to be 98 per cent, erythrocytes 5,000,000 and leucocytes 9,800 with normal differential count. The blood sedimentation rate was not increased. The blood Wassermann and Kahn reactions were negative. Repeated urinalyses revealed moderate albuminuria. The highest urine specific gravity was 1.008. The urea clearance test was 64 per cent and the phenolsulfonephthalein dye test revealed 25 per cent



Fig. 5. Aortogram in Case showing complete block at precisely the same level as in Case . Arrow indicates huge anastomotic channel between middle colic and left colic arteries as in Figure .

renal excretion in one half hour. The blood urea nitrogen was 20 milligrams. The venous pressure in the arm was 15 mill met. rs and the circulation time 12 seconds. The electrocardiogram suggested coronary artery insufficiency anterior in type.

A roentgenogram of the chest revealed emphysematous lung fields and a cardiac silhouette within normal limits. There was no notching of the ribs as might be expected with aortic coarctation. X-rays of abdomen and intravenous rogram were normal.

In spite of complete bed rest, sedation and salt poor diet the patient showed no improvement. Even with sodium amyltal narcosis there was no appreciable decrease in hypertension. On March 7, 1945 the patient signed his own release. It was felt that the probable diagnosis was coarctation of the aorta.

The patient was readmitted on March 22, 1945 with the same complaints. The physical examination revealed no significant changes since the last admission. Blood pressure in the left arm was 236/130, right arm, 190/110, left thigh 130/90 and the right thigh 120/90. The blood count and urinalysis revealed essentially the same findings as before. The sedimentation rate was still normal. Another intravenous urogram revealed ptosis of the left kidney.

Because the clinical picture simulated coarctation of the aorta and because roentgenograms of the chest

failed to confirm this belief it was felt that aortography might reveal the exact nature of the lesion. Accordingly this was done on March 23, 1945, puncture being made at the lower border of the twelfth thoracic vertebra. The aortogram (Fig. 5) revealed a sharply defined complete transverse block at the left of the middle of the second lumbar vertebra, just below the origin of the renal arteries. No dye was visualized in the iliac arteries or lower portion of the abdominal aorta. A large anastomotic communication between the middle colic branch of the superior mesenteric artery and left colic branch of inferior mesenteric was well delineated as in Case 1.

The day following aortography the patient was discharged as unimproved.

Following the second discharge the patient came back to his usual work as a waiter. Except for headaches and mild dyspnea on exertion he was able to work until January 28, 1946. At this time he experienced moderately severe substernal pain, radiating down the left arm, accompanied by dyspnea. These symptoms became severe on February 2, 1946 and on February 4 he was admitted to the hospital.

The patient was orthopedic, cyanotic, dehydrated, and poorly nourished. He was drowsy but oriented and co-operative. The temperature was 100° degrees F, pulse 120 and respirations, 36. The blood pressure was 60/110 in the right arm but unobtainable in lower extremities. There were moist rales at both bases but heart sounds were strong; no murmurs noted. There was moderate abdominal distention.

Blood count revealed a hemoglobin of 125 per cent, erythrocytes 5,400,000, leucocytes 14,000 with 90 per cent neutrophils, and 10 per cent lymphocytes. Urinalysis revealed occasional granular casts but was otherwise normal. The sedimentation rate was not increased. The blood nonprotein nitrogen was 75 milligrams and carbon dioxide combining power 30 volumes per cent. The electrocardiogram showed changes indicating an acute anterior coronary occlusion with involvement of a large posterior branch. The patient became progressively more dyspneic and died 33 hours later. During this final admission he voided only 200 cubic centimeters of urine.

Postmortem examination was performed by Dr. Peter A. Herbst. The salient gross pathologic findings were generalized arteriosclerosis, bilateral pleural adhesions, pulmonary congestion and edema, terminal pneumonia, cardiac hypertrophy, atherosclerotic thrombosis of the abdominal aorta both old and recent, and bilateral polar renal vessels. The heart, aorta, and kidneys were of the greatest interest and the findings in these are given in some detail.

The heart weighed 555 grams. The pericardial and endocardial surfaces were smooth and glistening. The myocardium was firm, hypertrophied and reddish brown. There was no definite evidence of old or recent infarction. The valves were normal in number, size, shape, and position. Coronary ostia patent, and vessels showed moderate atherosclerosis.

The thoracic aorta showed moderate atherosclerosis with several plaques. The abdominal aorta

showed a complete thrombotic occlusion extending from the renal vessels to the common iliac vessels (Fig 6). The proximal 5 centimeters of the thrombus extending equidistant above and below the upper renal vessels, was recent, dark red friable, and only moderately adherent to the wall of the aorta in places. The portion extending from the lower renal vessels to the common iliacs including the proximal vessels of the right common iliac was dense 4 centimeters of the right common iliac and con grayish white, fibrous, firmly adherent and continuous with the wall of the aorta.

The kidneys weighed 130 grams each and measured approximately 12 by 7 by 5 centimeters. The capsules stripped with ease. The external and cut surfaces were deep reddish brown and the demarcations were sharp. There were 2 renal vessels to each kidney (Fig 6). The upper renal vessels were 4 to 5 centimeters in length 7 to 8 millimeters in diameter and patent. The lower renal vessels were 4 to 5 centimeters in length 2 to 3 millimeters in diameter and occluded. The pelvis and ureters were normal.

The salient histologic findings were pleural fibrosis, pulmonary congestion and edema, terminal pneumonia, myocardial fibrosis, atherosclerosis and thrombosis of the abdominal aorta, and benign nephrosclerosis.

Histologic sections of the lower portion of each kidney disclosed only slight ischemic atrophy. Sections through the upper portion showed severe congestion severe arterial and arteriolar sclerosis hyalinization of the glomeruli proliferation of the glomerular epithelium and occasional necrosis of the glomerular tufts. Sections of abdominal aorta at level of injection for aortography showed no changes that could be attributed to needle puncture.

## DISCUSSION

Visualization of the level and degree of arterial obstruction as well as the amount of collateral circulation following thrombosis and embolism is possible by means of arteriography. Although employed for this purpose in selected instances for diagnosis of aortic lesions has been practically neglected. According to a review of the literature on thrombosis and embolism of the abdominal aorta by Greenfield in 1943 there were 161 cases on record and in none of these was aortography done to establish the diagnosis during life.

Blakemore (1) produced total occlusion of the aorta just distal to the renal arteries by wiring and electrothermic coagulation of a syphilitic aneurysm in this location. He then performed aortography by direct injection of 70 per cent diodrast solution into the lower thoracic aorta. The roentgenogram which un-

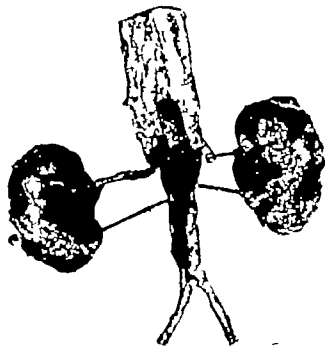


Fig 6. Postmortem specimen of aorta and kidneys in Case 2 showing old thrombus below renal arteries and recent thrombus above renal arteries. Note bilateral polar renal arteries. Death occurred 10 months following aortography.

fortunately was poor because of motion by the patient, nevertheless revealed radiopaque medium within both renal arteries one very large collateral artery going down the right side posteriorly opacification of the aneurysm and lack of visualization of the aortic bifurcation as evidence of complete obstruction. Farnas (3, 4) by means of retrograde abdominal aortography has demonstrated partial and complete occlusion of the aortic cone. So far as we are aware these represent the only previous reports of aortography in thrombotic occlusion.

It is interesting that, although the level of the block was identical in our 2 patients and both had hypertension the symptomatology was different. In the first patient, the symptoms centered about the diminished supply of blood to the lower extremities while in the second the symptoms were principally related to the hypertension. In both symptoms were slow in onset suggestive of a gradually narrowing process, but in the first the acute pain evidently represented completion of occlusion.

Collateral blood supply to the lower extremities in this condition is mainly by anastomosis



Fig. 5. Aortogram in Case 2 showing complete block at precisely the same level as in Case 1. Arrow indicates huge anastomotic channel between middle colic and left colic arteries as in Figure 1.

renal excretion in one half hour. The blood urea nitrogen was 20 milligrams. The venous pressure in the arm was 5 millimeters and the circulation time 12 seconds. The electrocardiogram suggested coronary artery insufficiency anterior in type.

A roentgenogram of the chest revealed emphysematous lung fields and a cardiac silhouette within normal limits. There was no notching of the ribs as might be expected with aortic coarctation. X-rays of abdomen and intravenous urogram were normal.

In spite of complete bed rest, sedation and salt poor diet the patient showed no improvement. Even with sodium amyltal narcosis there was no appreciable decrease in hypertension. On March 7, 1945 the patient signed his own release. It was felt that the probable diagnosis was coarctation of the aorta.

The patient was readmitted on March 22, 1945 with the same complaints. The physical examination revealed no significant changes since the last admission. Blood pressure in the left arm was 236/130, right arm 190/110, left thigh 130/90 and the right thigh 20/90. The blood count and urinalysis revealed essentially the same findings as before. The sedimentation rate was still normal. Another intravenous urogram revealed ptosis of the left kidney.

Because the clinical picture simulated coarctation of the aorta and because roentgenograms of the chest

failed to confirm this belief aortography might reveal the cause. Accordingly this was done, the picture being made at the level of the thoracic vertebra. The aorta was a sharply defined, complete block just below the origin of the renal arteries. It was visualized in the iliac artery of the abdominal aorta. A large communication between the middle superior mesenteric artery and the inferior mesenteric was well delineated.

The day following aortography the patient was discharged as unimproved.

Following the second discharge the patient went back to his usual work as a waiter. He had no chest aches and mild dyspnea on exertion. He worked until January 28, 1946. At that time he experienced moderately severe substernal pain radiating down the left arm accompanied by numbness. These symptoms became severe on February 1, and on February 4, he was admitted to the hospital.

The patient was orthopneic, cyanotic, dehydrated and poorly nourished. He was drowsy but alert and co-operative. The temperature was 100°F, pulse 120 and respirations, 36. The blood pressure was 160/110 in the right arm but unobtainable in the lower extremities. There were moist rales at the bases, but heart sounds were strong, no murmur noted. There was moderate abdominal distention.

Blood count revealed a hemoglobin of 22.5 per cent, erythrocytes 5,400,000, leukocytes 24,000 with 90 per cent neutrophils and 10 per cent lymphocytes. Urinalysis revealed occasional granular casts but was otherwise normal. The sedimentation rate was not increased. The blood nonprotein nitrogen was 75 milligrams and carbon dioxide combining power 20 volumes per cent. The electrocardiogram showed changes indicating an acute anterior coronary occlusion with involvement of a large posterior branch. The patient became progressively more dyspneic and died 33 hours later. During this final admission he voided only 200 cubic centimeters of urine.

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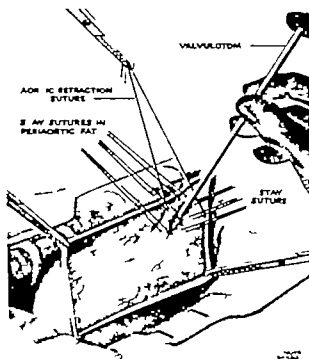


Fig. 1 Introduction of valvulotome into aorta after placing traction ligature around aorta and stay sutures in periaortic fat.

by digital pressure over the opening while the traction ligature was held taut thus bringing the exposed portion of the aorta into the wound and immobilizing it. A specially constructed valvulotome was then manipulated gently into the aortic opening and made to impinge upon the posterior wall of the aorta (Fig. 1). In contact with the latter the instrument was passed proximally within the aorta, its sheath tamponading effectively the wound in the aortic wall until its further progress was arrested within a cusp of the aortic valve. The hooked blade next was forced out of the sheath perforating the cusp in its pendent portion; then the valvulotome withdrawn thus dividing the free margin of leaflet (Fig. 2). In this maneuver the instrument was withdrawn as a whole without pulling the blade back into its sheath. Upon withdrawal of the valvulotome hemorrhage from the opening in the aorta immediately be-

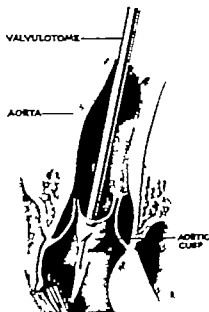


Fig. 2 Schematic representation of longitudinal section of aorta showing perforation of valve leaflet. Withdrawal upward of barbed blade divides free margin of cusp.

a problem of considerable magnitude. Its control was attempted by two methods. At the beginning of the experimental studies, closure of the defect by interrupted fine silk sutures placed in the aortic wall was the method employed. This resulted in a high mortality due to failure of the sutures to hold with tearing of the wall thus increasing the size of the wound to such an extent that uncontrollable hemorrhage ensued (Table II). The second procedure was found to be more effective. It consisted of digital tamponade of the bleeding point until the previously placed stay sutures or pursestring suture in the periaortic fat could be tied over an absorbable gelatin sponge which was manipulated beneath the

#### A. F. I.—MORTALITY

Num  
Surviv  
Operat  
Morta

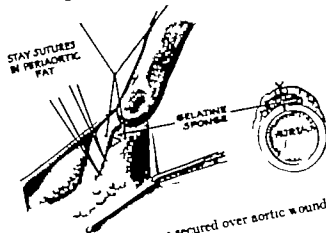


Fig 3. Gelatin sponge secured over aortic wound by fat sutures.

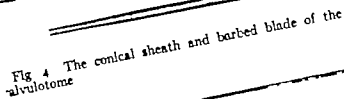


Fig 4. The conical sheath and barbed blade of the valvulotome

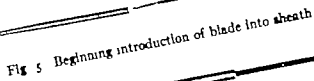


Fig 5. Beginning introduction of blade into sheath

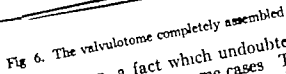


Fig 6. The valvulotome completely assembled

The valvulotome. The instrument used in producing the valvular defects consisted of two separate parts the first being an exterior brass sheath of graduated conical shape (Fig 4) the smaller diameter being at the distal end the larger at the proximal end. By this arrangement tamponading of the aortic opening occurred as the distal end of the instrument was introduced into the aorta. The second part of the instrument consisted of a barbed blade attached to the end of a long brass handle (Fig 4). The latter upon being introduced into the sheath in the manner of a trocar into a cannula (Fig 5) fitted snugly within the sheath so as to prevent the escape of blood around it. The interior of the sheath contained a circumferential ridge near its distal extremity which arrested further progression of the handle so as to permit only the blade to project from the distal end. Introduction of the sheath into the aorta was accomplished in each instance with the blade pulled up within the sheath so as not to damage the interior of the aorta during the downward progression of the instrument toward the valve leaflet. The blade was thrust out only after the sheath had become engaged within the cusp (Fig 2).

## RESULTS

Twenty two animals were subjected to operation. There were 14 survivals and 8 deaths a mortality of 36 per cent (Table I). All deaths occurred either during the operation or immediately thereafter and were due in each instance to severe blood loss from the aortic wound. No attempt was made to replace blood

by transfusion a fact which undoubtedly influenced the outcome in some cases. Table II summarizes the comparative mortality according to techniques employed to control hemorrhage from the aortic opening. In the first 7 animals operated upon stay sutures of fine silk were placed directly in the wall of the aorta instead of in the periaortic fat. Five of these animals died of hemorrhage because the sutures failed to hold cutting through the aortic wall and producing large rents which grew larger as further efforts at direct closure by suturing were made. Fifteen animals were operated upon with only 3 deaths (Table II) using the combination of periaortic fat suture and gelatin sponge tamponade of the bleeding point. A pursestring suture in the fat was found to be superior to interrupted stay sutures. The 3 deaths in the group treated by the fat suture-gelatin sponge technique resulted from hemorrhage incident to one or both of two factors slipping of the sponge from its proper location during closure of the unmanageable extent of the aortic opening during introduction of the valvulotome. The 14 surviving animals were sacrificed at intervals varying from 24 hours to 7 days after

TABLE III.—VALVULAR LESIONS PRODUCED IN SURVIVING ANIMALS

Surviving animals	14
Perforation of cusp	8
Division of cusp	4
Absence of lesion	3
Successful results, per cent	86
Failures, per cent	14



operation. Valvular lesions were found in 12 animals (86%). In 2 animals, no evidence of a valvular defect was noted (Table III). In the latter it is likely that the valvulotome failed to become engaged in a leaflet passing instead into the ventricular chamber during systole. Perforation or laceration of a cusp occurred in 8 animals while in only 4 animals was complete division of the free margin of the leaflet produced (Table III).

#### DISCUSSION

Of the technical aspects of the procedure described two features deserve special comment: first the effect of simple division of an aortic valve leaflet upon the ultimate course of aortic stenosis in the human and second the gelatin sponge tamponade method of controlling hemorrhage from a wound of the aorta. Regarding the former only hypothetical considerations are permissible from this preliminary report. As noted by Cutler and Beck (9) the presence of marked thickening, rigidity and calcification in the aortic valve in cases of stenosis would indicate that valvectomy, rather than valvulotomy, may be necessary to alter favorably the circulation in these cases. Furthermore an estimate of the effect of either procedure is difficult in the absence of a satisfactory method of producing aortic stenosis in the experimental animal. Further experimentation in this field is indicated.

Concerning the gelatin sponge method of tamponading hemorrhage from the aorta one might regard the technique employed as being relatively insecure. While it would appear that direct suture of the aortic wound is preferable a lower mortality resulted in those

animals treated by the gelatin sponge method. These findings are in keeping with the work of Jenkins (14, 15) and his associates whereby the successful use of absorbable gelatin sponge was demonstrated in controlling hemorrhage from wounds of the heart, aorta, and vena cava in experimental animals.

#### SUMMARY

With a view toward its possible application to the treatment of aortic stenosis in human subjects, a technique of aortic valvulotomy in dogs is described.

#### REFERENCES

1. ALEXANDER, J. and BYRON, F. N. *J. Am. M. Ass.* 1944, 126, 39.
2. ALLEN, D. S. *Arch. Surg.* 1924, 8, 37.
3. ALLEN, D. S. and GRAHAM, E. A. *J. Am. M. Ass.* 1922, 79, 1028.
4. BERNSTEIN, D. M. *Johns Hopkins Hosp. Bull.* 909, 20, 7.
5. BLALOCK, A. *Ann. Surg.* 1946, 24, 879.
6. BRUCKTON, L. *Lancet, Lond.* 90, 352.
7. CUSHING, H., and BRANCH, J. R. B. *J. M. Research.* 1908, 7, 471.
8. CUTLER, E. C., LEVINE, S. A. and DICK, C. S. *Arch. Surg.* 1921, 9, 680.
9. CUTLER, E. C., and BECK, C. S. *Arch. Surg.* 1929, 8, 403.
10. GROSS, R. E. *Surgery* 1915, 18, 673.  
*Idem. Surgery* 1916, 20.
11. HARKEN, D. L. *J. Thorac. Surg.* 1912, 656.
12. HARKEN, D. L., and GUIDICE, E. M. *J. Thorac. Surg.* 1913, 566.
13. JENKINS, H. P., JAXOD, R., and CL. BELL, J. *Surgery* 1916, 20, 24.
14. JENKINS, H. P. and JAXOD, R. *Ann. Surg.* 1916, 24, 952.
15. POWERS, J. H. *Arch. Surg.* 1929, 8, 945.
16. SHAW, M. M., ADAMS, W. E., RABKOWSKY, R. A., HIRSH, L. S. and ARONSON, H. G. *J. Thorac. Surg.* 1943, 2, 32.
17. SOUTHWELL, H. S. *Brit. M. J.* 1952, 2, 603.
18. TUPPER, T. and CARROLL, A. *Proc. med.* 1914, 22, 73.
19. TUPPER, T. Quoted by Cutler E. C., Beck, C. S. (9)

# ARTERIOVENOUS FISTULA EXPERIMENTAL STUDY OF INFLUENCE OF SYMPATHETIC NERVOUS SYSTEM ON DEVELOPMENT OF COLLATERAL CIRCULATION

RALPH A DETERLING Jr MD HIRSH E. ESSEX Ph D and  
JOHN M WAUGH MD FACS., Rochester Minnesota

UP to the time of John Hunter the ligation of a major vessel had been avoided because it was a fearful procedure in the treatment of infection owing to the high incidence of gangrene and secondary hemorrhage. Not until the early part of the nineteenth century was the concept accepted that collateral vessels were able to take over the function of a major artery in supplying adequate nutrition to the tissues. The high incidence of recurrence of symptoms as well as the development of severe trophic disturbances and gangrene after simple ligation of the artery proximal to the arterial and arteriovenous aneurysm (Anel ligation) led Makins in 1914 to suggest the simultaneous ligation of the companion vein. Further experimental and clinical studies of arteriovenous fistula by Holman (19-21, 23, 24) Reid (40, 43) Pemberton and others (36, 37) have established quadruple ligation and excision of the vascular lesion as an adequate means of treatment. Since a relatively small proportion of cases have been suitable for treatment by the Matas restorative endoarteriovenous anastomosis or the Blakemore Lord type of vein graft, we must be ultimately concerned with the degree of collateral circulation that results from an abnormal communication between a major artery and vein. Reid (42) in 1925 stated that the arteriovenous fistula is the most powerful stimulus to the development of collateral circulation known and consequently urged that sufficient passage of time should be allowed to permit the development

of adequate collateral circulation. The factor of time has been similarly emphasized by Matas, Holman and by Pemberton and Black (36). Itkin and many others.

It should be pointed out however that an arteriovenous communication acts entirely differently from other types of vascular lesions, which usually cause more or less obstruction with a resulting rise in resistance to the flow of blood through the affected vessels. In an arteriovenous fistula, on the other hand the blood in the arterial system on arriving at the fistula, enters a region of markedly reduced resistance and flows directly into the vein where its distal movement is obstructed by valves, by the decreasing caliber of the vessels and by elevated venous pressure. The blood consequently returns immediately to the right side of the heart thus by passing the distal arteriovenous anastomosis and capillary beds. The shunting of the arterial blood when sufficiently great, obviously deprives the distal tissues of the involved part of adequate nutrition and stimulates compensatory responses. To quote Holman (22) "All avenues of approach to the fistula open up to appense as it were the thirst of the fistula."

As stated in the preceding paragraph, one important factor in disrupting normal vascular physiologic processes in a part distal to an arteriovenous fistula is the rise of venous pressure. It is obvious that the arterial blood, under a tension of more than 100 millimeters of mercury on entering the venous system via the fistula will cause an elevation of the venous pressure which by contrast normally may be measured as a few centimeters of water. The mechanical obstructions to distal venous flow of this arterial blood mentioned previously are effective in diverting the greater part of the flow proximally toward the heart. This in crease of volume flow and pressure results in a

From the Division of Experimental Medicine, Mayo Foundation and the Division of Surgery, Mayo Clinic.  
Abridgment of part of thesis submitted by Dr. Deterling to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of M.S. in Surgery.  
Presented in the forum on Fundamental Surgical Problems before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16 to 20, 1946.

operation. Valvular lesions were found in 12 animals (86%). In 2 animals, no evidence of a valvular defect was noted (Table III). In the latter it is likely that the valvulotome failed to become engaged in a leaflet, passing instead into the ventricular chamber during systole. Perforation or laceration of a cusp occurred in 8 animals, while in only 4 animals was complete division of the free margin of the leaflet produced (Table III).

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- ALLEN, D. S. *Arch. Surg.* 1934, 8, 37.
- ALLEN, D. S. and GRAHAM, E. A. *J. Am. M. Ass.* 1927, 79, 135.
- BRUNTON, B. M. *Johns Hopkins Hosp. Bull.* 1909, 20, 67.
- BLALOCK, A. *Ann. Surg.* 1946, 24, 879.
- BRUNTON, L. *Lancet, Lond.* 1902, 352.
- CURRISO, H. and BRANCH, J. R. B. *J. M. Research.* 1908, 7, 47.
- CUTLER, E. C., LEVINE, S. A., and BECK, C. S. *Arch. Surg.* 1934, 9, 659.
- CUTLER, E. C. and BECK, C. S. *Arch. Surg.* 1939, 8, 43.
- GROSS, R. E. *Surgery* 1945, 8, 673.
- Idem. *Surgery* 1946, 20.
- HARKINS, D. E. *J. Thorac. Surg.* 1942, 2, 696.
- HARKINS, D. E. and GLIDOFF, E. M. *J. Thorac. Surg.* 1943, 2, 566.
- JENKINS, H. P., JACOBY, R. and CLARK, J. *Surgery* 1946, 20, 24.
- JENKINS, H. P. and JACOBY, R. *Ann. Surg.* 1946, 24, 95.
- POWERS, J. H. *Arch. Surg.* 1939, 8, 945.
- SHAW, M. M., ADAMS, W. E., RICHMOND, R. A., HEDGECOCK, L. S. and ARONSON, H. G. *J. Thorac. Surg.* 1943, 2, 32.
- SOUTHWELL, H. S. *Brit. M. J.* 1952, 2, 603.
- TUFFIER, T. and CARREL, A. *Progr. med.* 1914, 22, 73.
- TUFFIER, T. Quoted by Cutler, E. C., Beck, C. S. (1)

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As stated in the literature, the important factor in the response to an arteriovenous fistula is the degree of constriction of the artery. It is considered a temporary response to the fistula when the arterial pressure is maintained at a level above the normal pressure. The measurement of the arterial pressure is a mechanical process and is not a true measure of the flow of blood through the vessel.

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#### REFERENCES

- ALEXANDER, J. and HYBOK, F. V. *J. Am. M. Ass.* 944, 26, 1130.
- ALLEN, D. S. *Arch. Surg.* 924, 8, 37.
- ALLEN, D. S. and GRAHAM, E. A. *J. Am. M. Ass.* 944, 29, 28.
- BERNSTEIN, B. M. *Johns Hopkins Hosp. Bull.*, 909, 30, 107.
- BLALOCK, A. *Ann. Surg.* 946, 24, 879.
- BRUNTON, L. *Lancet, Lond.* 902, 1, 352.
- COBBING, H. and BRANCH, J. R. B. *J. M. Research*, 903, 17, 47.
- CUTLER, E. C., LEVINE, S. A., and BECK, C. S. *Arch. Surg.* 1924, 9, 689.
- CUTLER, E. C., and BECK, C. S. *Arch. Surg.* 924, 2, 43.
- GROSS, R. E. *Surgery* 945, 8, 673.
- Idem. *Surgery* 946, 30.
- HARKIN, D. E. *J. Thorac. Surg.* 942, 656.
- HARKIN, D. E., and GLIDDON, E. M. *J. Thorac. Surg.* 943, 2, 566.
- JENKINS, H. P., JANDA, R., and CLARKE, J. *Surgery* 946, 30, 124.
- JENKINS, H. P. and JANDA, R. *Ann. Surg.* 1946, 24, 952.
- POWERS, J. H. *Arch. Surg.* 1920, 8, 1945.
- SHAW, M. M., ADAMS, W. E., RANDOLPH, R. A., HEDGECOCK, L. S. and AROVON, H. G. *J. Thorac. Surg.* 943, 12, 322.
- SOOTER, H. S. *Brit. M. J.* 1935, 2, 601.
- TUFFIER, T. and CARREL, A. *Presse med.* 944, 23, 73.
- TUFFIER, T. Quoted by Cutler, E. C., Beck, C. S. (6).

# ARTERIOVENOUS FISTULA EXPERIMENTAL STUDY OF INFLUENCE OF SYMPATHETIC NERVOUS SYSTEM ON DEVELOPMENT OF COLLATERAL CIRCULATION

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UP to the time of John Hunter the ligation of a major vessel had been avoided because it was a fearful procedure in the treatment of infection which owing to the high incidence of gangrene, and secondary hemorrhage. Not until the early part of the nineteenth century was the concept accepted that collateral vessels were able to take over the function of a major artery in supplying adequate nutrition to the tissues. The high incidence of recurrence of symptoms, as well as the development of severe trophic disturbances and gangrene, after simple ligation of the artery proximal to the arterial and arteriovenous aneurysm (Anel ligation) led Makins in 1914 to suggest the simultaneous ligation of the companion vein. Further experimental and clinical studies of arteriovenous fistula by Holman (19-21, 23, 24) Reid (40, 43) Pemberton and others (36, 37) have established quadruple ligation and excision of the vascular lesion as an adequate means of treatment. Since a relatively small proportion of cases have been suitable for treatment by the Matas restorative endoarteriomyorrhaphy or the Blakemore-Lord type of vein graft, we must be ultimately concerned with the degree of collateral circulation that results from an abnormal communication between a major artery and vein. Reid (42) in 1925 stated that the arteriovenous fistula is the most powerful stimulus to the development of collateral circulation known, and consequently urged that sufficient passage of time should be allowed to permit the development

of adequate collateral circulation. The factor of time has been similarly emphasized by Matas Holman and by Pemberton and Black (36) Elkin and many others.

It should be pointed out, however, that an arteriovenous communication acts entirely differently from other types of vascular lesions, which usually cause more or less obstruction with a resulting rise in resistance to the flow of blood through the affected vessels. In an arteriovenous fistula on the other hand the blood in the arterial system on arriving at the fistula enters a region of markedly reduced resistance and flows directly into the vein where its distal movement is obstructed by valves, by the decreasing caliber of the vessels and by elevated venous pressure. The blood consequently returns immediately to the right side of the heart thus by passing the distal arterial and capillary beds. The shunting of the arterial blood, when sufficiently great obviously deprives the distal tissues of the involved part of adequate nutrition and stimulates compensatory responses. To quote Holman (22) 'All avenues of approach to the fistula open up to appease, as it were the thirst of the fistula.'

As stated in the preceding paragraph, one important factor in disrupting normal vascular physiologic processes in a part distal to an arteriovenous fistula is the rise of venous pressure. It is obvious that the arterial blood, under a tension of more than 100 millimeters of mercury on entering the venous system via the fistula will cause an elevation of the venous pressure which by contrast normally may be measured as a few centimeters of water. The mechanical obstructions to distal venous flow of this arterial blood, mentioned previously, are effective in diverting the greater part of the flow proximally toward the heart. This increase of volume flow and pressure results in a

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compensatory dilatation which is demonstrable in the centripetal venous channels as well as the right side of the heart. Distally in the extremity this elevated venous pressure also hinders circulation from collateral vessels that otherwise would be much more effective.

The presence of a region of markedly elevated venous pressure at the fistula serves to act as a block to the venous outflow of the distal parts by virtue of the pressure differential as well as the effect of keeping the distal valves in the veins shut. Since the normal direction of the arterial systolic thrust is centrifugal there is maintained a constant piston-like force on the distal venous tree so that eventually as a result of the distention of the vessels and the direct pressure on the cusps, the valves may become incompetent. The magnitude of this effect depends primarily on the duration, size and location of the fistula. Secondary to this interference with normal venous drainage is an increase of the intercellular fluid and lymph. The scarring about a traumatic fistula may block some of the major lymphatic channels and thus contribute to the formation of edema.

Hence in the presence of a fistula, the distal parts are frequently deprived more effectively of a normal circulation than following actual ligation of the major artery or arterectomy. That the so-called collateral circulation is unable to provide an adequate blood supply to the tissues is evidenced by the frequent occurrence of trophic alterations in the distal parts. Trophic changes are seen as well in persons who have congenital arteriovenous fistulas even when the maximal time for development of collateral circulation has elapsed. While gangrene is relatively rare following closure of an arteriovenous fistula in the lower extremity there is a high incidence of vascular insufficiency particularly in the aged which is manifested by chronic edema, intermittent claudication, ease of fatigue, sensation of heaviness and paresthesias. This was noted by Bigger who saw in his postoperative cases definite evidence that circulation is inadequate for sustained muscular activity. This is an important matter and one which has not received the attention which is its due. Other authors have seen fit to question the value of this type

of vascular response. La Roque in 1921 expressed the opinion that there was "much reason for believing that the development of circulation is antagonized by arteriovenous fistula." Elkin (8) in 1943 similarly pointed out the possible inadequacy of this collateral circulation when he said that this great collateral circulation was for the most part useless since the blood returns to the heart without nourishing the distal parts. Recently Freeman has called further attention to the vascular deficiency which may follow the surgical repair of arteriovenous fistulas. In the March 8, 1947 issue of the *Journal of the American Medical Association* Hennigman, Rives and Davis reviewed the results of the various operative procedures employed in a series of 53 cases of arteriovenous fistula. Local vascular insufficiency did not develop in any of the 8 patients treated by a restorative procedure whereas a third or more of those patients having an obliterative procedure suffered subsequently from the symptoms of vascular deficiency.

The acceptance by so many surgeons of the concept that great collateral circulation develops with time generally has resulted in a delay of 3 to 6 months in the treatment of arteriovenous fistulas. Consequently we were stimulated to attempt to determine the actual effective arterial collateral circulation present in a limb which had had a fistula functioning for periods of time up to one year. Further more, because of the claim of some investigators that attempts to improve collateral circulation (after time enough has elapsed for it to have developed) are foolhardy if not actually contraindicated, an investigation was made of the cutaneous temperature in the limb distal to a long standing arteriovenous fistula, both before and after lumbar sympathetic gangliectomy.

#### I. DEMONSTRATION OF COLLATERAL CIRCULATION IN A LIMB IN WHICH THERE IS A CHRONIC ARTERIOVENOUS FISTULA

*Method.* In 19 adult dogs under ether anesthesia, lateral arteriovenous fistulas were made, in the femoral vessels, 1 to 2 centimeters below the profundus branch of the artery by the suture method (7). The communication between the artery and the vein ranged from 1.5

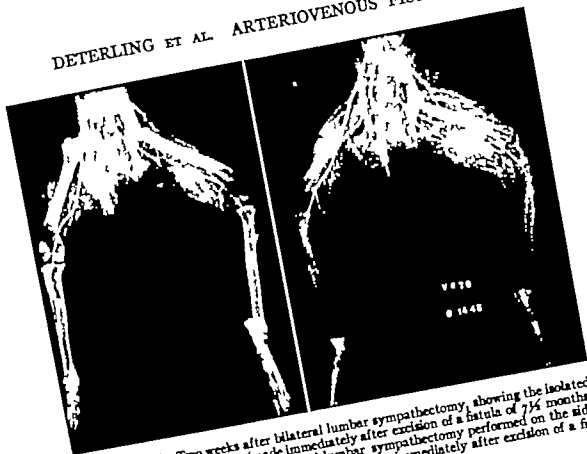


Fig. 3. a, left, Two weeks after bilateral lumbar sympathectomy, showing the isolated arterial collateral circulation (made immediately after excision of a fistula of 7½ months' duration). b, Two weeks after unilateral lumbar sympathectomy performed on the side of the fistula (left). In this case the picture was taken immediately after excision of a fistula of 7½ months' duration.

isolated arterial tree with the complete arteriovenous bed.

**Group III Method.**—The legs of the 4 remaining animals of series A were perfused in the usual manner and the fistula was dissected free. Carrel clamps were placed on the proximal and distal vessels to occlude the arteriovenous communication effectively. Injection was then carried out and roentgenograms of the isolated arterial circulation were made. Later the clamps were released and the injection of the barium mass was completed as in group I. Roentgenograms were again taken.

**Results.**—This set of experiments showed clearly the paucity of arterial collateral circulation compared with the total vascular bed in the region of the fistula (Fig. 2a and b) in the same animal. A differential study of this kind in a group of animals having comparable fistulas of varying duration makes possible an understanding of the rate of development of the vascular changes. It is evident that the arterial response appears very rapidly reaching its maximal development early while the augmentation of the venous system is gradual, occurring during a period of many weeks.

**Series B Method.**—The remaining 7 animals were also used in a study of the effect of lumbar sympathetic ganglionectomy on blood flow and cutaneous temperature. In 4 animals, bilateral lumbar ganglionectomy was performed and in 3 the ganglionectomy was restricted to the side of the fistula. In all the animals, the arteriovenous communication had been active for about 7 months before sympathectomy. In this series the fistula was excised 2 weeks after sympathectomy (a) to demonstrate further the isolated arterial system as an entity and (b) to show any effect on this system that sympathectomy might have had. Immediately after the quadruple ligation and excision of the fistula, the injection of the isolated arterial tree was carried out as described for group II.

**Results.**—Roentgenograms were made of the lower arterial vascular bed of the sympathectomized animals after perfusion and injection. In the group on which bilateral lumbar ganglionectomy had been performed 2 weeks previous to the excision of the fistula there was a minor degree of vasodilatation and tortuosity of the small arteries just distal to





Fig. 2. a, left, Isolated arterial collateral circulation after occlusion of the abnormal communication with Carrel clamps. b The same animal after removal of the clamps and completion of the injection with the fistula patent. This indicates that the predominant vascular response has been venous.

crease of venous pressure and blood flow. This

'Medusa's head' in the region of the fistula is what many authors have referred to when they described the collateral circulation of an arteriovenous fistula. This is also an example of what one sees in a clinical angiogram of this type of lesion for the patent communication allows the contrast medium to fill the entire network of vessels and permits identification of the fistula. It must be realized that a clear picture of the arterial circulation is necessary to evaluate collateral circulation. Any obliterative surgical procedure will close the communication between the artery and the vein, and consequently exclude the dilated venous vessels from the collateral vascular supply. To demonstrate the isolated arterial bed, the following procedure was used.

**Group II. Method.**—In 4 animals the perfusion with Ringer's solution was carried out as described. The fistula was then exposed by cautious dissection without sacrifice of any major collateral vessel. The proximal artery and vein were identified and ligated adjacent to the site of the fistula. The distal vessels were similarly ligated and the fistula was excised. In all instances the arteriovenous com-

munication had been patent up to the time of closure. Injection was then carried out to demonstrate the arterial system alone.

**Results.**—In this series, a representation of the venous response to the presence of a chronic arteriovenous fistula was eliminated completely by excision of the fistula. The injected vessels represented only the arterial channels in the limb. These in turn were the true collateral circulation or that part of the circulation which would function after surgical closure of the fistula (Fig. 1b). The marked contrast in the appearance of the vessels before and after closure of the arteriovenous fistula cannot be overemphasized. However it must be admitted that there was a marked difference in the appearance of the injected vascular beds of successive animals. In some of the animals, except for the region from which the fistula had been excised, the arterial tree was approximately the same in the control limb as in that with the fistula. On the other hand, a number of animals that had fistulas of the same size and duration had a definite augmentation of arterial circulation just distal to the fistula. With such variation possible, it was therefore necessary to compare in the same animal the



the region of the aneurysm (Fig 3a). This was seen also in the series without sympathectomy and represents the degree of arterial response primarily as a result of time. As the denervation had been bilateral, there was no significant gross difference in the general vascular bed of both limbs beyond that resulting from the aneurysm alone. The differences of cutaneous temperature of the limbs found are reported farther on in this paper. They were accounted for on the basis of differences in the circulation supplying the limbs.

In the animals which had sympathectomy only on the side of the fistula, there was a slight increase in diameter of the vessels on the denervated side over that of the control side. In all these animals, the greatest apparent increase was in the region just distal to the excised fistula (fig 3b) since here there were superimposed the outlines of those many small arteries which had dilated as a result of the aneurysm. However further evidence that the vasodilatation following sympathectomy affected the entire vascular segment will be presented in the section of this report dealing with cutaneous temperature.

*Comment.* A comparison of roentgenograms taken on animals having arteriovenous fistulas of shorter duration than the fistulas of the dogs already considered indicates that the arterial response is rapid requiring only a few days to be significant. This is in agreement with studies on the development of collateral flow by other investigators which have shown most of the channels involved in collateral circulation to be present at the time of an obstruction of a major vessel. The venous component of the circulation resulting from an arteriovenous fistula, on the other hand develops more slowly and relentlessly over a period of weeks or months, and is without beneficial effect on the limb. Concurrent with the local dilatation of the venous bed there are increases of circulating blood volume and cardiac size. Experimentally we have found microscopic evidence that there are pulmonary renal, cardiac and hepatic changes which may or may not be reversible.

On inspection of the arterial collateral circulation developed during a period of more than six months, it is important to note that

the localized region of increased vascularization is actually *distal* to the arteriovenous fistula. It would appear therefore that the small arteries, visualized by injection methods, had been subjected to an excessive function, but in a manner different from the usual collateral channels which develop in response to an obstructive lesion. The tremendous return flow of blood from the fistula toward the heart indicates that the dilated channels in the arterial system have been draining blood into the site of the fistula with its low pressure by diversion of much of the blood which flows normally to the pelvic structures and limb via anastomotic channels of the deep circumflex iliac, internal and external iliac, pudendal, gluteal and lateral sacral vessels among others. One may consider as well the possibility that when reversed venous flow occurs, some of this blood finds itself back in arterial channels, and by retrograde flow again enters the site of the fistula. Consequently with the fistula patent, these channels do not serve to by-pass the lesion and act as supplementary vessels as in obstructive vascular lesions. In the latter by contrast, the accessory vessels have their greatest function and are the most numerous in the actual region of obstruction. They arise from the immediately adjacent derivatives of the affected vessels, particularly from the proximal branches. Consequently it is difficult to escape the belief that the arterial collateral circulation in the presence of an arteriovenous fistula may contribute much less to the subsequent viability of the limb after obliterative operation than is ordinarily believed. The rise of cutaneous temperature of the toes observed (5.4°) after closure of a more proximal fistula is but a qualitative and not a quantitative index of the increase of distal blood flow. Consequently this rise of cutaneous temperature gives no indication of the actual amount of collateral circulation. That this increase of blood flow may be inadequate is attested by the reports of gangrene and circulatory deficiency following the repair of a fistula.

One would expect the beneficial effects of lumbar sympathetic block on collateral circulation to involve the entire limb in contrast to the response of the vessels to time alone, in which latter case the dilatation would very

# DETERLING ET AL. ARTERIOVENOUS FISTULA

TABLE I — AVERAGE TEMPERATURE GRADIENT OF THE HIND LIMB OF AN ANIMAL HAVING A CHRONIC LEFT FEMORAL ARTERIOVENOUS FISTULA

Site of measurement	Right	Left
	37.0° C	37.5° C
a Before bilateral lumbar sympathectomy		
Poupart's ligament	37.0	38.5
Thigh	36.0	38.0
Upper third	35.0	37.5
Middle third	33.0	34.5
Lower third	32.5	32.0
Lower leg	32.0	31.0
Ankle	31.5	30-30.5
Foot		38.0
Interdigital web	37.5	
b After bilateral lumbar sympathectomy		
Poupart's ligament	37.5	39.0
Thigh	37.0	38.5
Upper third	36.5	38.0
Middle third	36.0	36.5
Lower third	35.5	36.0
Lower leg	35.5	35.5
Ankle	37.0	
Foot		
Interdigital web		

## II. STUDIES OF CUTANEOUS TEMPERATURES OF ANIMALS HAVING CHRONIC ARTERIOVENOUS FISTULAS BEFORE AND AFTER LUMBAR SYMPHETECTOMY

Experimental studies (6, 11, 45, 46) have proved that under certain conditions the cutaneous temperature of the paw of an animal may be taken as an indication of the distal arterial blood flow. Consequently alterations of significant magnitude following sympathectomy should similarly serve as an acceptable indirect index of blood flow.

**Methods:** Two recording devices were employed in the measurement of cutaneous temperatures: (1) the Tycoos dermaterm a gal vanometric apparatus with thermocouples adaptable to flat skin surfaces and (2) a mercury-bulb chemical thermometer used for measuring the temperature between the toes of the animal. Readings were taken in triplicate and careful control of the environmental variables was exercised as advocated by Sheard (45) and Roth. A constant air temperature of 26 degrees C. was maintained and the humidity was kept at 40 per cent. Linear air movement was limited to 15 to 30 feet (4.6 to 9 meters) per minute. The skin surface was always dry, clean and smooth shaven. The animals were kept comfortably recumbent for one hour to allow adjustment of the vasomotor system to a constant temperature. They were fasted 18 hours to exclude metabolic effects and the readings were taken at the same hour each morning to avoid diurnal variation.

These studies were performed on the same group of 19 animals used for the arteriographic studies already described. During the 8 to 10 month period of observation the increase of circulating blood volume (average increase of 31 per cent) and heart size (average increase of 32.5 per cent) was noted. Together with the signs of arteriovenous fistula—vibratory con-

tinuous thrill, machinery murmur, distended pulsating venous channels, bradycardiac reflex, and so forth—there was adequate evidence that the fistula was patent during the entire time.

**Results:** The average normal temperature gradient as determined by cutaneous thermocouple readings on the medial aspect of the hind leg of a normal animal, from Poupart's ligament to the toes, was recorded. These values are those obtained on the control or right hind limb of the animals having left femoral arteriovenous fistulas (Table I a). From a temperature of 37.0 degrees C. obtained at the groin of the normal limb there was a gradual decrease distally to 31.5 degrees C. as measured in the interdigital web of the foot. On the leg with the fistula the temperatures ranged from 37.5 degrees C. at the groin to 30.0 to 30.5 degrees C. at the toes. In this limb, however, the thigh was warmer than proximally in the groin because of the presence of the aneurysm (38.5° C.). This effect by virtue of increased vascularity in the region of the aneurysm has been utilized clinically to localize a fistula. The great distention of superficial vessels made this entire thigh warmer than on the control side but there was a rather sharp decrease of temperature of the ankle and foot to a value below that of the normal side.

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In the animals which had sympathectomy only on the side of the fistula there was a slight increase in diameter of the vessels on the denervated side over that of the control side. In all these animals, the greatest apparent increase was in the region just distal to the excised fistula (fig 3b) since here there were superimposed the outlines of those many small arteries which had dilated as a result of the aneurysm. However further evidence that the vasodilatation following sympathectomy affected the entire vascular segment will be presented in the section of this report dealing with cutaneous temperature.

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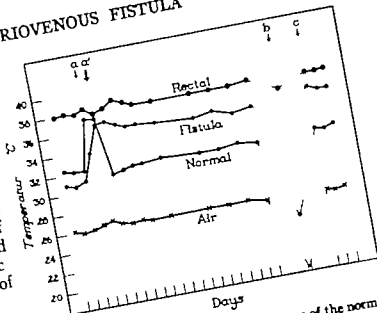


Fig 5. Cutaneous temperature of the toes of the normal foot and of the leg with the fistula, 7 months after its production, in addition to rectal and air temperatures. a, response to light ether anesthesia; b, deep ether anesthesia and concurrent left lumbar gangliectomy; c, cool room experiment; d, quadruple ligation and excision of the fistula.

thema or operation (Fig 5a'). This functional change in the response to stimuli which normally call forth a high degree of vasomotor activity had been similarly seen previously in the cool room experiment in which the abnormal limb did not constrict as well as the normal limb. This abnormal response may be explained by (1) altered distribution of blood volume in the limb, (2) the abnormal rôle of venous channels in carrying arterial blood and (3) disturbance of the functional and structural characteristics of the vessels as a result of long standing effects of the fistula.

A number of preliminary trials with ether anesthesia demonstrated this delayed response of the abnormal leg to be a constant finding. Despite the evidence of good 'collateral' circulation we performed our operative removal of the lumbar sympathetic ganglia (L<sub>2</sub> to and including L<sub>5</sub>) with the intervening chain by a transabdominal route. In 4 animals, the excitation was bilateral in one stage so that there might be a control side with which to compare the physiologic response to sympathectomy. In the remaining 3 the procedure was carried out only on the side on which there was a fistula. This would more clearly reveal the results to be expected from clinical application of sympathectomy to a limb having an arteriovenous fistula.

Cutaneous temperatures of the toes and entire limb were obtained after the sympathetic denervation and these observations were recorded daily thereafter for more than two weeks. Then after a cool room test, the fistulas of 2 animals from both groups were excised after quadruple ligation.

**Bilateral sympathectomy.**—Before sympathectomy the previously normal right leg showed a marked gradient of from 37.0 degrees to 31.5 degrees C. whereas after sympathectomy the skin surface of the entire limb was close to 37.0 degrees C. being lowest (35.5 C.) at the ankle (Table 1b). This demonstrated a maximal response of the cutaneous vessels to vasomotor denervation. The left limb which had had an arteriovenous fistula in the thigh for 7 months responded in much the same manner except for quantitative differences. As before sympathectomy, the thigh and leg were warmer than those of the

control limb but the foot and toes were 0.5 to 1.5 degrees C. cooler than those of the control sympathectomized side. This relationship of toe temperatures therefore continued to be constant, even after sympathectomy indicating the rôle the fistula plays in preventing a normal distal blood flow, regardless of environment or vasomotor activity.

Following the bilateral sympathectomy the same elevation of cutaneous temperatures of the toes was recorded as was obtained when the animals were under deep ether anesthesia preliminary to both unilateral and bilateral sympathectomy (Fig 5a'). During the succeeding 2 weeks however the temperature of both limbs decreased gradually about 1.0 to 1.5 degrees C. as measured between the toes.

When these animals were given the cool room test, that is exposure to an air temperature of 18 degrees C. for 30 minutes, neither limb showed significant evidence of vasoconstrictive ability. In 2 of the animals that had bilateral sympathectomy of 2 weeks duration the fistula was isolated and removed by quadruple ligation and excision. It was immediately noted that the removal of this communication was attended by a slight but significant rise in toe temperature to almost the equal of the control side. This is explained by a redistribution of arterial blood through the distal arteries.



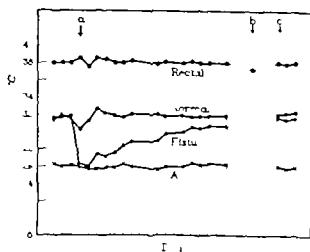


Fig. 4. Cutaneous temperature of the toes, in addition to rectal and air temperatures, the operative production of left arteriovenous fistula, *b*, cool room experiment *c*, quadruple ligation and excision of the fistula.

Having demonstrated by arteriograms that these dilated channels did not extend to the foot we could depend with considerable confidence on temperature changes of the toes as being a reliable index of arterial flow.

In order to follow these changes closely cutaneous temperatures of the toes were measured daily following the establishment of an arteriovenous communication in the left femoral vessels. Concurrent recordings were made of the rectal and air temperatures in order to note excessive variations of temperature in the body or in the environment. The control values noted prior to the vascular operation were rather constant (Fig. 4). Immediately after the production of an arteriovenous fistula there was a sharp drop of toe temperatures of the limb on which operation had been performed almost to room temperature (Fig. 4*a*). This was due to (1) vasospasm resulting from manipulation and (2) the distal ischemia due to the blood flow into the low pressure region at the fistula rather than to the tissues beyond. During the next day there was a sharp rise of the temperature of the leg with the fistula of about 2 degrees C., probably representing a decrease of vasospasm that had resulted from the operation. The normal leg and rectal temperatures rose slightly as evidence of a general reaction to the operation. This lasted but 1 to 3 days, and thereafter these temperatures followed the normal levels

(toe =  $31.5^{\circ}$  C. average rectal =  $38.0^{\circ}$  C. average). During subsequent days the toe temperature of the limb with the fistula increased but became relatively constant about 10 degrees to 20 degrees C. below the control temperature of the right limb in 7 to 12 days.

In the subsequent period the response of the limbs to an abnormally cool environment was studied (Fig. 4*b*). On several occasions each animal was exposed to air temperature of 18 degrees C. for 30 minutes, and 15 minutes after removal of the animal to a room at about 26 degrees C. the temperature of the toes was recorded. It is significant that the normal side responded most efficiently to alterations of external environment. This greater vasoconstrictive ability of the normal limb made the leg with the fistula seem relatively warmer.

In some of the animals, quadruple ligation and excision of the fistula was performed after six months. A rise of toe temperature of the fistulous leg was noted on excision of the communication (Fig. 4*c*). This was probably due to redistribution of arterial blood with a more normal blood flow through the distal capillary beds.

**Effects of sympathectomy.** After a period of 7 months had been allowed for definite physiologic changes to have taken place, so far as the general and local cardiovascular systems were concerned 7 dogs were selected from the group and repeated preoperative temperature readings were taken (Fig. 5 up to *a*). Prior to a sympathectomy the animals were given ether anesthesia in an effort to simulate the effects of the operation since Herrick and associates and Baldes and associates had showed that the 2 procedures caused an identical increase in blood flow in the femoral artery of the dog. We soon discovered that under light ether anesthesia there was a lag in vasodilatation in the limb with the fistula, the rise in temperature being only about 2.5 degrees C. instead of the 5.5 degrees C. average of the normal side (Fig. 5*a*). This lessened response was shown to be a lag rather than organic inability to respond since under deep ether anesthesia (or lumbar sympathetic ganglionectomy) the temperature of the leg with the fistula continued to rise to a total average of 4.5 to 5.0 degrees C. higher than before anes-

# DETERLING ET AL. ARTERIOVENOUS FISTULA

Bush (32) have reported cardiac failure in a period of only a few days or weeks after the development of a traumatic fistula. Fick found some of the vascular alterations irreversible and argued for early operation on patients who have arteriovenous fistula. Harbison has similarly urged early operation after employing sympathectomy to increase the collateral circulation so that frequently associated lateral injuries can be repaired easily. Elkin (9, 10) reported early operation to have been performed frequently on soldiers without even sympathectic block being necessary. However the important effect that sympathectomy exercises on the full development of collateral systems has been emphasized by Mulvihill and Harvey. They concluded that at least the interruption of efferent vasomotor impulses by ganglionectomy initiates the establishment of the collateral circulation and to all appearances in the same manner as it occurs after a time of itself.

The first clinical application of this fundamental principle was reported by Gage (14) in 1933 in the treatment of a mycotic aneurysm of the iliac artery. By paravertebral sympathectic block the circulation in the limb was increased sufficiently to allow ligation of this large vessel with impunity. Subsequently in 1939 (15) he stated that he "had similar and satisfactory results with arterial and arteriovenous aneurysms."

Bird in 1935 was perhaps the first to report the preoperative use of sympathectomy preparatory to the repair of a major peripheral aneurysm. Plotkin in 1939 reported excellent results from lumbar sympathectic ganglionectomy performed in the presence of marked ischemia of the leg 13½ hours after excision of a popliteal arteriovenous fistula. In 1940 Waugh treated an arteriovenous fistula in which the collateral circulation was so poor that sympathectomy was done before excision of the fistula. The patient experienced such symptomatic improvement that he temporarily refused further treatment for the fistula. (Subsequently Waugh has had further recourse to sympathectomy as a preparation for obliterative procedures for arteriovenous fistulas.) In 1943 the "Military manual of traumatic surgery" (35) suggested that in cases of arterio-

venous fistula in addition to the usual methods of treatment, sympathectomy 'may be of value. Subsequently a War Department "Bulletin on care of battle casualties" (48) noted that while most arteriovenous fistulas do not require emergency treatment, a certain number must have early surgical treatment in the presence of hemorrhage, impending rupture, paralysis from the pressure on the nerves near the aneurysm or threatened gangrene. It suggests that preoperative and postoperative injections of 1 per cent solution of procaine hydrochloride to block the sympathetic ganglia or sympathectomy may be used in vascular cases to improve circulation by removing vasospasm. Recently there have been promising reports by Linton and White, Pugh, Harbison, Kirtley, Mason and Giddings (31), Shumacker and Carter and Freeman in which there was definite evidence of stimulation of collateral circulation in chronic arteriovenous and arterial aneurysms by paravertebral block or sympathectomy. Early operation has been possible and when there was an attendant nerve injury repair of the nerve has been facilitated. Naide has had encouraging results from sympathectic block to supplement anti-toxin and penicillin in gas gangrene infections. This study has shown that while such a series of sequel to arteriovenous fistula as ischemic gangrene is relatively uncommon there does exist frequently a preoperative and postoperative chronic vascular insufficiency which may be relieved by interruption of the sympathetic vasomotor control. The influence exerted by the earlier investigators in so far as depending on the time factor for the development of collateral circulation is very strong. Elkin (9) in his treatment of 106 patients who had traumatic aneurysms observed in a military hospital has not employed procedures that might be used to stimulate collateral circulation other than intermittent compression before employing obliterative operations. Many competent physicians have gone so far as to declare that attempts to improve circulation in cases of chronic arteriovenous fistula were actually contraindicated.

The results of clinical application of interruption of the sympathetic nerves performed to develop collateral circulation before opera-

olar and capillary beds as a result of removing the arteriovenous communication

**Unilateral sympathectomy** —As in the preceding experiment concurrent readings were made of both hind limbs rectal and air temperatures (Fig 5) These results represent the type of response one may expect in the clinical application of lumbar sympathectomy to patients having arteriovenous fistula of the leg

The response to ether anesthesia in this series of animals was again identical with that previously described for the animals in other series. Under light anesthesia a lag in the temperature rise was noted in the limb with the fistula compared to the immediate complete response of the control normal limb (Fig 5a) With deep ether anesthesia the temperature continued to rise to a level about 1.0 degree C below that of the normal side (Fig 5a') At this point left lumbar ganglionectomy was performed

After recovery from ether anesthesia, the temperature of the control limb fell to the pre-operative level or slightly lower indicating in some instances a contralateral vasoconstriction This latter phenomenon was only transient however On the sympathectomized side the elevated cutaneous temperature persisted at a level of about 37 degrees C. During the subsequent 2 weeks this significant rise of toe temperature was maintained with only a slight decline to about 36.0 degrees C or an elevation of 3.0 to 4.5 degrees C over that of the normal control side (Fig 5a to 5b) Thus fact demonstrated conclusively that the vessels distal to the fistula were indeed capable of further vasodilatation even after a period of 7 months in which collateral circulation had developed.

As in the other groups, these animals were given the cool room test there was only a slight fall of about 1.0 degree C. in the temperature of the sympathectomized limb as compared with a decrease of temperature of more than 8 degrees C in the normal limb (Fig 5b) This is clear evidence that an anatomic interruption of the vasomotor nerves had been accomplished by the sympathetic ganglionectomy

Two animals were selected from this group Two weeks after the unilateral sympathec-

tomy the fistula was excised by quadruple ligation and excision. Once again a slight but significant rise of toe temperature was observed indicating increased distal arterial flow after obliteration of the fistula (Fig 5c).

**Comment** It is evident that our experiments have indicated that the blood flow in a limb may be significantly increased in the presence of a chronic arteriovenous fistula of a major peripheral artery following sympathetic denervation The adequate treatment of arteriovenous fistula depends primarily on the condition of the collateral blood supply when an obliterative procedure is the method of choice Naturally the secondary factors of general condition of the patient, his cardiac status and presence of infection or nerve involvement are important but in the presence of insufficient blood supply little choice remains to the surgeon beyond temporary ven ligation amputation or in certain cases, restorative endoaneurysmorrhaphy In any operative procedure in which the arteries are involved one runs the ever present danger of disastrous vasospasm as a result of the surgical manipulation The present-day safeguards against thrombosis, such as precise aseptic technique improved antibiotic agents and the anticoagulant drugs, heparin and dicoumarol, have made direct repair or ligation of major peripheral arteries a less formidable procedure than in the past century or even during World War I

There is considerable evidence both direct and indirect that the majority of channels composing a collateral system are in existence, even though relatively inactive in the normally functioning part In the dog many investigators have demonstrated by arteriography the ready appearance of supplementary arterial channels when obstruction had occurred in various regions Vvedenski in the hind limb Kolesnikow in the fore limb Andreyev in the head

The demonstration of the great differences in the arterial and arteriovenous bed in the limbs of our animals that had fistulas raises the question whether a surgeon is justified in waiting several months for collateral circulation to develop before closure of a fistula in a patient. Mason (30) and Mason Graham and

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The results of clinical application of interruption of the sympathetic nerves performed to develop collateral circulation before opera-

# A NEW OPERATIVE TREATMENT FOR ELEPHANTIASIS

EDGAR J POTH M.D. Ph.D., F.A.C.S., SAM R. BARNES, M.D., and  
GRIFF T ROSS M.D. Galveston, Texas

WE shall not consider the various etiological factors of elephantiasis (Matas 1913) but shall concern ourselves with the late stage of persistent irreversible edema with fibrosis of the subcutaneous tissues and derma in those instances or recurrent erysipeloid infections due to lymphatic obstruction.

Homans (1928) Homans and Zollinger (1929) Homans Drinker and Field (1934) Reichert (1926 1927 1930) and many others have treated this subject experimentally and clinically. It has been concluded that the most satisfactory treatment of this malady is the complete removal of the lymphatic bearing tissues especially of the legs and occasionally of the thighs. Of the various procedures used to accomplish the removal of these tissues the Kondoleon (1912) operation of excising segments of skin and the underlying fibrous connective tissues extending down to the

muscles or by the undercutting of thin skin flaps and excising the lymphatic bearing subcutaneous tissues (Sistrunk 1927) have been used most extensively and are considered as giving the best results. These procedures are multiple time-consuming operations requiring long hospitalization. The condition frequently recurs or is not relieved. In a true elephantiasis with progressive fibromatosis as defined by Matas, the lymphatics of the derma are involved in addition to those of the subcutaneous tissue.

This paper describes a single operation for the removal of the lymphoid bearing tissues. The procedure is simply the excision of all tissues down to the sheaths of the muscles of the thigh and leg excepting a narrow strip covering the tibia anteriorly, and then grafting the denuded surface with thick split grafts.

Alternate procedures are illustrated in Figures 1 and 2.

## CASE REPORT

C. M., No. 275574, white male aged 34 years was first observed to have an enlarged left leg at the age of 2 months which was subsequently diagnosed as

From the Department of Surgery, University of Texas, Medical Branch, Galveston, Texas.

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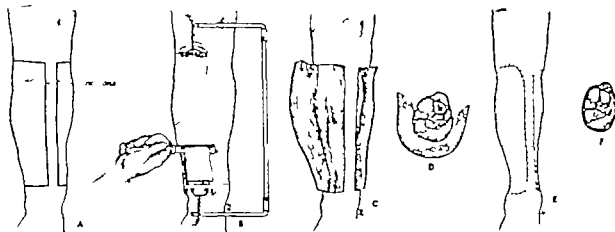


Fig. One stage operation for elephantiasis. A, The incisions are outlined so as to preserve full thickness of tissue over the tibia. B, If the condition of the skin is satisfactory, thick split grafts are cut before the tissues are dissected from the operative field. Grafts are cut from the entire circumference except for the narrow strip over the

tibia. C and D show the remaining derma and subcutaneous tissues being excised down to muscle with preservation of a strip of tissue over the tibia. E and F illustrate the situation after grafting with split skin grafts. Note: If indicated, the subcutaneous tissue over the tibia could be excised after healing has occurred.

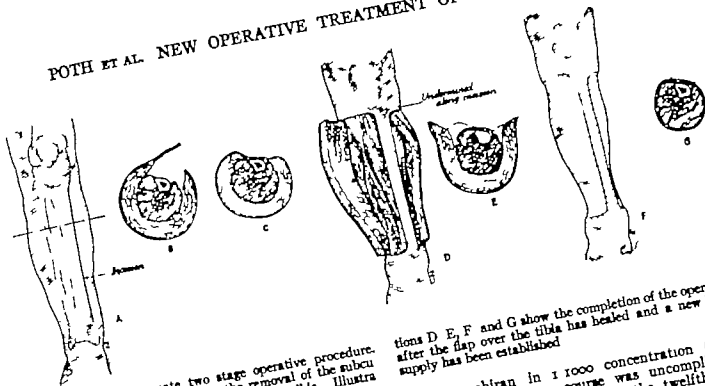


Fig. 2. An alternate two stage operative procedure. Illustrations A, B and C show the removal of the subcutaneous tissue from the area covering the tibia. Illustrations D, E, F and G show the completion of the operation after the flap over the tibia has healed and a new blood supply has been established.

Milroy's disease. The enlargement and edema have increased progressively with recurrent attacks of erysipeloid infection pain, and fever. A Kondoleon operation in 1935 gave temporary improvement. Daily baths followed by sponging with 1:4000 zephiran solution as a preoperative measure succeeded in clearing the left leg of numerous small furuncles. The skin of the leg was thickened but still retained some elasticity. It was decided to cut split grafts from this surface before excising the remaining skin and subcutaneous connective tissues down to the muscle sheathes, and to use these grafts to cover the dissected area. A strip of skin and subcutaneous tissue was left to cover the tibia anteriorly (Figure 1). If the local skin is not suitable for transplantation other donor sites should be selected. It is questionable whether the local skin should ever be used because the lymphatic vessels of the derma are involved in elephantiasis.

The skin grafts were dressed with glycerine con-

taining zephiran in 1:4000 concentration (Poth 1945). Postoperative course was uncomplicated. Dressings were first changed on the twelfth postoperative day. The appearance 3 weeks and 3 months postoperatively is shown in Figures 5 and 6.

The patient has been relieved of his disability and is working as a laborer. The edema of the foot has become progressively less. A year has passed without recurrence of infection. While no supportive dressing has been worn by this patient, it is desirable to use an elastic bandage or stocking for a year to 18 months following operation.

## DISCUSSION

Many patients with elephantiasis are incapacitated by the enlarged limb. The operation outlined here causes considerable disfigurement and should not be undertaken early.

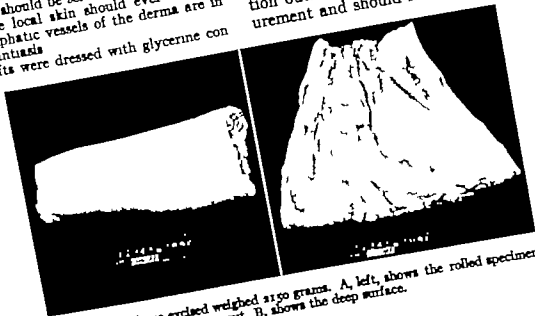


Fig. 3. The tissue excised weighed 2150 grams. A, left, shows the rolled specimen from which split grafts were cut. B, shows the deep surface.



# INDICATIONS FOR PORTACAVAL ANASTOMOSIS— ANALYSIS OF CASES

ARTHUR H. BLAKEMORE, M.D. New York, New York

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THE first anastomosis to join the portal and caval system of veins was made in 1877 by Von Eck, a Russian physiologist. His operation upon dogs, anastomosing the portal vein to the vena cava, side-to-side, became widely known as the Eck fistula. Surgeons early recognized the rationale of establishing portacaval shunts for the relief of portal hypertension and over the years from 1903 to 1914 occasional case reports appeared in the literature (3, 4).

That severe portal hypertension may cause gastrointestinal hemorrhage has long been known, but the rôle of portal hypertension in conjunction with deranged blood proteins in association with ascites is more recently better understood. In an experience covering the completion of 23 portacaval anastomoses with follow up observations, some data having bearing upon the selection of cases for portacaval shunt have been accumulated. Since the portacaval shunt affords a rational approach to the control or amelioration of hemorrhage due to portal hypertension I will first discuss indications for its use for this purpose.

Patients with congestive splenomegaly exhibiting Banti's syndrome who give a history of one or more episodes of gastrointestinal bleeding but whose liver function tests are essentially normal may be classified as cases of portal hypertension due to extrahepatic portal block. Such patients are candidates for a portacaval shunt. In the majority of these cases the portal block is due to cavernomatous transformation or atresia of the portal vein. Since it is not feasible to anastomose the portal vein to the vena cava in the above type of case the splenic vein to renal vein becomes the portacaval anastomosis of choice in this group. It is the surgeon's responsibility in dealing

with such cases to be prepared to perform a splenorenal anastomosis before proceeding with a splenectomy. Venous pressure readings, properly taken at operation, are an indispensable aid in localizing the site of obstruction in the portal radicals. It is now an established fact that splenectomy alone for congestive splenomegaly will cure only that relatively small group of cases of thrombosis of the splenic vein in which the site of obstruction is distal to the junction of the coronary vein. In such cases venous pressure readings taken from known branches of the superior mesenteric and coronary veins are found to be normal.

## THE RÔLE OF THE PORTACAVAL SHUNT IN PORTAL CIRRHOSIS OF THE LIVER

The very fact that hemorrhage or ascites or both can occur in cirrhosis cases purely on the basis of extremely depressed liver function places a great responsibility upon the surgeon in the selection of cases for the portacaval shunt operation. I will cite cases to illustrate this point.

The first case was that of the wife of a physician whose first complaint was that of uterine bleeding. A dilatation and curettage revealed no cause for the bleeding and finally during the performance of a hysterectomy cirrhosis of the liver was discovered. Subsequent liver function and chemistry studies revealed a badly decompensated liver. The prothrombin time was markedly elevated. The patient's general condition progressively deteriorated. Some 3 months later she experienced her first episode of gastrointestinal hemorrhage. Over a period of 3 months the patient was continuously confined in the hospital suffering repeated hematemeses occurring at monthly intervals. Finally the patient was placed upon a high protein high carbohydrate diet with large doses of vitamin B complex. Gradually her appetite and strength improved. Some 4 months later following a 6 weeks vacation in Florida the patient was admitted to the Presbyterian Hospital for study. The liver was found to be rather hard and enlarged. There was no ascites present. Esophagograms revealed small esophageal varices. The blood proteins

From the Department of Surgery, The Presbyterian Hospital of the City of New York.  
Presented in the forum on Fundamental Surgical Problems before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.





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ARTHUR H. BLAKEMORE, M.D. New York, New York

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# BLAKEMORE INDICATIONS FOR PORTACAVAL ANASTOMOSIS

marized and clarified by classifying cases of cirrhosis in three groups as follows Group I, cases in which ascites or a tendency to hemorrhage is based on the inability of the damaged liver to form albumin or prothrombin in adequate amounts. Portacaval anastomosis is not indicated in this group Group II cases of cirrhosis in which the liver function is adequate to furnish the required amount of albumin and prothrombin but as a result of fibrotic contraction and periportal fibrosis a severe degree of portal hypertension has supervened. Wasting ascites and severe hemorrhage can be controlled in this group only by the portacaval shunt. Group III cases of cirrhosis having varying degrees of depressed liver function plus evidence of considerable elevation of the portal pressure. Such cases are candidates for the portacaval shunt operation but the question is when. It is our present policy to study the individual case with exceeding care when ever possible over a sufficient period of time to become thoroughly familiar with the behavior of the liver before bringing the case to operation. This is usually possible even in patients who have been subject to recurring hemorrhages. The idea is to improve liver function to its maximum employing a comprehensive liver regimen energetically applied for as long a period as necessary.

## DISCUSSION

The portacaval shunt operation is indicated and affords a chance of ultimate survival for cases of Banti's syndrome with extrahepatic portal block cases in which there is hypertension in the coronary or portal veins.

The portacaval shunt has an equally important rôle in the treatment of portal hypertension due to cirrhosis of the liver. But, its application must be decided on the basis of portal hypertension being the primary cause of hemorrhage or ascites in the individual case.

## ANALYSIS OF CASES

The portacaval shunt operation has been completed in 23 cases. There have been 4 postoperative deaths.

Hemorrhage from a sizable collateral vessel discovered at the conclusion of an anastomosis of the portal vein to vena cava accounted for

death in a case of cirrhosis of the liver. One cirrhosis patient died of cholemia 4 days following the establishment of a splenorenal shunt. Another cirrhotic patient died also of liver failure 6 days following the establishment of a portal vein to vena cava anastomosis. The fourth death resulted from mesenteric thrombosis occurring on the 14th day following a splenorenal anastomosis. The first death was the result of technical error. Death from liver failure in the 2 cirrhotic patients involves essentially errors in judgment in the selection of cases. Whereas mesenteric thrombosis is in the lap of the gods!

Patients have been explored in whom it was not feasible to accomplish a shunt operation. The majority of these patients had been subjected to a previous splenectomy. Of the 23 cases in which portacaval shunts were completed there were 15 patients who had anastomosis of the splenic vein to the renal vein following splenectomy and left nephrectomy. One of these patients had a splenectomy at a previous operation. In one other post-splenectomy bleeder it was possible to anastomose the stump of the splenic vein to the vena cava end to-side, by suture.

Anastomosis of the portal vein to the vena cava end to-side, was carried out seven times. A 12 millimeter vitallium tube was used four times (1) a 10 millimeter once. An 8 millimeter vein lined tube once and suture anastomosis once.

Seventeen of the 19 patients surviving operation have a follow up exceeding 6 months. Two deaths have occurred one a child having portal cirrhosis, died some 2 years 4 months postoperatively of uremia due to polycystic disease of the kidney. The second case a man with bad portal cirrhosis, died 1 year following operation of cholemia. A necropsy examination was made in each case. In the child the splenorenal shunt had become occluded. This outcome was not unexpected because at operation in this, our first case there was considerable angulation of the splenic vein over the funnel edge of the vitallium tube. The splenorenal anastomosis in the second case was found to be patent.

Five additional patients with bad cirrhosis of the liver have been followed (2 cases 2



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TABLE I.—PROTEINS

Name		Preoperative			Postoperative		
		Total proteins	Albumin	Globulin	Total proteins	Albumin	Globulin
1. Decker 47, M 797171	Esophageal varices Splenorenal shunt	6.6	9	3.7	7	1.6	5
Box 47, F 77756	Esophageal varices Eck shunt	7.8 8	4.3 3.9 4	3.5 4	1.6 1.6	1.4 1.4	1 4
3. Pabaci 5, F	Ascites Esophageal varices Splenorenal shunt	8	4.5	3.7	7.4 7 7.3	3.3 3.7 3.8	9 1 5.1
4. Schellingman 48, M 857 30	Esophageal varices. Eck shunt Vein graft	8.5	3.3	5	6.9 7 7.9 8.8 6	6 4 (10)	3 4.1 6.7 6.3 7
5. Coccolo 43, M 784188	Ascites Esophageal varices Splenorenal shunt	7.5	3.3	4	6 5.8 6.3	5 6	3.7 4.3 5.9
6. Mooney 35, M 536880	Esophageal varices Splenorenal shunt	5.7 7 6	3.8 3.3 3.5	5 3.3 9	6 5.8 6.5	3.7 4 3.6	7 3 2.9
7. Long 49, M 78307	Ascites Eck shunt	8.3	3	3	3.9 5 5.7	3.6 6	1 1 6
8. Iacolelli 58, M 784005	Ascites Eck shunt	8	9	3	4.8 4.0 5 5 6	5 3 9 3	4 3 3 3 3

NOTE. All cases of cirrhosis of the liver

any time evidence of decompensation of the liver. Furthermore up until the time of disappearance of the ascites following the establishment of the portacaval shunt, the patient was not on a liver dietary regimen. In view of the above fact, if the bleeding episode which occurred 10½ months after operation in this man had been due to a sudden closure of the splenorenal shunt one would have expected a prompt return of the ascites. In fact, in a very recent case in which thrombotic occlusion did take place the prompt occurrence of ascites antedated the appearance of esophageal bleeding by 2 weeks.

It seems reasonable that this man's splenorenal shunt may be open but not of a size adequate to shunt enough blood to afford complete protection against hemorrhage. After

all, he has had only three episodes of gastrointestinal hemorrhage in a 24 months post-operative period compared to 5 attacks over an 8 months period before operation. He is free of ascites, and working.

We do not have, as yet, enough follow-up data on portal pressures before and after opening portacaval shunts to predicate what pressure level will afford absolute protection against hemorrhage. However we do have data upon portal pressures to indicate that the splenic vein may not always be of adequate size to afford a shunt sufficiently large to protect against episodes of hemorrhage. As a possible corollary to the importance of the size of the shunt our follow-up has not so far been complicated by hemorrhage in those cases in which direct anastomoses of the portal



terminal illness from liver failure. Whereas it seems likely that a low blood prothrombin level may have contributed to the initiation of hemorrhage, it must be remembered that this patient still had a portal pressure of 240 millimeters of water following opening of the shunt. Before operation the portal pressure was 400 millimeters of water—the highest pressure we have yet recorded on a case of cirrhosis. Though this patient's ascites cleared following operation his jaundice persisted. His terminal illness was ushered in by a high fever from what appeared to be an upper respiratory infection. It is only fair to state at this point however that following the establishment of a splenorenal shunt, this man's appetite strength and weight improved. He was able to return for part time work to his job as a barber.

The above case proves that a splenorenal shunt, though patent, may not be of a size adequate to shunt an amount of blood sufficient under all conditions to afford absolute protection against future hemorrhage. Three additional cases over a 2 year follow up period have shown such marked overall clinical improvement following the portacaval shunt operation as to justify including them in the above classification.

One of the cases has already been discussed in detail. One case a girl of 15 years having Banti's syndrome with extrahepatic portal block was found to have a portal pressure of 310 millimeters of water. Following the opening of a splenorenal anastomosis the portal pressure receded to 190 millimeters of water. This patient gained strength and weight following operation but over a 2½ year (30 month) follow-up period she has had three episodes of gastrointestinal bleeding. Two of these hemorrhages were comparatively trivial to the attacks which came regularly at 6 month intervals before operation.

A third case a cirrhotic who gave a long past history of hematemesis, was operated upon following a month's seizure of hemorrhage during which the stools failed to become guaiac negative. Following the establishment of a portacaval shunt, this man's general condition improved markedly. His jaundice gradually improved as well as his liver

function tests. A few months after operation, the patient returned to his job and has been working ever since. Over a 2 year follow-up period this man has had one comparatively minor bleeding episode consisting of 2 or 3 tarry stools.

Finally there are 3 cases in which the evidence points to closure of the portacaval anastomoses. All 3 cases have Banti's syndrome with a past history of frequent episodes of gastrointestinal bleeding including hematemesis. In 1 case that of a 15 year old girl, who 4 years previously had had a splenectomy an anastomosis was effected by suture of the stump of the splenic vein to one branch of the left renal vein. To the other branch of the renal vein (following nephrectomy) the proximal stump of the inferior mesenteric vein was anastomosed employing a 5 millimeter vitallium tube. Thrombotic occlusion of the anastomoses was heralded by the sudden appearance of ascites on the seventh postoperative day. Some 2 weeks later the patient had an attack of hematemesis. The bifurcated renal branches were rather small in this case and in retrospect it would possibly have been better judgment to have been satisfied with one anastomosis.

The second case was that of an 8 year old boy who one year previously had had a splenectomy. The boy had Banti's syndrome complicated by bronchiectasis. During the year following splenectomy the boy suffered 5 episodes of severe gastrointestinal hemorrhage including hematemesis. The proximal stump of the splenic vein was anastomosed to the vena cava by suture end-to-side. During a year following this procedure, as presumptive evidence of closure of the anastomosis, the hemorrhages have recurred with equal frequency and severity.

Finally in a child 3 years of age an end-to-end suture of the splenic vein to the renal vein has failed to lessen the tendency to hemorrhage over a year's follow up period.

#### SUMMARY

In presenting the rationale of the portacaval shunt for the relief of portal hypertension, special stress is placed upon the selection of cases.

# BRANTIGAN ANOMALIES OF PULMONARY VEINS

553

The procedure is presented as the one hope of relief for those cases with Banti's syndrome who have essentially normal livers but present the problem of control of gastrointestinal hemorrhage.

The importance of exercising extreme care and judgment in the selection of cases of cirrhosis for operation and the reasons thereof are discussed.

An analysis of 23 cases having portacaval anastomosis was presented

## REFERENCES

1. BLAKEMORE, A. H. and LLOYD J. W., Jr. Ann Surg. 1945, 121: 476
2. ECK, N. Voprosno-med. f. st. paterab. 1877 130: 1
3. ENDERLEIN, E., HOTT, G. and MAGNUS ADELHEIM. Zschr. ges. exp. Med., 1914, 3: 223
4. ROSENSTEIN P. Arch. klin. Chir. 1918: 98: 1082

## ANOMALIES OF THE PULMONARY VEINS

### Their Surgical Significance

O. C. BRANTIGAN M.D. F.A.C.S., Baltimore, Maryland

THE reports of anomalies of the pulmonary veins are appearing more frequently in the medical literature. In the past all descriptions and case reports have come from autopsy material or from studies made in the anatomic laboratory. This article will describe and discuss anomalies of the pulmonary veins found at the time surgical operations were being performed upon the lungs.

Brody made a review of the literature and in 1942 presented an excellent discussion of the subject. The final study included 106 patients. Since 1942 seven different authors have reported 14 additional cases (3, 4, 7, 8, 10, 11, 12). Brody classified the anomalous venous drainage from the lungs as (1) total drainage into the right atrium or its tributaries, 36 per cent and (2) incomplete drainage into the right atrium or its tributaries, 64 per cent. When the venous drainage from the lungs into the right atrium or its tributaries is incomplete the most common site for drainage in order of frequency is the superior vena cava, right atrium and the left innominate vein. The right pulmonary vein is anomalous in its drainage twice as frequently as the left.

Anomalous pulmonary veins have been described as draining into the following superior vena cava, right atrium, left innominate vein, coronary sinus, inferior vena cava, azygos vein, left subclavian vein, portal vein and persistent left superior vena cava.

It has been suggested that if less than 50 per cent of the pulmonary blood is abnormally shunted into the major venous system or into the right side of the heart, the patient is unlikely to develop cardiac decompensation. Such an assumption is based upon a normal heart. Hughes and Rumore were the first to give actual figures that might indicate the quantity of pulmonary blood that flows abnormally into the major venous system from an anomalous pulmonary vein. Both of the patients they described died of cardiac failure and both had rheumatic heart disease. By comparison of the cross-sectional area of the anomalous veins with the cross-sectional area of the normal pulmonary veins they calculated that in one patient 26 per cent and in another 20 per cent of the pulmonary blood was shunted into the major venous system. It is difficult to calculate the effects of this additional effort upon the already injured heart. Conant and Kurland described a patient who tolerated extensive tuberculosis in the left lung but died rapidly when the right lung became infected. At autopsy it was found that

From Department of Surgery School of Medicine, University of Maryland.  
Presented in the forum on Fundamental Surgical Problems before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-7, 1946.



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A third case a cirrhotic who gave a long past history of hematemesis, was operated upon following a month's seizure of hemorrhage, during which the stools failed to become guaiac negative. Following the establishment of a portacaval shunt, this man's general condition improved markedly. His jaundice gradually improved as well as his liver

function tests. A few months after operation, the patient returned to his job and has been working ever since. Over a 2 year follow-up period this man has had one comparatively minor bleeding episode consisting of 2 or 3 tarry stools.

Finally there are 3 cases in which the evidence points to closure of the portacaval anastomoses. All 3 cases have Banti's syndrome with a past history of frequent episodes of gastrointestinal bleeding including hematemesis. In 1 case that of a 15 year old girl, who 4 years previously had had a splenectomy an anastomosis was effected by suture of the stump of the splenic vein to one branch of the left renal vein. To the other branch of the renal vein (following nephrectomy) the proximal stump of the inferior mesenteric vein was anastomosed employing a 5 millimeter vitallium tube. Thrombotic occlusion of the anastomoses was heralded by the sudden appearance of ascites on the seventh postoperative day. Some 2 weeks later the patient had an attack of hematemesis. The bifurcated renal branches were rather small in this case and in retrospect it would possibly have been better judgment to have been satisfied with one anastomosis.

The second case was that of an 8 year old boy who one year previously had had a splenectomy. The boy had Banti's syndrome complicated by bronchiectasis. During the year following splenectomy the boy suffered 5 episodes of severe gastrointestinal hemorrhage including hematemesis. The proximal stump of the splenic vein was anastomosed to the vena cava by suture, end-to-side. During a year following this procedure, as presumptive evidence of closure of the anastomosis, the hemorrhages have recurred with equal frequency and severity.

Finally in a child 3 years of age an end-to-end suture of the splenic vein to the renal vein has failed to lessen the tendency to hemorrhage over a year's follow up period.

#### SUMMARY

In presenting the rationale of the portacaval shunt for the relief of portal hypertension special stress is placed upon the selection of cases.

## BRANTIGAN ANOMALIES OF PULMONARY VEINS

An analysis of 23 cases having portacaval anastomosis was presented

The procedure is presented as the one hope of relief for those cases with Banti's syndrome who have essentially normal livers but present the problem of control of gastrointestinal hemorrhage

The importance of exercising extreme care and judgment in the selection of cases of cirrhosis for operation and the reasons thereof discussed

## REFERENCES

1. BLAKEMORE A H and LORD J W Jr Ann Surg., 1945 122 476
2. ECK N Voyerdo-med f st. peterab., 1877 130 1
3. ENDERLEIN E., HOTZ G and MAERUS-ALALEHEN Zchr ges. exp. Med. 1914, 3 223
4. ROSENSTEIN, P Arch. klin Chir 1912, 98 1082

## ANOMALIES OF THE PULMONARY VEINS

## Their Surgical Significance

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THE reports of anomalies of the pulmonary veins are appearing more frequently in the medical literature. In the past all descriptions and case reports have come from autopsy material or from studies made in the anatomic laboratory. This article will describe and discuss anomalies of the pulmonary veins found at the time surgical operations were being performed upon the lungs.

Brody made a review of the literature and in 1942 presented an excellent discussion of the subject. The final study included 106 patients. Since 1942 seven different authors have reported 14 additional cases (3, 4, 7, 8, 10, 11, 12). Brody classified the anomalous venous drainage from the lungs as (1) total drainage into the right atrium or its tributaries, 36 per cent, and (2) incomplete drainage into the right atrium or its tributaries 64 per cent. When the venous drainage from the lungs into the right atrium or its tributaries is incomplete, the most common site for drainage in order of frequency is the superior vena cava, right atrium and the left innominate vein. The right pulmonary vein is anomalous in its drainage twice as frequently as the left.

Anomalous pulmonary veins have been described as draining into the following superior vena cava, right atrium, left innominate vein coronary sinus, inferior vena cava, azygos vein left subclavian vein portal vein and persistent left superior vena cava.

It has been suggested that if less than 50 per cent of the pulmonary blood is abnormally shunted into the major venous system or into the right side of the heart, the patient is unlikely to develop cardiac decompensation. Such an assumption is based upon a normal heart. Hughes and Rumore were the first to give actual figures that might indicate the quantity of pulmonary blood that flows abnormally into the major venous system from an anomalous pulmonary vein. Both of the patients they described died of cardiac failure and both had rheumatic heart disease. By comparison of the cross-sectional area of the anomalous veins with the cross sectional area of the normal pulmonary veins they calculated that in one patient 26 per cent and in another 20.1 per cent of the pulmonary blood was shunted into the major venous system. It is difficult to calculate the effects of this additional effort upon the already injured heart. Conant and Kurland described a patient who tolerated extensive tuberculosis in the left lung but died rapidly when the right lung became infected. At autopsy it was found that

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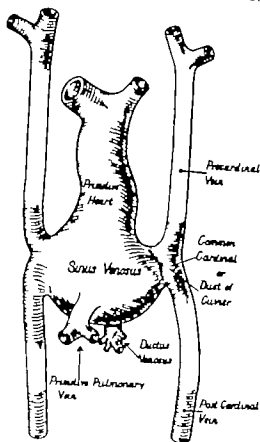


Fig. A diagrammatic conception of the primitive venous system viewed from the dorsal aspect. The primitive pulmonary vein enters the dorsal all of the sinus venosus. This conception was accepted by the early embryologists.

the blood from the left lung drained anomalously and completely into the left innominate vein. Disease of the nonfunctioning lung caused little embarrassment to the patient, but disease of the functioning lung was rapidly fatal. Thus, the physiologic effect of pulmonary blood shunted into the major venous system will be influenced by disease in the functioning lung or by disease of the heart.

The seemingly wide and unrelated variations that occur in pulmonary venous anomalies have been studied from the embryologic point of view in an endeavor to simplify and correlate the anomalies encountered. Brown reviewed the research that had been done on the development of the pulmonary veins and wrote it is evident that (1) The anlage of the vein and its connections with sinus venosus has not been described in detail and (2) the method by which the vein changes its orifice in the center of the sinus venosus for one in

that position of the sinus which lies to the left of the left sinus valve has not been considered. In addition the general relation which the pulmonary venous system bears to the systemic has been entirely neglected in the study of the embryology of the vein." In the 4.5 millimeter cat embryo he reported "At this stage the pulmonary vein exists as a single vessel having two main vascular connections, (1) ventrally a single rounded orifice in the sinus venosus (Fig. 1) and (2) dorsally a connection with that portion of the splanchnic plexus which is pushed forward by the growing pulmonary anlage which it joins at the ventral pole of the lung bud. Thus, the pulmonary venous plexus through the splanchnic venous plexus is connected with the primitive major venous system by the way of both the pre-cardinal and postcardinal veins. In the 6.5 to 7 millimeter embryo he further related "The sinus venosus with the exception of the openings of the cornua has been incorporated into the auricle. The right valve of the sinus is very prominent and is continued into the septum spinum which has shifted to the left and fused with the septum superius. The left valve of the sinus has likewise shifted to the left and its cephalic extremity on the dorsal wall of the auricle has fused with the dorsal caudal portion of the septum superius. As a result of the latter shift the orifice of the pulmonary vein has preceded the left valve of the sinus, passed under the septum superius and now empties into the left auricle having both septum superius and left valve of the sinus or in other words, the interauricular septum on the right. This view is no longer considered to be true in human development. It is thought that the venous plexus covering the primitive lung bud is probably a development from the splanchnic venous plexus (Fig. 2). The pulmonary venous plexus is gathered together into a common pulmonary vein that joins directly and definitively with the left auricle (6 16). Patten in describing human embryology said "Phylogenetically the lungs are relatively new structures. It is not surprising, therefore, that we find the pulmonary veins arising independently and not by the conversion of old vascular channels. They originate as vessels which drain the various branches of

## BRANTIGAN ANOMALIES OF PULMONARY VEINS

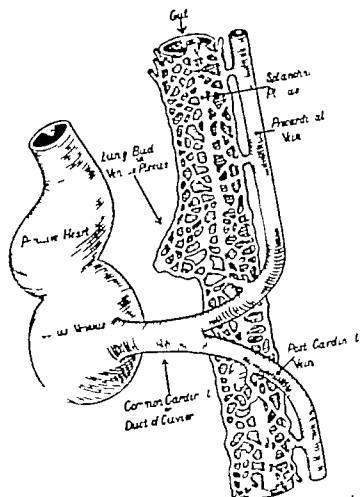


Fig. 3. A lateral view diagrammatically representing the primitive venous system and the lung bud and its venous plexus. The primitive pulmonary plexus is an outgrowth from the primitive splanchnic venous plexus. The primitive splanchnic venous plexus communicates with the precardinal and postcardinal veins. The pulmonary vein will join the common duct of the common cardinal vein. This conception of development for the most part is accepted by contemporary embryologists.

the lung bud and converge into a common trunk entering the left atrium dorsally. In the growth of the heart this trunk vessel is gradually absorbed into the atrial wall until usually 4 of its original branches come to open into the left atrium as the pulmonary veins of the adult. Less than the usual amount of resorption of the primitive common pulmonary vein not infrequently results in the pulmonary veins from the right and the left lungs entering the left atrium as single instead of the usual paired vessels (Fig. 4). In continuation of the discussion Patten made the statement "Occasionally startling anomalous connections of the pulmonary veins are seen such as

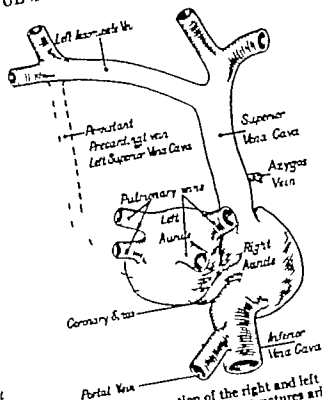


Fig. 3. With the exception of the right and left atria, the diagram presents the normal adult structures arising from the primitive venous system. It is viewed from the posterior aspect. If there is a left superior vena cava it is the result of a persistence of the normal remains of the old precardinal vein on the left side. If the pulmonary blood is drained abnormally into the right atrium or its tributaries it will drain into one of the structures indicated on this diagram.

the entrance of one of them into the superior vena cava the left innominate or the azygos. Such conditions are explicable only on the basis of exceedingly early embryonic stages in which the developing foregut trachea and lung buds are supplied by a common plexus of small channels which thread in all directions through the loose mesenchyme and communicate with the primitive cardinal veins freely in many places (Fig. 2). With the enlargement of certain channels in the primordial vascular bed to form pulmonary veins leading to the left atrium the primitive connections with the cardinal veins ordinarily disappear. The unusually strong development of some of these early channels and its retention by the adult derivative of the particular part of the cardinal system involved is behind the occurrence of these abnormal pulmonary connections."

The primitive venous system containing of the cardinal veins and sinus venosus give rise

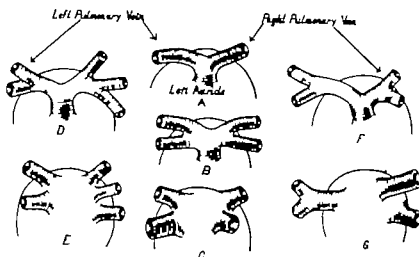


Fig. 4. The method of development of an abnormal number of pulmonary veins entering the left atrium is indicated by the diagrams A to G. The dorsal aspect is presented. The primitive pulmonary vein enters the left atrium as a single venous trunk. The primitive single venous trunk is divided into a right and a left pulmonary vein, A. The right and left pulmonary veins are divided into two veins, B. There is resorption of the venous trunks into the wall of the left atrium until in the normal adult atrium four pulmonary veins open separately into the posterior aspect of the atrium, C. If the right pulmonary vein divides into three branches, D. one for each lobe, close to the atrium they will be resorbed into the atrial wall, thus giving rise to three separate openings on the right side E. If the left pulmonary vein divides into two branches at a greater than normal distance from the atrial wall F they will not be taken up into the atrium and thus only one orifice will open into the atrium on the left, G.

in the adult to the right and left innominate veins, the coronary sinus, the axillary vein, the superior vena cava, the portion of the inferior vena cava adjacent to the atrium, a part of the right atrium and a portion of the portal vein adjacent to the liver. Abnormalities in the persistence of the cardinal veins may give rise in the adult to abnormal axillary veins and to a left superior vena cava (13, 14). When there is anomalous drainage of blood from the lungs, according to all past reports, it has drained into one of the structures above named. Abnormal sites of drainage of pulmonary blood at first glance seem unpredictable but actually they are rather normal from the embryologic point of view. This blood will always drain into some structure originating from the primitive venous system (Fig. 3).

If the early pulmonary veins once drained into the sinus venosus an abnormal shift of its final drainage point could easily account for an abnormal pulmonary drainage into any of the structures originating from the primitive venous system and especially the emptying of pulmonary veins into the right atrium.

Should the pulmonary veins originate from the splanchnic venous plexus (Fig. 2) and then drain first and definitively into the left atrium, certain early connections of the splanchnic venous plexus with the cardinal venous system may persist and thus account for the anomalous drainage of pulmonary blood into any part of the major venous system originating from the primitive venous system. If there is failure of junction of the early pulmonary vein with the left atrium then all blood from the lungs must find an anomalous pathway for drainage. Thus, all anomalies that have been described can be accounted for whether one accepts the old or the new embryologic theory of pulmonary vein development (Fig. 1, 2, 3 and 4).

Embryologists seem to agree upon the essential method of development of multiple openings of the pulmonary vein into the left atrium. The method is described adequately in the quotation from Patten. The various anomalous openings and their method of development have been indicated by the diagrams in Figure 4.

## BRANTIGAN ANOMALIES OF PULMONARY VEINS

In the last 3 years pulmonary venous anomalies have been recognized by the author at the operating table. While undergoing pneumonectomy 3 patients were found to have only one pulmonary vein on the left side. Thus, to remove the left lung only one pulmonary vein was ligated. In each patient the single vein was ligated as it entered the pericardium. During pneumonectomy 2 other patients presented 3 pulmonary veins on the right side, or an individual vein for each lobe of the lung on the right side. Upon removal of the lung in these 2 patients 3 veins were ligated as they entered the pericardium. In 1 patient where the right lung was removed for tuberculosis the pulmonary vein from the upper lobe of the right lung drained into the inferior part of the superior vena cava. The pulmonary vein from the middle and lower lobes of the right lung drained into the left auricle. While doing a closed intrapleural pneumonolysis on the left side a pulmonary vein from the upper lobe of the left lung was found draining into the left innominate vein. Since this lung was not removed and since it was viewed through a thoracoscope the interpretation may be erroneous.

When the various anomalies of the pulmonary veins are understood it is reasonable to expect that they will be recognized with greater frequency at the operating table. It is evident that these anomalies are of considerable surgical importance. This importance is mitigated by rarity and enhanced by common occurrence.

Pulmonary vein anomalies can be classified into two groups (1) an abnormal number of pulmonary veins emptying into the left atrium (2) abnormal drainage of the pulmonary veins (a) partial drainage into the right atrium or its tributaries (b) total drainage into the right atrium or its tributaries.

In performing a lobectomy by means of the individual ligation technique the presence of more than a single pulmonary vein must be demonstrated in order to avoid devitalizing the whole lung. When 3 veins are present on the right side the ligation of the vein draining the lobe is facilitated. The variable number of veins that may be found draining the lung is well recognized and described in the stand-

ard textbooks of anatomy (95). If the pulmonary veins were inspected inside the pericardium it seems reasonable to expect that a single pulmonary vein on either side would be of more common occurrence.

It has been recognized that the drainage of pulmonary blood into the major venous system or into the right atrium is a burden upon the heart. The thoracic surgeon endeavors to conserve healthy lung tissue when resection of the lung is necessary. It is important to recognize pulmonary venous anomalies when the thorax is open, since the removal of such a lobe of the lung would be beneficial to the patient by eliminating the burden placed upon the heart. Lobectomy of the lower lobe is more common than lobectomy of the upper lobe of the lung. If the pulmonary vein of an upper lobe drains into the major venous system and the normally draining lower lobe is removed it will increase the relative percentage of pulmonary blood drained into the major venous system. Accordingly it will increase the cardiac burden and should be removed. The most common anomalous pulmonary venous drainage is the drainage of the pulmonary vein from the upper lobe of the right lung into the superior vena cava.

For the thoracic surgeon it is frightening to contemplate the possibility of removing one lung only to find that the other lung drained its blood into the major venous system as in the patient described by Conant and Kurland. Fortunately the drainage of one lung into the major venous system is uncommon. Judged from case reports it occurs about as often as drainage of the total pulmonary blood into the right atrium or its tributaries. Actually, 31 such cases have been reported.

In the past a diagnosis of total drainage of pulmonary venous blood into the right atrium or its tributaries has not been made before death. In such patients death usually coincides with the closure of the foramen ovale. It is not unreasonable to believe that some day the condition will be diagnosed before death. If that were possible it would be interesting to speculate upon an operative attack. The interatrial septum might be removed or a major pulmonary vein could be anastomosed to the left atrium.

## CONCLUSIONS

1 The anomalous drainage of pulmonary blood is being recognized with increasing frequency

2 When there is anomalous drainage of blood from the lung it drains into some structure arising from the primitive venous system.

3 An anomalous number of pulmonary veins draining into the left atrium is not uncommon and is recognized by the standard textbooks of anatomy

4 In the individual ligation technique for lobectomy of the lung it is important to demonstrate the presence of more than one pulmonary vein if devitalization of the whole lung is to be avoided.

5 If there is anomalous drainage of pulmonary blood into the major venous system the patient will be benefited by removal of the portion of lung thus drained

## REFERENCES

1. BRODY H. Arch. Path., 1942, 33: 221.
2. BROWN, A. J. Anat. Rec., 1913, 7: 202.
3. COMPTON, D. E. and FURSEY, H. F. J. Thorac. Surg., 1944, 3: 63.
4. COMANT, J. S., and KURLAND, L. T. Pulmonary Telangiectasis Associated with Anomalous Common Pulmonary Vein Entering the Left Internal Vein. J. Thorac. Surg. (in press)
5. CUNNINGHAM, D. J. Cunningham's Manual of Practical Anatomy, 8th rev. ed., vol. 2: 63, by A. Robt. New York: William Wood and Co., 1927.
6. DAVIS, CARL. Personal communication.
7. DIDION H. Virchows Arch., 1942, 309: 1.
8. GRAHAM, P. M. Med. J. Australia, 1944, 2: 545.
9. GRAY H. Gray's Anatomy, 24th ed. rev. by W. Lewis, p. 644. Philadelphia, Pa. Lea & Febler, 1942.
10. HUCKER, C. W. and RUMBLE, P. C. Arch. Path., 1942, 37: 364.
11. KIRMAN, J. D. Ann. Otol., Rhinol., 1944, 53: 1.
12. MERRILL, H. Virchows Arch., 1942, 309: 291.
13. McILANUS, J. F. A. Canad. M. Ass. J. 1941, 45: 1.
14. PAPER, J. W. Anat. Rec., 1938, 70: 91.
15. PATTEN B. M. Human Embryology p. 644. Philadelphia. The Blakiston Co. 1946.
16. STREETER G. L. Personal communication.

# THE USE OF VASODILATION IN THE TREATMENT OF VENOUS THROMBOSIS

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THE rationale for vasodilatation obtained by sympathetic block in the treatment of venous thrombosis is that in true thrombophlebitis because of the irritative lesion within the vein impulses are set up and carried over the sympathetic nervous system to the arterioles and venules resulting in severe spasm. As we have emphasized previously (10-15) it is imperative to differentiate between two types of venous thrombosis one in which the thrombus is associated with and is dependent upon an inflammation of the vein wall i.e. thrombophlebitis and another in which the clot is a coagulation thrombus and occurs not as a result of an inflammatory process in the vein wall but because of two other factors a pre-disposing one consisting of increased coagulability of the blood caused by tissue damage and another, a precipitating one consisting of circulatory stasis which determines the site of the thrombus. These two types of venous thrombosis must be differentiated not only from an etiologic standpoint but also from the standpoint of their clinical manifestations their prognosis, and their treatment. Pathologically the clot in thrombophlebitis is a white or mixed thrombus. It is firmly attached to the vein wall and will not become detached. For this reason there is little or no danger of embolism except in the rare instance in which there is suppurative and in which because of liquefaction of the clot infected emboli can become detached. On the other hand in phlebothrombosis the clot is a red or coagulation thrombus. It is not firmly attached to the vein wall and can become detached easily. The patient with phlebothrombosis is a potential fatality and, although the symptoms

are minimal or lacking, there is great urgency for radical therapy. The symptomatology of the two conditions are entirely different. The patient with thrombophlebitis has definite symptoms which vary according to the location whether the deep or the superficial veins are involved. In femorotibial thrombophlebitis which is the most frequent type and which is a typical example of phlegmasia alba dolens the symptoms are maximal. There is pain and the extremity is swollen white and cold. The significance of the paradox the whiteness and coldness of an extremity in an individual with pyrexia and whose surface temperature elsewhere is increased was not previously appreciated, but is now known to be due to concomitant spasm of the arterioles. These patients although having marked symptoms, do not succumb to the disease but unless adequate therapy is instituted early have persistent sequelae which last for years months or even for the duration of their lives. In the relatively rare case of superficial thrombophlebitis there is also pain and fever. Instead of the extremity being white and swollen as it is in the deep thrombophlebitis there is redness over the involved vein and there is minimal swelling. Superficial thrombophlebitis is usually seen in conjunction with varicose veins or is associated with peripheral arterial disease.

Whereas it is our belief that the treatment of phlebothrombosis consists of radical surgery i.e. ligation of the vein above the site of the thrombus or thrombectomy and ligation after removal of the thrombus, the treatment of thrombophlebitis should be conservative with the exception of the relatively rare case in which there is suppuration.

At the outset it should be emphasized that the treatment of venous thrombosis should consist principally of prophylaxis, and it is our belief that in most instances venous thrombosis can be prevented by the minimization of

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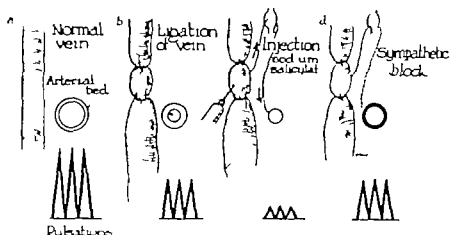


Fig 1 Diagrammatic illustration showing the effect of experimentally produced thrombophlebitis on arteriolar pulsation. a, The normal findings in the veins, the arteries, and the arterial pulsations as determined plethysmographically. b, The decrease in the size of the arterioles following ligation of the common femoral vein. This results in decrease in the arterial pulsations. c, A marked decrease in the size of the arteriole and marked diminution of the arteriolar pulsation, following the production of chemical thrombophlebitis produced by injecting 40 per cent sodium salicylate into the isolated segment of vein. d, The return to normal of the lumen of the arteriole and the arteriolar pulsations following the blocking of the sympathetic impulses originating in the thrombophlebotic segment. This interruption is produced by anesthetization of the sympathetic ganglion.

trauma and infection and by the speeding of the circulation in the veins of the lower extremity venous thrombosis can be greatly minimized. Only after thrombosis has occurred is it necessary that active therapy be instituted. It is a rule on our service that in all patients past forty years of age who have any tissue injury operative accidental during delivery or as the result of destruction of tissue by neoplastic disease or infection the lower extremities are wrapped with compression bandages (Ace No. 8) from the toes to the groin in order to increase the rate of blood flow through the deep venous system. The patient is also made to contract the muscles of the calf and the thigh. Tight abdominal bandages are avoided and the return flow of blood through the venous system to the chest is favored by having the patient take deep breaths. Those positions such as the Fowler's position which favor circulatory retardation of the lower extremity are avoided.

Thrombophlebitis of the deep venous system, particularly the femorotibial, is an interesting biologic phenomenon, because although the lesion is in the large deep veins, the symptoms are the result of arteriolar spasm. Where-

as previously it was thought that the pain was due to the inflammatory process in the veins, that the swelling was due to the plugging of the vein by the thrombus, and that the white discoloration was due to the lymphedema, we have been able to demonstrate experimentally and clinically that all of these manifestations are the result of vasospasm. Experimentally DeBakey, Burch, and I (3) showed that in an isolated thrombophlebotic segment of vein, impulses originate and are carried over the sympathetic nervous system producing spasm of the arterioles of the homolateral extremity (Fig 1). Subsequently we (16) showed in clinical cases of phlegmasia alba dolens that there is a very definite diminution in the arteriolar pulsation of the involved extremity which can be relieved by sympathetic block. (Fig 2) Concomitant with the relief of the vasospasm there are relief of pain, prompt subsidence of the fever and disappearance of the edema. That the edema is not secondary to the mechanical plugging of the vein by the thrombus is demonstrated by the fact that ligating a vein surgically will not produce a similar edema and that the edema in thrombophlebitis will subside quickly following the

# OCHSNER VASODILATATION IN VENOUS THROMBOSIS

chemical section of the sympathetics even though the thrombus still remains. The edema in thrombophlebitis and its persistence are undoubtedly due to the associated vasospasm of the homolateral arterioles, resulting in such a marked diminution in blood flow through the capillary bed that a relative anoxia of the capillary endothelium ensues. Because of this the permeability of the capillary endothelium is increased and there results an excessive exudation of fluid to the outside producing the edema. The edematous fluid has difficulty in getting back into the vascular system for two reasons, first, because the pump which is responsible for the movement of the lymph namely arteriolar spasm and, second because spasm of the venules increases the pressure at the venule end of the capillary and inhibits absorption at this point. By overcoming the vasospasm by anesthetization of the sympathetic ganglia, the pain which is the result of ischemia is relieved and because of the prompt re-establishment of the normal circulation through the capillary bed the relative anoxia is overcome, the excessive exudation to the tissue spaces is prevented and by the establishment of the normal arteriolar pulsation the pump which is again brought into movement of lymph is again diminished and the edema quickly diminishes. Prompt subsidence of fever following novocain anesthetization of the lumbar sympathetic ganglia in phlegmasia alba dolens is probably due to the more rapid resolution of the inflammatory process in the vein wall resulting from better vascularization.

Because of the demonstration of these vaso-spastic phenomena associated with thrombophlebitis and their relief by anesthetization of the regional sympathetic ganglia, the treatment of phlegmasia alba dolens by sympathetic block is rational. Also the fact that these patients who would otherwise be incapacitated for weeks or months with persistent post phlebitic edema, recurrent erysipeloid infections and recurrent ulcerations are well within a few days time is additional proof of the adequacy and efficacy of blocking of the sympathetic ganglia in the treatment of phlegmasia alba dolens.

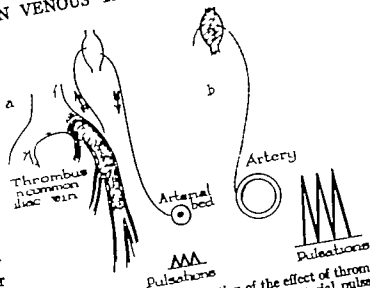


Fig. 2 Diagrammatic illustration of the effect of thrombophlebitis on the arterial bed and on the arterial pulsations. As shown in a, impulses originating in the thrombotic segment, which are carried over the sympathetic nervous system to the lumen of the vessel and a marked decrease in the size of the lumen of the vessel and a diminution in pulsation. b, Following anesthetization of the sympathetic ganglia, there is an interruption of these vasoconstrictor impulses, resulting in a return of the arterial lumen to normal and a re-establishment of normal pulsation.

The technique of lumbar sympathetic block is extremely simple and has been described adequately in previous reports (13-15, 4, 16-18) (Fig. 3). Although, theoretically, the employment of a single needle is sufficient it is our belief that if one uses multiple needles the block is much more likely to be successful because at best the injection is done blindly. With multiple needles the chances of striking the level in which the sympathetic chain is located are greatly increased. Because the patient with phlegmasia alba dolens is usually quite ill we prefer performing the sympathetic block with the patient in the lateral decubitus position. Points two finger breadths lateral to the spinous processes of the first, second, third and fourth lumbar ganglia are chosen. A cutaneous wheal is made. A long fine special needle  $5\frac{1}{2}$  inches in length, is used. It is important to use a long needle because otherwise the anesthetic solution may be deposited into psoas muscle. The needle is introduced perpendicular to the skin until the point hits the transverse process. The transverse process serves as a landmark, because whereas there may be considerable difference in the thicknesses of the subcutaneous fat and the sacrospinalis muscle of a large, muscular,

unnecessary procedure when better results can be obtained more safely and more simply by sympathetic block with procaine.

### CONCLUSIONS

1 Because the symptoms and signs in true uncomplicated deep vein thrombophlebitis (phlegmasia alba dolens) are due to spasm of the arterioles of the involved extremity vasodilatation produced by section with procaine of the regional sympathetic ganglia is rational

2 Although ligation of the involved vein is imperative in phlebothrombosis and in suppurative thrombophlebitis in order to prevent emboli gaining entrance to the systemic circulation sympathetic block is sufficient in suppurative thrombophlebitis

3 By the prompt induction of vasodilatation the symptoms and signs in phlegmasia alba dolens are quickly alleviated and the postphlebitic sequelae are eliminated.

4 The use of multiple needles in performing sympathetic block greatly enhances the efficacy of the injection

### REFERENCES

1. AYCOCK, T. T. and HENDERSON, J. W. The Problem of Venous Thrombosis (In press).
2. COLLIER, CONRAD G. and NELSON, E. W. Phlebothrombosis and Thrombophlebitis in Gynecology and Obstetrics. Presented before the Am. Gyn. Soc., 1916.
3. DEBAKEY, M. L., BURCH, G. L., and OCHSNER, ALTON. Proc. Soc. Exp. Biol., New York, 1930, 41: 585.
4. DEBAKEY, M. E., and OCHSNER, ALTON. J. M. A. Alabama, 1941: 87.
5. LEROUX, R. Bull. Soc. nat. chir., Par. 1927, 53: 127.
6. LEFRANC, R., and KUTLER, J. Crée. Méd. Mex., 1934, 33: 389.
7. MCINTOSH, H. O. and ALEXANDER, H. A. Minnesota M. 1916, 30: 43.
8. NICHOLSON, M. J. Surg. Clin. N. America, 1941, 34: 535.
9. OCHSNER, ALTON. Surgery 1930, 6: 29.
10. OCHSNER, ALTON and DEBAKEY, M. E. C. Jeff. M. B. Lecture South Surgeon, 1930, 8: 269.
11. Idem. Arch. Surg. 1940, 40: 208.
12. Idem. N. England J. M., 1941, 2: 3: 207.
13. Idem. J. Bone Surg., 1941, 23: 788.
14. Idem. Surgery 1943, 41: 679.
15. Idem. Thrombophlebitis and phlebothrombosis, Levin Practice of Surgery, Vol. 2, Chap. 5B, Hagerstown, Md. W. F. Prior Co., 1945.
16. Idem. J. Am. M. Ass., 1940, 14: 117.
17. Idem. Tri-State M. J., 1941, 13: 2654.
18. Idem. N. Orleans M. & S. J. 1941, 94: 173.

# ANTICOAGULANTS IN VENOUS THROMBOSIS AND THE PREVENTION OF PULMONARY EMBOLISM

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THE object of this paper is to discuss the effect of anticoagulants in the treatment of venous thrombosis, its prevention and the prevention and treatment of pulmonary embolism.

To approach this problem it seemed logical to consider the subject under the following headings:

1 Whether or not venous thrombosis is in fact in origin. It is my impression as stated in a previous paper (7) that in only 0.5 per cent of the cases of venous thrombosis was infection a factor in production of the thrombus and even in these cases it is possible that the infection was a secondary invasion of a thrombus or clot which had formed from other sources. This evidence is based on the fact that in 28 cases of venous thrombosis which were operated upon cultures taken from the surrounding tissue from the wall of the vessel and from its lumen, showed no growth of organisms on ordinary cultures, aerobic cultures or on special media. The fact also that in the majority of cases if the extension of thrombosis can be prevented they clear up rapidly without further evidence of infection or suppuration leads further support to this view.

2 The beginning and extension of the thrombus. On clinical evidence, which was supported also by experimental evidence, I think it can be safely assumed that whatever may be the factors precipitating the thrombosis the lesion begins in a localized area and extends from such area as a propagating thrombus. This is well demonstrated in the cases in which the clinical signs and symptoms would indicate that the calf muscles may be the site of origin. From that point the progression of thrombosis with clinical symptoms

and signs extends through the adductor region to involve the femoral and presently the iliac vessels. In many cases at a later period the opposite leg is involved in what would appear to be a retrograde fashion. Also in the post mortem study of the vascular tree of the lungs in patients dying of pulmonary embolism, the primary embolus has been well demonstrated and on top of that has been built up a thrombus which is of more recent duration which extends more widely through the vascular tree until ultimately a fatal effect is produced—a fact which has been well demonstrated by Professor Boyd.

3 Ligation of vessels an exciting cause. There is evidence to suggest both clinically and experimentally that ligation of vessels, especially veins, may be the exciting cause for thrombosis, from which extension can occur. This is well known in operations involving dissection and removal of organs in the pelvic region where thrombosis with pulmonary embolism as a complication, is a fairly common occurrence. It has been demonstrated experimentally that if any major or minor vessel is divided tied sewn or allowed to become occluded by natural clotting and thrombosis that there is a process of thrombosis set up which extends proximally through that vessel for varying distances. In a vessel very carefully dealt with these thrombi may be only small fragments occurring in clinks in the vessel where it is gathered into a cone by ligation or where there are small irregularities from suture of the end of the vessel. However once this process is set in action it is purely a matter of accident just how far it will extend, if the other conditions favoring thrombosis are present. It is suggested, therefore that any form of surgery on the vascular tree, especially on the venous side, is not without some hazard as regards the initiation of this process of thrombosis with the unpredictable accident of pulmonary embolism as a complication.

From the Department of Surgery, Toronto General Hospital.  
Presented at the Symposium on Venous Thrombosis and Prevention of Pulmonary Embolism before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-20, 1946.

It would seem obvious therefore, if thrombosis and clotting can be prevented or is not initiated that pulmonary embolism cannot occur leaving out for the moment, of course fat embolism. Much has been done in the way of clinical care of patients in an attempt to prevent early thrombosis in the vascular tree and from statistics in our own hospital the incidence of thrombosis and pulmonary embolism has been considerably reduced by care of the patient on the operating table and the avoidance of many of the conditions which are conducive to thrombosis. It may be stated emphatically that with the ultimate in view if by any means including giving anticoagulants, thrombosis in the venous tree could be prevented then the solution of pulmonary embolism and the late effects of thrombosis in vessels would be eliminated. It is obvious, of course that there are difficulties and objections to giving anticoagulants with this objective. For example there are groups of patients in whom the administration of an anticoagulant must be undertaken with great caution. In the postoperative group there may be the danger of initiating hemorrhage into the wound or in the operative field. However if the surgeon has in mind that an anticoagulant may be used, if the larger or medium sized vessels are adequately dealt with by ligatures, the danger of this is exceedingly small and this danger can be reduced to an absolute minimum by the careful administration of the anticoagulant and its proper control so that the clotting times and prothrombin times are kept within normal and reasonable limits as advocated in the early studies on these subjects. As well there is the added work and difficulty required in such treatment. However with the proper control and a fine understanding of the objective and the principles, these difficulties are not insuperable and in my experience they justify the end results.

I quite agree, for example in varicose veins with localized thrombosis in a varix, that ligation with continued activity of the patient offers simple and adequate relief of symptoms and almost certainly eliminates or prevents complications such as pulmonary embolism or extension to the main vascular tree. On the other hand with widespread thrombosis

through an uncertain area, it is more difficult to know just where ligation would be effective in loculating the area of thrombosis, to prevent further embolism. In my experience the question regarding the terminology of phlebotrombosis versus thrombophlebitis rests on the knowledge of the pathology of the course of events in thrombosis in the venous tree. As every operator has demonstrated, there may be thrombosis of vessels far in advance of the area suggested by clinical symptoms or physical findings of edema, tenderness, etc. As was explained in an earlier paper I believe these effects are as stated by Dr Homans many years ago the result of the inflammatory reaction to a thrombus which has formed some hours or days previously. These inflammatory changes provide the patient with the cause of his symptoms, and the surgeon, with the findings of thrombosis. It is obvious, therefore, that the extent of the thrombus in the vascular tree is exceedingly difficult to delineate by physical examination. Also phlebography has given only partial satisfaction in delineating the uppermost extension of such a thrombus. As the surgeon has the objective in tying vessels, of loculating the process below his ligature difficulties immediately arise. It is just here that anticoagulants enter into their best atmosphere. The effect throughout the vascular tree is universal and thrombosis, no matter where it is or where its extensions may proceed comes under the influence of anticoagulants. This is just as true in the question of further extension of thrombosis when embolism has occurred in the pulmonary artery as well as in the distal tree. It also has the advantages of having its effect in preventing intracardiac thrombosis (5). Especially is it true in the prevention of thrombosis in surgery either on the arteries (6) or on the veins themselves. I have found it of very great value in doing anastomoses as first done by Blalock, and have used it in 15 cases of the Tetralogy of Fallot. In none of these patients has there been thrombosis at the site of anastomosis as far as one can determine clinically and in none has there been cerebral thrombosis or other cerebral accidents neither has there been any evidence of pulmonary or peripheral embolism.

My evidence as regards the effect of anti-coagulants on venous thrombosis and pulmonary embolism, is based on

1 Four hundred postoperative cases in which patients were treated with an anticoagulant with the objective of cutting down the incidence of thrombosis and consequently of pulmonary embolism. In this group no patient developed peripheral thrombosis and there were no cases of pulmonary embolism. Our experiment obviously includes too few cases to be of much significance except that the treatment was carried out in groups of cases in which from our hospital statistics, thrombosis and pulmonary embolism reached the highest figures recorded.

2 Three hundred and seventy-one cases of venous thrombosis in which treatment by anticoagulants was carried out with the objective of (a) preventing pulmonary embolism and (b) as treatment for the progressive thrombosis in the venous tree with a hope of relieving symptoms and of diminishing the ill effects so obvious and evident following venous thrombosis, such as persistent edema, varicose veins, ulceration, etc. All these patients had typical symptoms and signs of venous thrombosis before treatment was started.

The results of treatment were satisfactory in that none of the patients had pulmonary embolism. Moreover the late effects of the thrombosis were less severe than in a control group. There was less persisting edema, fewer ulcers in a 9 year period and fewer varicose veins during this time.

3 One hundred and forty nine cases of pulmonary embolism treated by anticoagulants. The cases were not selected and were obviously those which had survived the first embolism. In many of these the patients were in extremis at the time of beginning of treatment. Fifty two of these presented a state with which you are all familiar, the patient in alarming shock with no palpable pulse at the wrist, bordering on unconsciousness and with all the serious and dreadful effects of massive pulmonary embolism. From an analysis of histories of the hospital together with the postmortem findings, it has been demonstrated as shown on a previous paper that about 1 in 5 of all cases surviving the first pulmonary embolism is apt

to succumb to future embolisms or from the effect of propagating thrombosis increasing the effect of the original or subsequent embolism.

This group of patients with pulmonary embolisms here reported are those over whom I had control during treatment. In these I had information that the treatment was adequate that the necessary effect on the clotting time or on the prothrombin time was obtained. I saw a fairly large number of similar cases in consultation with other doctors who undertook the treatment of the patients and for that reason these are not included in this report. I have learned subsequently of 3 deaths in this group treated by other doctors. In those in whom I had control of the treatment and knew that the adequate effects on the clotting and prothrombin times had been obtained there were no deaths from embolism in 149 cases. Four of these following the beginning of treatment, had further embolisms which were obviously small in nature because they produced only slight effects on the patient.

It is very impressive to see the effect on a patient with massive pulmonary embolism or with extensive thrombophlebitis or both the improvement that takes place in a matter of very few hours is striking once the effect on clotting time has been obtained. The pulmonary distress with dyspnea, pain etc. together with the embarrassment of heart action are diminished progressively in relatively short time so that within a few hours there is a measurable change and within 24 to 36 hours the alarming symptoms have largely disappeared. It may take several more days before there is complete relief of all symptoms.

During the course of such treatment, it has frequently been observed that there was no obvious swelling or edema of extremities at the time of the massive embolism. However, during the course of treatment one leg has enlarged and showed "quite marked edema" on some occasions at the same time, or within a few days the other leg has gone through similar changes. It is my impression from a study of the pathology that this is no indication of ineffectiveness of the treatment by anticoagulants. I believe that at the time of the embolism there obviously was a massive thrombus at some site in the venous tree

which was so insecurely attached that it broke off and floated as an embolus. However at this stage the inflammatory reaction in the wall of the vein and surrounding tissue had not reached the point where it had produced clinical symptoms. Even under the treatment by the anticoagulant, which can only prevent the further extension of thrombosis, the remaining thrombi have excited the inflammatory reaction which has gone through the changes necessary to healing of the lesion.

To accomplish this effect, in the presence of thrombosis or embolism, it is absolutely essential that the original principles of application of anticoagulants be followed. First, if heparin is administered it must be carried to the point where the clotting time in the patient is kept at or about 15 minutes. It is of no use whatever to give heparin blindly and not know that the effect is being obtained. Because the effect of heparin is so evanescent and because the dose is variable for the individual, the only safe way to be sure of this effect is to do clotting times at short intervals. The next principle is to give the anticoagulant until the healing process in the area of existing thrombosis has reached the stage where no further thrombosis will take place. From our experience in the average patient who is able to get out of bed the patient is kept at rest for 3 or 4 days under the treatment. Following this exercise is encouraged and within 6 or 7 days of the beginning of treatment the patient is urged to be out of bed and exercising actively. When the patient can go through this with some energy probably on the seventh, eighth, or ninth day the heparin treatment is discontinued. If however the patient has some lesion or operation which necessitates staying in bed then the treatment is continued for longer periods up to 3 and occasionally 4 weeks, in such cases as spinal fusion where the patient has not been allowed to be out of bed. It was demonstrated experimentally that a thrombus placed in a vessel is endothelialized well within this period of time and probably that is the best protection against further extension provided the remaining physiology of the patient has reached normal.

Dicoumarol has many advantages over heparin in the way of expense and the ease of

administration. However in my experience it is not quite as effective as is heparin, in preventing extension of thrombosis. It can be used however as an important adjunct. When the patient has begun treatment with heparin for 2 or 3 days, the dicoumarol can be added as a supplement and the patient encouraged to be ambulatory under this treatment with greater ease.

I have not used any of the thrombolytic substances in an attempt to dissolve clots. A few patients were treated with sodium tetrathionate, but not enough to determine its value. In those treated the effect seemed to be excellent.

Dr. Allen at the Mayo clinic has reported (1) a large group in which anticoagulants were administered with excellent effects. Also the group in Scandinavia namely Zilliacus, Hedenius, Jorpes have reported large groups treated with anticoagulants with satisfaction.

One advantage of using anticoagulants also is that in a patient who is on the verge of collapse the treatment involves very little disturbance and in my experience the effect has been dramatic. This may have advantages over operative procedures where either injection or operation involves the undertaking of more active and energetic measures for which a patient may be in very poor condition.

#### CONCLUSIONS

1. Intravascular thrombosis and clotting can be prevented by anticoagulants, heparin, and dicoumarol.
2. If thrombosis and clotting have occurred, anticoagulants in appropriate doses will prevent further extension of the process.
3. If a patient is adequately treated with anticoagulants following pulmonary embolism, the chances of survival are excellent.

#### REFERENCES

1. ALLEN, E. V. *Proc. Mayo Clin.*, 30: 302-307.
2. JORPES, E., AND BERGSTROM, S. *Zachr. physiol. Chem.* 1936, 244, 253.
3. HEDENIUS, P. *Acta med. scand.*, 1936, 83, 434.
4. HOSKINS, J. J. *Internat. Chir.* 1938, Vol. 6.
5. MURRAY GORDON D. W. *Brit. J. Surg.*, 1940, Vol. 27.
6. *Idem.* *Arch. Surg.* 1940, 40, 307-315.
7. MURRAY GORDON AND MACKENZIE, R. *Am. J. Surg.* 1941, 57, 414-428.
8. ZILLIACUS, H. *Specific Treatment of Thrombosis and Pulmonary Embolism with Anticoagulants, etc.* Supplement to *Acta med. scand.*, 1940.

# CARCINOMA OF THE COLON

## A Statistical Analysis

WILLIAM J VYNALEK, M.D F.A.C.S Berwyn Illinois, LESLIE L. SAYLOR M.D Topeka Kansas, and ROBERT SCHREK M.D., Hines, Illinois

**T**HIS paper represents a study of all the patients with carcinoma of the colon not including the rectum and sigmoid admitted to the Veterans Administration Hospital, Hines Illinois from 1931 to 1945 inclusive. A similar review is being made by other workers at this Hospital on carcinoma of the rectum and sigmoid. During this 15 year period this institution has been the tumor center for all Veterans hospitals of the Midwest and a large volume of material and records is available for study and analysis.

The purpose of this paper is to add to the growing number of cases being reported so that totals of statistical significance may be amassed to analyze the material and to attempt to draw pertinent conclusions. Each record of admission was studied with reference to age, duration of symptoms and laboratory findings, surgery operative mortality effects of irradiation pathology and numbers and length of survivals. It is a difficult task to take a maze of data and present conclusions in a simple readable form. Follow up records are practically one hundred per cent complete because of government pension regulations and the persistent efforts of a specially created tumor registry section.

There were 131 279 admissions of all types during this 15 year period and 16 097 (primary admissions) of these were patients with carcinoma. In 1330 of these admissions, the primary lesions were in the large bowel colon, and rectum included. In Figure 1 are shown

the sites of predilection. Many writers have repeatedly stressed that two-thirds of all carcinomas of the large bowel involve the rectum and rectosigmoid and can be felt by the finger of the careful examiner. These and certain others in the lower sigmoid likely to be missed by barium enema can be seen through the proctosigmoidoscope and specimens obtained for biopsy study. Points of flexure and the cecum have a moderately high incidence considering their short span. They presumably receive the maximum mechanical and chemical trauma which might play a rôle in carcinoma of the colon.

The close similarity in the frequency of the sites of involvement in our patients with those reported by others is shown in Table I and is of biological significance.

This study concerns itself primarily with the 486 patients who had involvement above the rectosigmoid. The histories were divided into two groups before and after January 1 1941. This division is convenient because it gives data as to 5 year cures and because of the adoption of improved methods in anesthesia and in preoperative and postoperative care in the latter period. These included better colon decompression, the various sulfa drugs later penicillin, and liberal use of blood transfusions and continuous gastric suction. Their salubrious effect on surgical mortality and morbidity seems clinically and statistically to have ushered in a new era in colon surgery.

In Figure 2 are given percentages of resectability for the entire period. In the term resectable are included only those cases in which a cure can reasonably be anticipated following removal of all gross carcinomatous tissue. It includes those in which adjacent resectable organs and lymph glands are involved. A non resectable lesion implies distant metastatic spread to liver lung bone brain or non removable lymph glands. In the nonresectable

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3. HEDENIUS, P. *Acta med. scand.*, 1935, 83: 434.
4. HOWANS, J. J. *Internat. Chir.* 935, Vol. 6.
5. MURRAY GORDON D. W. *Brit. J. Surg.* 1940, Vol. 27.
6. *Idem.* *Arch. Surg.* 943, 40: 307-325.
7. MURRAY GORDON AND MACKENZIE, R. *Am. J. Surg.* 1942, 57: 414-422.
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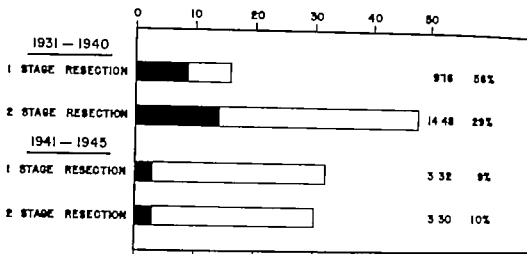


Fig. 5. Number of one and multistaged resections of carcinoma of colon and operative mortality

Resections in all segments of the colon reflects this statistically significant lowering of the operating mortality but the right half of the colon is especially favored. Pack and Livingston state that an operative mortality of 10 to 15 per cent can be expected if there is no selection of cases. However with some clinics reporting a surgical mortality of less than 4 per cent, there is ample room for improvement in our results.

Figure 4 shows the operative mortality by years. The change began gradually during 1940 and is striking thereafter. It cannot be attributed to improvement of surgical technique.

In Figure 5 it is noted that resections were done in one stage in only 25 per cent of the 1931-1940 cases, but in 51.6 per cent in the 1941-1945 group. Although the mortality in single and multiple stage procedures in the 1941-1945 group is about the same the increased number of one stage procedures possible is of great significance since it reduced the period of hospitalization from 2 months or more to 3 weeks or less, and it added to the comfort of the patient. With the present day shortage of hospital beds, the successful shift to one stage procedures is of tremendous value and is in line with the general trend throughout the nation. The good reason for the early tendency toward multiple stage procedures in the 1931-1940 period is indicated by the mortality rate of 56.2 per cent for the

one stage, contrasted with 29.1 per cent for the other.

In Figure 6 the survivals of 5 to 15 years following resections in the 1931-1940 group are shown. Of the 281 colon cases admitted in this first period, omitting those resected or explored elsewhere and sent here for routine x ray therapy or terminal care 193 candidates were left for possible resection. In 64 resection was accomplished and 21 or 32.8 per cent of the resectables are alive today. Of the resectables who survived the operation in that first period when the mortality rate was so high, 51.2 per cent are alive over 5 years. With the lowered mortality rate of the second period, it is to be expected that approximately 50 per cent of the resectables can be offered a 5 year cure and this is the approximate figure of the most successful tumor clinics. Post operative prognosis is best in right side lesions.

In 41 cases resection was done elsewhere in the 1931-40 group and the patients were sent to Hines for routine x ray therapy or terminal care. Of these 13 or 32 per cent, were alive 5 to 15 years later. Improvement in the surgical mortality rate is gradually reaching a point where for further progress the only means of obtaining more cures is to make earlier diagnoses to increase the percentage of resectables. Herein lies considerable room for improvement.

Figure 7 presents a comparison of the survival of patients following curative resection

## VINALEK ET AL. CARCINOMA OF COLON

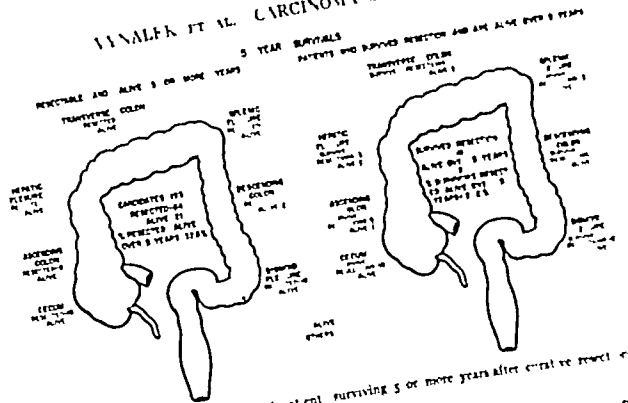


Fig. 6. Number and percentage of patient surviving 5 or more years after curative resection of the colon, 1931-1949

for carcinoma of the colon in 1931 to 1940 and in 1941 to 1945. The method of construction of the graph is shown in Table II.

During 1931 to 1940 there were 64 patients with resections. Of these 64 per cent survived 1 month after the operation, 44 per cent 3 years and 30 per cent 5 years. To compare the survival of the patients operated on during 1941 to 1945 it is necessary to analyze the data by years as shown in the table. In 1941 10 patients were resected. Of these men 9 survived 1 month and 7 men survived 4 years. As the cases were analyzed early in 1946 the 1941 patients were followed only 4 years. The 1942 cases 3 years, and for the 1945 patients only the 1 month follow up can be used. The results obtained on the 1941 to 1945 patients can be totaled as shown in the table and the percentage of survivors calculated for the entire 1941-1945 group. By this method it is possible to obtain survival curves for the patients that have been operated on within the last five years.

It is seen from Figure 7 and Table II that there has been considerable improvement in the survival of patients after operation. A large part if not all of this improvement is evidently due to the fact that a greater percentage of patients died postoperatively in

1931 to 1940 than in later years. To determine whether the improvement in survival is due exclusively to the decrease in postoperative deaths it was necessary to construct Figure 8 which shows the follow up of patients who survived 1 month or more after resection. Even after the postoperative deaths are excluded there is still a higher percentage of survivals in the patients operated on in 1941 to 1945. This suggests that surgeons in recent years were capable of removing completely the

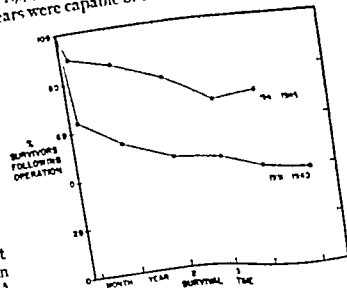


Fig. 7. Survival curves of patients with curative resections for carcinoma of the colon.

## SURGERY GYNECOLOGY AND OBSTETRICS

TABLE II.—DATA FOR THE CONSTRUCTION OF 1931-1940 AND 1941-1945 SURVIVAL CURVES

	No. of patients with curative resections	month		year		year		3 year		4 year		5 year	
		No. survived	No. followed	No. survived	No. followed	No. survived	No. followed	No. survived	No. followed	No. survived	No. followed	No. survived	No. followed
1931-1940	64	41	64	34	64	30	64	28	64	26	64	25	64
Per cent survivors	100	64		53		45.3		43.8		40.6		39	
1941	10	0	10	8	10	8	10	7	10	7	10	30	
1942	14		14	10	14	9	14	9	14	7	10		
1943	3	3	3	3	3	3	3	3	3	3	3		
1944													
1945	3		3										
1941-1945	62	50	62	43	62	37	62	34	62	7	62	30	
Per cent survivors	100	80.6		69.3		59.7		54.8		11.3		48.4	

tumor in a higher percentage of cases than formerly

## SYMPTOMS

These patients were all veterans the majority from World War I. They were all males, the youngest was 21 the oldest 77 and in most cases the carcinomas occurred between the ages of 45 and 50 years. Symptoms were present from sudden onset to several years before a diagnosis was made. An average of 6 months passed between the onset of symptoms and hospitalization. In those found to be resectable the average duration was 6.3 months, in the nonresectable group 9.7 months. Lahey states that at that clinic the interval for all cases has been 9 months with no appreciable improvement in recent years.

There are no pathognomonic symptoms of cancer of the large bowel but sufficient warning is given to justify study which will usually lead to an accurate diagnosis. Unfortunately many patients still undergo trial medical treatment, hemorrhoidectomies, or appendectomies before diagnostic studies are instituted. The most common and suspicious complaints are enumerated as follows (Fig 9)

1. *Abdominal distress* frequently marked in the region involved, though often enough to cause confusion, obstruction of the left colon may cause most distress in the dilated right bowel. The character of the distress varies and seems to be directly related to the lesion tends to be located more toward the left with its semisolid stool and a tendency toward the formation of annular constricting lesions, obstructive pain occurs with colic, nausea, and vomiting. Discomfort is usually aggravated by eating and relieved by bowel movements especially if the stools are kept liquefied by cathartics. In 7 per cent of left colon lesions an acute obstruction ushered in the first sign of trouble. Fourteen per cent of splenic flexure lesions began in this manner. Gordon Heyd states that 5 per cent of sigmoid tumors begin with acute obstruction. Carcinoma of the cecum is frequently diagnosed clinically as an appendicitis, and appendectomies had been performed on 19 of the cecal cases just before admission to this hospital. Usually the surgeon recognized that there was cecal pathology present at operation.

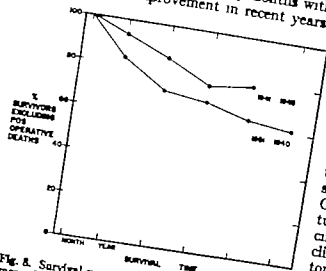


Fig. 8. Survival curves of patients surviving one month or more after curative resections for carcinoma of the colon.

## VYNÁLEK ET AL. CARCINOMA OF COLON

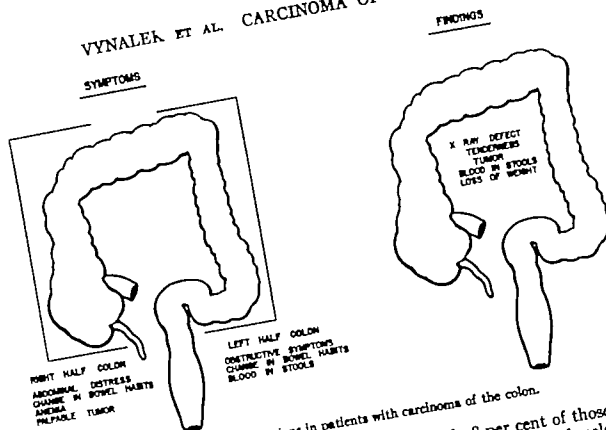


Fig. 9. Symptoms and signs in patients with carcinoma of the colon.

2 *Change in bowel habits* is an important and frequent symptom elicited only by a carefully taken history. Constipation is common regardless of the location of the lesion but more pronounced and annoying in left half colon pathology. It frequently alternates with diarrhea, often because the patient doses himself with cathartics at regular intervals. How ever diarrhea instead of constipation may be the patient's complaint.

3 *Mass in the abdomen* was mentioned by the patient himself in 25 per cent of the cases with involvement of the cecum or ascending colon, 6 per cent of the sigmoid group and rarely by others. Gordon Heyd states that 10 per cent of the people with carcinoma of the cecum discover a lump in the right side before consulting a physician.

4 *Weight loss*, contrary to the usual belief is often an early sign and is present in practically all. It may occur rapidly but ordinarily appears slowly. From 16 to 75 pounds loss of weight was common but in some patients with a violent obstructive onset there had been no previous loss.

5 *Blood in the stools* is mentioned in the histories of 33 per cent of patients with lesions in the left half of the bowel with their tendency toward the appearance of conspicuous red

blood but only 8 per cent of those with right colon involvement mentioned melena. Unfortunately the record often fails to note any questioning on this important point.

6 *Other complaints.* Anemia, of an intense degree is always stressed in the literature in connection with cancer of the cecum. It is spectacular and impressive when it occurs but was uncommon in this series. The red count was usually normal even in the cecal cases until late in the disease when curative surgery was impossible. Only 13 of the 102 cecal cases had a red blood count below 3,000,000. In only 2 patients anemia and weakness were the main complaints. Of the 53 ascending colon lesions 6 had a red blood count below 3,000,000.

Indigestion, weakness, nausea, vomiting, anorexia and fever were frequently mentioned.

## FINDINGS

1 *A palpable mass* was noted at the initial examination by the Veterans Hospital physician in 81 of the 102 cecal cases, 14 of the 53 ascending colons, 20 of the 27 hepatic flexures, 26 of the 55 transverse colons, 11 of the 27 splenic flexures, 22 of the 49 descending colons, 87 of the 173 sigmoids averaging 69 per cent.

This is a rather high figure compared to that of others who mention 10 per cent to 33½ per cent as having palpable masses on the right, seldom on the left, and again indicates that many of our patients arrive late. However the palpation of a tumor does not necessarily indicate a hopeless process.

2 *Tenderness* of varying degree is frequently present at the site of involvement.

3 *Occult blood* in the stool was surprisingly seldom searched for but usually positive if the tests were ordered.

4 *Barium enema x ray studies* practically always revealed a suspicion-arousing defect which was usually properly interpreted. The segment where pathology was most often overlooked was the sigmoid in which x ray studies missed the lesion in 9 per cent of these cases.

5 *Proctoscopy* following digital rectal examination is without a peer in lesions up to 23 centimeters from the anus.

#### PATHOLOGY

Pathology was proved by microscopic studies in 68 per cent of the series. Autopsies were secured in 145 (37%) of the 390 known dead. Adenocarcinoma or a colloid modification was the usual finding occasionally an undifferentiated carcinoma. In lesions thought by the operator to be nonresectable a large firm mesenteric gland was frequently taken for biopsy and the pathologist's report was usually negative for carcinoma. This implies that neither surgeon nor pathologist is able to diagnose cancer of the lymph nodes grossly or to differentiate from inflammation. A frozen section at operation might prevent classifying a condition as inoperable.

Operative deaths were usually due to peritonitis, embolism, pneumonia, shock and myocardial damage. One cecal case succumbed to gangrene of the terminal small bowel after resection due to thrombosis of the ileocolic artery.

Multiple polyposis was noted by the pathologist, surgeon, proctologist or roentgenologist in 11 (2%) of the 486 patients of this study. The primary carcinoma in these cases was located as follows: cecum, 2; transverse colon, 3; splenic flexure, 1 (this patient also

had a concomitant cancer of the hepatic flexure); descending colon, 4; and sigmoid, 1.

In 3 instances in this entire series multiple cancers of the large bowel were found. Perforations into small bowel and stomach were noted in a few instances. Bladder attachment, but not perforation, was occasionally mentioned. Hydronephrosis secondary to orcinomatous obstruction of the ureter seldom occurred. Abscesses often complicated the picture, and required preliminary drainage.

#### IRRADIATION

Irradiation was used frequently as a "palliative" measure in the earlier years with no outstanding improvements. Doses of a total of 100 to 6000 roentgens are reported, but deep therapy is no longer considered of much value for lesions above the rectosigmoid. It was felt that x ray therapy following drainage of abscesses definitely shortened the period of waiting preparatory to radical surgery.

#### AVERAGE SPAN OF LIFE

In the inoperable cases death occurred 11 months after onset of symptoms, a speed which suggests a vicious process. In those having a simple exploration death occurred 6 months after operation and 16 months after onset of symptoms. Those who underwent palliative resections lived 17 months after operation. As had been shown previously the majority who died after attempted curative resections did so in the first and second years but some died of recurrence as late as 6 years following operation.

#### SUMMARY

A survey has been made of the 486 cases of carcinoma of the colon seen at Hines Veterans Hospital, Hines, Illinois, during the past 15 years. The sites of predilection are almost identical with large groups reported elsewhere. The resectability rate of 35.6 per cent is low. The drop in the mortality rate following surgery from 35.9 to 9.7 per cent in recent years is encouraging. The 5 year survival rate approaches the 50 per cent figure of the larger clinics. More one stage procedures are being done in recent years. A review of pertinent data is given.

REFERENCES

1. ARNELL, IRVING Surg. Gyn Obst., 1934, 58 430.
2. BEHLM, D S Radiology 1944, 42 539-544.
3. BOHMER, E. J., and HAMMON F J Surg. Clin. N America, 1946, 26 551-552
4. COLLIER, F A., and VAUGHAN Ann. Surg., 1945 121 395-411
5. HIRSH, C. G Am. J Surg., 1945 67 479-487
6. MAYO, C. W Proc. Staff Meetings, Mayo Clin., 1941, 16 67
7. MAYO C. W. and SCHLICHT, C. P Surg. Gyn Obst., 1943, 74 83-91
8. PAGE, G T., and LIVINGSTON E. M Treatment of Cancer and Allied Diseases. Vol. 2 New York Paul B. Hoeber Inc., 1940
9. PRANKERTON J DEJ., and DIXON D F Surg Gyn. Obst., 1934, 58 463-464.

# ANTICOAGULANT THERAPY IN THROMBOSIS

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THE specific treatment of thrombosis seems to demand the use of anticoagulants. Thrombosis arises through intravascular clotting of the blood a pulmonary embolism is simply a fibrin clot detached from the walls of a peripheral vessel. In the past considerable attention has been paid by such men as Morawitz, Howell and others to the possibility of using anticoagulants to prevent thrombosis. Although heparin the natural anticoagulant of the body itself was discovered in 1916 by MacLean<sup>1</sup> working with Howell, very little benefit came of it during the next 20 years. As early as 1933 Charles and Scott of Toronto elaborated a method for large scale extraction of heparin from liver and lungs and the chemical nature of the drug was elucidated 2 years later (Jorpes). Thanks to these efforts heparin has been made available Crafoord of Sweden and Murray of Toronto were the two surgeons first to use heparin clinically

## PROPHYLACTIC USE OF HEPARIN

During the years 1935 to 1940 it was clearly demonstrated that postoperative thrombosis and pulmonary embolism could be prevented if heparin were administered in adequate doses over an adequate length of time. In Sweden Crafoord Wetterdal and Leissner heparinized about 800 patients postoperative-

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For references see Jorpes, E. Heparin in the Treatment of Thrombosis, 2d. ed. New York and London Oxford University Press, 1946.

ly and in Canada Murray reported the results in treating 400 patients in the same way. Although a high incidence of thrombosis was expected 2 or even 4 per cent, practically no complications occurred. Two hundred fifty milligrams of heparin a day was found to be an adequate dosage. In the Swedish series heparin was given to 657 patients, the treatment being started on the second or third day after operation or childbirth.

Similar successful results have been reported from the use of dicoumarol. Barker and his co-workers at the Mayo Clinic administered dicoumarol postoperatively to 1,000 patients and in Sweden Bruzelius treated 1,600 patients in the same way. In each series there was a marked decrease in the number of thrombotic complications.

Because of the expense involved and the risk of hemorrhage there will however, be no question about giving heparin or dicoumarol to every patient after operations or childbirth.

Prophylactic treatment with anticoagulants must be restricted to cases in which the risk of a thrombosis occurring is considerable e.g. after parturition in a patient who has had thrombosis during pregnancy or after operations on patients who have suffered from earlier repeated thromboembolic attacks after operation childbirth, or miscarriage. In such instances heparin has frequently been used in Swedish hospitals, starting with 50+50+50+100 milligrams of heparin a day at 8, 12, 16 and 20 hours from the second or third day onward for 5 to 8 days, until the patient is able to get up and can move about freely.



TABLE IV—THE FREQUENCY OF THROMBOSIS AND EMBOLISM AFTER SURGICAL OPERATION AND CHILDBIRTH IN PATIENTS ALLOWED FREE MOBILITY AND EARLY AMBULATION

Author	Place	Years	Surgical cases	Thrombosis		Fetal pulmonary embolism		
				Number	Per cent of the whole material	Number	Thrombosis	Per cent of the whole material
Johansson and Holmstedt	Göteborg	1933-1944	45,376	246	54	84	31	0.26
Westerberg	Göteborg	Q3 1944	43,737	274	56	96	21	12
Eklund	Stockholm	Q3 1944	70,000	143	73	30	11	0.26
Fallinder	Örebro	1937-1941	36,480	226	63	33	23	0.14
Zilliacus	Stockholm	1940-1945	126,524	646	51	134	204	0.29
Dahl-Iverson	Copenhagen	1943-1944	796	70	56			
Keller	Zürich	Q3-1943			Absent			

only were quite without discomfort. The 13 remaining had symptoms in the leg. All suffered from swelling of the lower part of the leg in most instances moderate to severe. Five had in addition swelling of the thigh. 3 had severe pain and a feeling of heaviness in the leg.

At Bauer's clinic, where all cases except those with thrombosis diagnosed before their arrival at the hospital received early heparin treatment, the process did not progress beyond the calf in 80 per cent of the cases and it stayed in the calf in all cases where heparin was given before a phlegmasia had developed. From Zilliacus's data on conservatively treated cases, it appeared that thrombosis spread to the thigh in 80 per cent of the cases. In his series of cases treated with anticoagulants—the cases presumably were not treated in the most efficient manner as far as early diagnosis and therapy were concerned—the process spread to the thigh in spite of the specific therapy in 55 per cent of the cases.

It was noted by Zilliacus that when the thrombosis had extended to the thigh there was little difference between the conservatively treated cases and those treated with heparin. Swelling of the calf with discoloration induration with large varicose veins were present in most of the cases of both groups. Ulcus cruris occurred in 11 of 154 cases treated with heparin and submitted to follow-up examination. The result in this group was the same as that among the conservatively treated cases. An important difference, however, as compared with the conservatively treated cases,

was that bilateral symptoms occurred only in 3 cases instead of in 33 per cent as found among the conservatively treated cases.

The sequelae in the patients with thrombosis of the calf who were treated with heparin were generally mild. Of 130 such cases 66 were completely free from symptoms, while the remaining patients showed only swelling of the calf after exertion. Only 1 patient in this group suffered from ulcer of the leg.

The specific therapy had, thus, in cases in which the thrombosis remained localized to the calf permanently saved the patients from a chronic, painful, more or less severe, disablement.

#### THE TECHNIQUE OF ADMINISTERING HEPARIN

In most of the Swedish clinics heparin administration is started as follows: 350 to 450 milligrams a day are divided into four intravenous injections which are given at 8:00 a.m., 12:00 m., 4:00 p.m. and 8:00 p.m. or 10:00 p.m. in amounts of 125, 100, 100 and 125 milligrams. On the third day the dose is lowered, e.g. to 300 to 350 milligrams. In case dicoumarol is given on the first day heparin is omitted as soon as an appropriate prothrombin level is reached. The same scheme is followed even in case of an acute pulmonary embolism. The use of dicoumarol alone is not permitted because it has repeatedly been observed that thrombosis in the calf proceeds to the thigh in spite of dicoumarol treatment. In fact heparin treatment has aborted the disease before the full action of dicoumarol

## JORPES ANTICOAGULANT THERAPY IN THROMBOSIS

has evolved. Patients are consistently asked to move about in the bed as much as possible even on the second day and early ambulation is routine. Thus the average time in bed in Bauer's series was 4.6 days and in the other Scandinavian series 1 week to 10 days instead of 5 to 6 weeks as found in the series of patients treated conservatively.

Treatment now varies under different conditions. In small hospitals where no thrombin analyses can be made only heparin is used. The time of coagulation of the blood is as a rule not determined. There seems to be a very small risk in using heparin without blood analyses. As to the use of heparin the contraindications seem to be very few. The risk of hemorrhages occurring is minimal. Hemorrhage is to be considered in the prophylactic treatment of postoperative cases but it has proved to be very insignificant in the ordinary treatment of leg thrombosis and pulmonary embolism.

### OTHER THERAPEUTIC MEASURES

The question arises whether similar results as those reported here also could be obtained by other means, such as through active movements and early getting up from bed. Sympathetic block causing vasodilatation in the leg and surgical ligation of the larger veins.

It is evident that exercises under medical supervision and the early getting up of patients

can reduce the incidence of thromboembolism. The incidence of thrombosis can be reduced to about 0.6 per cent in surgical clinics as is evident from Table IV.

Even in the Scandinavian series the mortality rate in thrombosis is still about 20 per cent, the same figure as that found at the beginning of this century in the surgical clinics of Germany and Austria as well as at the Mayo Clinic in this country during recent years. Consequently, there is a need for specific therapy.

The principles to be applied will at least partly depend upon the prevailing conditions. Venous ligation has in larger surgical units in this country given extraordinarily good results. In clinics where the prothrombin level of the blood can be adequately followed, dicoumarol has been used either alone or in conjunction with heparin. In all smaller hospital units, like that of Bauer in Sweden, heparin treatment can be applied successfully. It is in fact to be resorted to in every case of early peripheral leg thrombosis and in acute pulmonary embolism.

The relative value of the different methods for the treatment of peripheral leg thrombosis or pulmonary embolism will of course become the subject of closer study during the next 5 to 10 years. At present we can confine ourselves to the statement that physiology and biochemistry have given us specific means which are highly effective in the treatment of thrombosis.

# THE TREATMENT OF CHRONIC NONTUBERCULOUS PULMONARY ABSCESSSES BY HIGH VACUUM SUCTION DRAINAGE

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**D**URING the past few years there has been progressive improvement in the management of chronic pulmonary abscesses. Lobectomy or occasional external drainage is now being employed with excellent results. It is felt, however, that in some well selected cases equally good results might be obtained by simpler means.

Often simple external drainage will fail and lobectomy despite the excellent results, remains a formidable procedure which may result in the loss of some functional pulmonary tissue which demands much of the time and energy of a skilled thoracic surgeon, an experienced anesthesiologist, and a trained surgical team as well as the services of a blood bank. No time need be spent, therefore, in advancing the desirability of a simpler method of treatment.

The purpose of this brief communication is to describe what may be such a method of treatment for certain carefully selected cases of chronic pulmonary abscess. To date, it has been employed in only 10 cases, but the results in all in which the method has had a fair trial have been so good that it seems justifiable to place the small series on record in the hope that other surgeons may be encouraged to test the method and that a group large enough to be of statistical significance may be accumulated for analysis within a reasonably brief period of time.

The method proposed is an application of the continuous high vacuum suction drainage described by Neville in 1939 for the management of chronic empyema thoracis. He was confronted with a patient slowly wasting away with chronic empyema of 2½ years duration.

Within 4 weeks after thoracostomy and the institution of high vacuum suction drainage, the previously extensive empyema cavity had been reduced to a straight tract the size of the drainage tube, and within 7 months the patient had returned to work and was apparently completely well.

When this method came to my attention shortly after it had been described, it struck me that it might be useful in certain types of pulmonary abscess which in chronicity and other respects could be considered analogous to chronic empyema. The validity of the method as applied to chronic pulmonary abscesses seemed enhanced by a careful study of pulmonary lobes resected for this cause. In some of these cases the conclusion seemed warranted that a cure might have been obtained by simpler means, with greater economy of time and personnel, with conservation of pulmonary tissue, and with less risk to the patient.

The term chronic in this connection is used to designate that type of pulmonary abscess which has existed sufficiently long to show roentgenologically a definite fibrous tissue capsule. Not all observers, of course, would agree with this definition but as the basis of selection of cases for high vacuum suction drainage, it is an entirely adequate point of departure. If the zone of surrounding fibroplastic tissue is slight as in the type of abscess which in some quarters might be termed subacute or even acute, the abscess is given the opportunity to heal spontaneously or simple external drainage is employed. If on the other hand a considerable degree of lobar fibrosis and bronchiectasis is present, lobectomy is regarded as indicated.

The selection of cases for this method of treatment rests on still other criteria. The abscess must be single. It must be peripherally

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Fig 1 Roentgenogram taken prior to operation revealing a spherical mass peripherally placed in the lower part of the upper lobe and in contact with the parietal pleura.



Fig 2 Lateral projection corresponding to Figure 1 showing the lesion to occupy the posterior part of the upper lobe.

located. A pleural bridge must exist, so that satisfactory external drainage can be instituted without traversing the pleural space. If malignancy is a possibility and if the usual diagnostic measures do not absolutely exclude it, exploratory thoracotomy and biopsy must be carried out. Finally the lesion must be observed sufficiently long to make certain that the cavity is not decreasing in size spontaneously or under conservative methods of treatment. If these various criteria are met, the case is regarded as suitable for high vacuum suction drainage.

The operation is preferably done under intercostal nerve block. If preliminary aspiration reveals the existence of an adequate pleural bridge the lesion is approached directly. If there is doubt regarding or definite evidence against the existence of such a bridge, exploratory thoracotomy is carried out by way of a small strategically placed incision and the site of the skin incision for drainage is determined by the location of the pleural bridge.

If no bridge is found the method of treatment contemplated must be discarded in favor of lobectomy.

The abscess cavity is entered after resection of a small segment of overlying rib and a drainage tube of appropriate size is inserted and made air tight by the use of flanges and sponges. Patent bronchial openings in the walls of the cavity are fulgurated but if this procedure be necessary suction drainage is not instituted until they have closed.

Neville described the machine which he had devised for his patient, but in hospitals equipped with built in suction systems no special machines are necessary. The suction apparatus is set at between 5 and 10 inches of mercury and the level is decreased only if the patient complains of a sense of severe pulling in the chest or if hemorrhage of serious degree occurs. The routine described by Neville is carried out with minor modifications. Thoracoscopic inspections of the cavity are made at weekly intervals and the measurements are

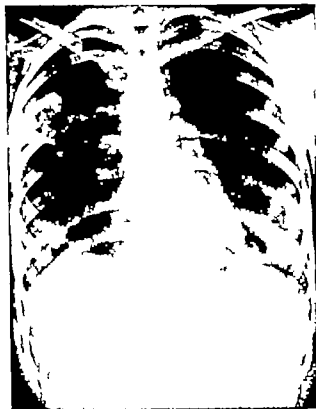


Fig. 3. Roentgenogram taken after operation shows the drainage tube passing through the resected segment of the fifth rib and the decrease in density of the lesion following suction therapy. The abscess cavity previously invisible is now quite apparent.

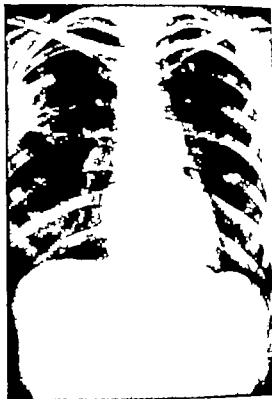


Fig. 4. At the time this film was taken the tube had been removed although the film indicates that a cavity may still be present. This is due to the peculiar arrangement of the fibrous tissue remaining in the upper lobe. The cavity has been observed fluoroscopically to flatten out against the parietal pleura and become obliterated. This patient has been asymptomatic for over 3 years and bronchograms reveal no abnormalities.

recorded at the same time for comparative purposes.

As soon as the patient is sufficiently improved to leave the hospital, he is instructed in the use of a small suction machine (available on rental from a commercial firm) which is similar to the standard tonsillectomy suction machine but is mechanically superior. It is capable of maintaining high vacuum suction for prolonged periods, with only brief intervals of nonoperation for the purpose of cooling the motor. The patient returns at intervals as necessary for observation until the abscess cavity is obliterated.

In every case in which a patient was treated by this method the clinical course has been the same. Following closure of the fulgurated bronchial orifices, if fulguration has been necessary and the institution of high vacuum suction drainage the size of the abscess cavity decreases rapidly and striking changes occur in the granulation tissue lining it. Previously

pale and edematous, it rapidly assumes a healthy appearance and many new blood vessels are observed. The sites of the bronchial openings gradually disappear and the medial wall of the cavity approaches, and finally flattens out against, the parietal pleura. This important development in the healing process is hindered when the cavity is packed but is encouraged by the suction method of treatment.

In about half of these cases suction was discontinued for periods of as long as 2 weeks, as a control measure. Invariably the diminution in the size of the cavity previously progressive, was halted and was not resumed until suction was reconstituted.

The 10 patients in this series ranged in age from 20 to 65 years, every intervening decade being represented. The duration of illness prior to treatment had ranged from 3 to 18 months. Suction drainage was necessary for

an average of 3 weeks. In no instance in the series did it fail to bring about prompt decrease in the size of the cavity eventual complete obliteration and corresponding improvement in the condition of the patient. No untoward results of any kind have been connected with its use. The earliest of the cases has been followed for a 2 year period and all other patients have been followed for at least a year. During the period of observation there has been no recurrence in any case though, because of the short time interval since treatment, the possibility of recurrence cannot be entirely discounted. Roentgenologic exami-

nation after obliteration of the abscess cavity has revealed in all cases persistence of shadows indicative of residual fibrosis.

Although the present series, as stated, consists of only 10 cases, the results secured seem to justify this preliminary report, chiefly because it is hoped that others will test high vacuum suction drainage in chronic nontuberculous pulmonary abscess and will report their results.

#### REFERENCE

Neville, J. V. H. *Surg. Gyn. Obst.*, 1939, 69, 240-246 (Aug.)

## RATE OF GAIN IN STRENGTH IN SUTURED ABDOMINAL WALL WOUNDS

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**I**N recent years a great deal of attention has been given to early ambulation following laparotomy. The strength of a wound immediately following the placement of sutures depends primarily on the total number of sutures which have been placed and upon the ability of the tissues to hold the sutures as well as the tensile strength of the suture material employed and the manner of placement of those sutures. A review of the literature on wound healing yields very little reference to the rate of strength gain across incisions through the rectus muscle and fascia following approximation of the muscle and fascia with interrupted silk sutures. In the present study our objective is the determination of the amount of healing at different periods of time by measuring the tensile strength of the healing wound with non-absorbable sutures remaining in place.

According to Howes and Harvey the rate of strength gain in a healing wound resembles the curve of growth in general (4). There are 2 periods in the strength gain of a healing wound, the first, the so-called 'latent period' (2) lasts from 3 to 5 days. In the second period of the curve of normal healing strength increases rapidly and this phase continues until the wound is completely healed. Microscopically this period is associated with the process of fibroplasia (5).

#### METHODS

For the purpose of this experiment commercially raised healthy white rabbits were employed. These rabbits were maintained throughout the experiment, on a stock rabbit diet consisting of rabbit pellets and water. They were kept on this diet both before and after operation, and no attempt was made to add or subtract any dietary factor which would enhance or hinder the process of wound healing. Also no attempt was made to choose a uniform size, weight, or sex. Both medium and large healthy rabbits were employed.

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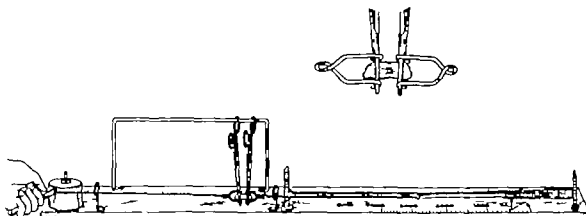


Fig. Tensiometer employed for determination of strength of tissues. The strip of tissue to be tested is gripped in two forceps which remain perpendicular to the line of tension. The tension is slowly increased by turning a large spool connected by a wire to one of the forceps on the

tissue. The other forceps is attached by wire to the spring. A rider point is moved over the calibrations of the guide bar by the stretching of the spring, and reads the point of maximum tension. Control tissues repair ruptured mid-ay between the clamps.

The rabbits were anesthetized by the injection of a necessary amount of aqueous sodium pentobarbital into the marginal vein of the ear. Roughly 35 milligrams of the drug were used per kilogram of weight. The hair was removed from the abdomen with barium sulfide and the skin washed thoroughly with water to remove all traces of the chemical. No marked skin reactions were observed from the use of the barium sulfide as a depilatory. Skin sterilization was obtained by the use of Novak's solution (6) and sterilization was maintained by the use of sterile towels as drapes around the operative field. Rubber gloves were not worn during the operation but operations were preceded by a 10 minute scrub with soap and water followed by rinsing in aqueous zephiran solution. Surgical instruments, heat sterilized prior to the first operation of the day were kept in a solution of aqueous zephiran 1:1000 between cases. The No. 000 and No. 0000 black silk (Dehnated) used for closure was autoclaved at 250 degrees for 10 minutes. All suture material was new and none of it was autoclaved more than once.

A midline skin incision roughly 14 centimeters long was made beginning at a point just below the xiphoid process and carried down to the lower midabdomen. This incision exposed the linea alba. At this point the superficial fascia was separated either to the right or to the left of the midline and one an-

terior rectus sheath was exposed. An 11 centimeter incision was then made through the midanterior rectus sheath, rectus muscle, posterior rectus sheath, and peritoneum, usually about 1 centimeter from the midline.

The closure of the rectus incision was made by interrupted sutures. No. 000 silk was used in some rabbits, and No. 0000 silk was used in others. The anterior rectus sheath, rectus muscle, posterior rectus sheath, and peritoneum were all included in interrupted through-and-through stitches placed at regular 5 millimeter intervals. The bite included 2 millimeters of tissue on each side, and knots were tied with one square knot just tight enough for apposition without blanching. The skin was closed by means of a continuous suture of black cotton.

The rabbits were studied at varying times during their periods of wound healing. Some were sacrificed immediately and their wounds measured for tensile strength, others were sacrificed at 24 hours, 48 hours, 72 hours, 7, 9, 11, 15, 21 days and 6 weeks. No fewer than 6 rabbits were used for any single period's determinations except 9 days, and as many as 18 rabbits were used for some. In all, a total of 128 rabbits was used in this series, roughly 20 to 24 determinations were made on each rabbit, a total of roughly 2400 separate observations in all.

The rabbits were killed by the intravenous administration of 10 to 15 cubic centimeters

TABLE I.—TENSILE STRENGTH OF SILK SUTURED ABDOMINAL WOUNDS IN RABBITS

Ratio of strength of wound to strength of previously undisturbed side			
No. of rabbits	No. of observations	Mean ratio per cent	Standard deviation
0	0	0	0
4	6	39.9	—
2	6	—	1.0
3	7	—	5.5
2	6	1	—
2	6	14.0	1
2	—	73	9
2	5	15.5	5.3
3	7	5.9	—
4	—	7	6
4	6	8	—

N.B. The ratio of tensile strength of the control sides, read from the graph, was fully ascertained in the multiple test in which the animals were tested. The animals were tested in each case with irregularly sutured wounds of the same width as the wounds of the animals which were tested. The control sides were tested with the same suture material and the control sides were tested with the same suture material and the control sides were tested with the same suture material.

of air. Immediately after the animal had expired the skin was stripped from the abdomen. Careful note was made at this time of the presence or absence of any serous bloods, or purulent accumulation near or on any of the wounds of the rectus muscles also any gross evidence of stitch infection.

Next the entire abdominal wall was excised and placed on a moist towel to prevent drying. This block of tissue was pinned to a cardboard beneath the towel to prevent the specimen from slipping during the process of sectioning into strips. The tissue was then cut into strips 1 centimeter in width each strip running across the midline through the intact rectus muscle on the opposite side as well. Thus each strip of tissue consisted of a portion of the rectus wound with two silk sutures in place linea alba and the previously undisturbed rectus on the opposite side the entire transverse piece being 1 centimeter in width and about 4 centimeters long. Using a modified suture testing device (1), the tensile strength of each side of the midline was tested. The mean tensile strength of the sutured portions of each rabbit was divided by the mean tensile strength of the previously undisturbed portions to determine the per cent tensile

WOUND STRENGTH  
Per cent of previously undisturbed side

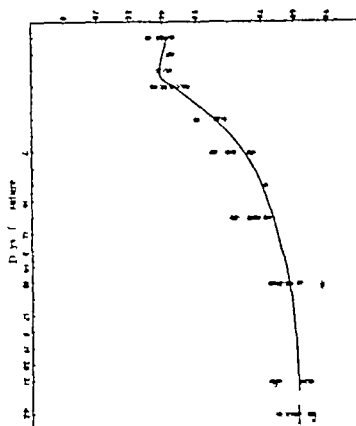


Fig. 2. The tensile strengths of silk-sutured abdominal wound in rabbits at various periods after repair. The smooth curve gives in most instances within 0.6 times the standard deviation from the mean from the average for each time period, and in all cases within the width of the standard deviation from the mean.

strength of the wound. Usually 10 determinations were made on each side of each rabbit. Between 4 and 18 rabbits were tested for each period & determinations. An average of all percentages was taken for all the rabbits tested at a specified period to plot the curve of wound healing.

Where there was any evidence of gross infection or abnormal appearance of the wound the rabbit was not used in the study. Microscopic sections of all wounds tested were made and studied. Here too, when there was any evidence of infection or variation from normal wound healing the determinations were not included.

Tensile strength. We were unable to find in the literature a description of a tensile meter adequate for our purposes. One was therefore devised on the basis of the general principle employed for the suture testing apparatus.



previously reported by one of us (1). A stout spring is stretched by tension on the strip of tissue to be tested. The rupture tension is recorded by a free rider which remains at the point of maximum tension after rupture has occurred (Fig. 1).

At the conclusion of these experiments a tensiometer of German make was found described in Sandblom's paper (8) on skin healing. It has the added factor of constant rate of increase of tension prior to rupture, and is therefore probably superior to the one we have used.

### RESULTS

The first difficulty encountered was wound infection. Routine gross examination of wounds and microscopic examination of one segment of each wound resulted in the discard of 17 animals on this basis and 1 on the basis of hemorrhage into the wound.

It was found possible to construct a smooth curve of strength gain which falls well within the limits of the standard deviations from the mean value for each time period (Fig. 2 Table I).

At the completion of closure the wound with sutures present was 41.9 per cent as strong as the previously undisturbed opposite side. This value dropped very slightly during the next 3 days, and then rose sharply approaching 80 per cent at 15 days and rising significantly no more after that point.

Certain variations in these results were found to attend variations in type of suture material including catgut, and manner of placement. These are the subject of further studies by 2 of us (Carleton Nelson and John Fast) and will be reported in later communications.

### CONCLUSIONS

1. The strength at varying periods of the healing wound plus the sutures employed is of paramount interest to the surgeon in the light of the present trend toward early ambulation.

2. In rabbits, the strength of the freshly silk-closed abdominal wall wound is about 40 per cent of the undisturbed opposite side and remains at this value 3 days. Thereafter it rises steeply to about 80 per cent at 2 weeks.

3. In the 6 weeks of observation in rabbits, silk-closed wounds never regained full preoperative strength remaining at about 80 per cent of that value.

### REFERENCES

1. DICKSON, C. *Surgery* 1943, 14, 640.
2. HOWES, E. L. *Surg. Gyn. Obst.*, 1933, 57, 229-237.
3. HOWES, E. L., and HARVEY S. C. *Internat. J. M. & S.* 1930, 43, 225-230.
4. *Idem.* *Ann. Surg.*, 1935, 103, 94-94b.
5. LOCALIO A. S., et. al. *Surg. Gyn. Obst.*, 1943, 77, 47-49.
6. NOVAK, M., and HALL, H. *Surgery* 1939, 57, 560-564.
7. PRATER, D. G. *Am. J. Surg.*, 1940, 49, 76-83.
8. SANDBLUM, P. *Acta chir. scand.* (Supp. 89), 1944, pp. 1-68.





Fig. 2.

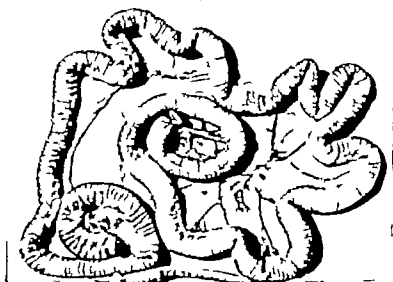


Fig. 7

Fig. 2. Close-up Kodachrome of group of adhesions showing the agglutinated talc masses appearing as white flecks within the adhesions.

Fig. 7. Kodachrome of small bowel of dog treated with powder No. 03. This shows the complete absence of any adhesions or any demonstrable inflammatory reaction.

*Experiments with Non-Irritating Glove Powder — C. Marshall Lee  
and Edwin P. Lehman*

# EXPERIMENTS WITH NONIRRITATING GLOVE POWDER

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SINCE the introduction of dry glove technique now almost universally employed by surgeons everywhere the powder used on rubber gloves has been under some degree of suspicion. But since any ill effect it might produce was masked by other more obvious factors such as infection, trauma, or suture material it attracted comparatively little attention. The incrimination of lycopodium powder as the causative agent in many granulomatous lesions and intra-abdominal adhesions is now too well known to require detailed review. The historical aspects of this subject have been ably presented by Seelig Verda, and Kidd (13). The use of lycopodium powder was rapidly abandoned in favor of magnesium silicate or talc. This inorganic material was thought to be physiologically inert in contact with living animal tissue and is now generally employed as a dusting powder for surgeons' gloves. With recognition of silicosis as an industrial disease entity some interest was aroused in the possibility that talcum powder might not be entirely innocuous. In 1933 Antopol reported 2 cases of granuloma due to talc—one in the neck and one in the serosa of the appendix. These 2 cases were mentioned in passing in a report on lycopodium granuloma and the possibility was suggested that unrecognized talc granuloma might be quite common. Feinberg reported 2 cases of talc granuloma in 1937 and for the first time employed polarized light both to demonstrate and to identify the crystals responsible for the lesions. He injected small amounts of talc suspended in saline into three mice and produced granulomas, but no adhesions, and warned against the indiscriminate use of talcum powder in the operating room.

Although scattered confirmatory reports (2, 4, 6, 10, 11) appeared in the literature, little attention was paid to them by clinical surgeons and in 1943 a second and quite comprehensive article by German (7) emphasized the danger of granuloma formation but minimized the tendency to form intestinal adhesions. In 40 of 50 unselected patients who were subjected to a second laparotomy German found intra abdominal granulomas which he proved by means of polarized light to be the result of foreign body reaction to talc. Although there was a close parallel between the number of adhesions present and the number of granulomas the adhesions were attributed entirely to collateral causes. He stated "In the mechanism of the formation of adhesions it is well known that fibrin plays an important part. The inability of silica *per se* to induce an exudation of fibrin would suggest that it is not important in the formation of adhesions. These observations would point to a very efficient mechanism for disposal of talc by the peritoneum."

German based his conclusions on the intra peritoneal injection of a 0.5 per cent saline suspension of talc into mice and on dry powder application in which he used only one test rabbit and one control rabbit, with and without trauma. He produced granulomas, but no adhesions. On this basis he concluded that

Talc *per se* in the abdomen in the absence of injury to the peritoneum is quickly removed from the peritoneal cavity, immobilized and covered with serosal cells, without the formation of an exudate and without adhesions. Adhesions do not develop without some form of traumatization of the peritoneum sufficient to produce exudation of fibrin. Even in the presence of peritoneal trauma and exudation of fibrin the talc plays a secondary rôle, in that it is caught up in the fibrin and is incorporated in the adhesions. Thus the developing granulomas may either add to the bulk and density of the developing adhesions or may

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TABLE I.—POWDERS USED IN STUDY

	Flow and dusting qualities Raw	Flow and dusting qualities Aclarified
1000-D Regular amyloform (Contains 1 per cent bound HCHO)	+++	++
POC treated starch (Phosphorus oxychloride)	+++	+++
05 Calcium alginate	+++	++
06 HCHO treated starch (Contains about 3 per cent HCHO)	+++	++
3 Raw corn starch	+++	+
04 Talc	+++	+++
3 A Tantalum oxide	++++	++++
00 Corn starch derivative	+++	+++
Corn starch derivative	+++	+++
07 Corn starch derivative	++++	++++
08 Corn starch derivative	++++	++++

\*Changes color to brownish tint

impede the resolution of any adhesions once formed. In this sense it may be said to contribute to the disability produced by adhesions resulting from surgical operations.

It remained for Seelig (12-13) to re-emphasize strongly the danger of talc as an adhesion producing agent. Although mice are notoriously recalcitrant to the production of adhesions, he was able to produce generalized adhesions quite uniformly in a large series (194 mice) in which 2 cubic centimeters of a 5 per cent saline suspension of talc was injected intraperitoneally. He tested some 24 different powders and selected potassium bitartrate as a nonreactive substitute. Later he employed a starch powder which was said to withstand autoclaving fairly well. This represents the first reported use of a starch derivative for this purpose and our studies constitute an extension of Seelig's work with certain modifications in methods and materials.

In a comprehensive and detailed study Lichtman, McDonald, Dixon and Mann have shown that talc is not an inert foreign body. They point out that commercial talcum is a mixture of talc, serpentine, dolomite or tremolite. Talc itself is a hydrous magnesium silicate. The material leached out of a talc crystal is not the same as the parent substance. The degree of hydration of this derivative substance determines its toxicity. For ex-

ample a mole of alpha silicic acid may bind as many as 300 moles of water. The size, shape, and cleavage of a talc particle and its surface energy affect its so called solubility. In the body alteration of the pH and the presence of protein in tissue fluids alter the size and characteristics of the dispersed aggregates. By means of the now common use of polarized light they conducted an extensive study of the pathogenesis of talc granulomas and adhesions, resulting from dispersed talc particles 0.5 to 10 microns in size.

The greatest barrier to the abandonment of talcum as a glove dusting powder has been the lack of an acceptable replacement for it. Many powders have been studied and the commonest single defect in those which are physiologically safe has been a tendency to gelatinize or agglutinate in the autoclave, thus defeating the primary purpose of the powder, namely to lubricate gloves and hands.

A further barrier to replacement of talcum powder has been a general failure fully to appreciate its danger. In most hospitals surgeons do not even take the precaution of washing the powder from their gloves before operating.

The purpose of our study was to verify the increasing evidence that talcum powder is a dangerous agent in human surgery and to evaluate certain proposed replacements for it.

#### EXPERIMENTAL STUDIES

*Physical properties.* Preliminary selective studies were made on the physical properties of ten powders, with commercial talc as the control.

The powders (Table I) used in this study were made available to us by the Department of Clinical Research, Ethicon Suture Laboratories, Division of Johnson and Johnson, New Brunswick, New Jersey. The first four powders have already been tried out by other investigators (7-11) and were included for comparative purposes. The last four powders, designated 100, 101, 107 and 108 are derived from corn starch which has been treated by physical and chemical means to prevent gelatinization in the autoclave. These four powders differ substantially only in degree of treatment, except that numbers 107 and 108 have

had a special chemical treatment to improve their lubricating value. The identity of the remaining powders in Table I is self-evident.

The fineness and flow and dusting qualities of the raw powders were arbitrarily classified by gross estimation from + to +++++ the latter representing the greatest freedom of flow and ease of distribution in dusting gloves and hands. Samples of each were then autoclaved under 15 pounds of pressure for 15 minutes and retested. The results are shown in Table I.

Examination of these results shows that powders 100 and 101 were about comparable to talc and that powders 107 and 108 and tantalum oxide were superior with respect to physical qualities after autoclaving. No experiments on tissue tolerance were conducted with the group of powders showing inferior physical qualities. Powder 107 was also eliminated because since No. 108 was known to represent a further refinement of it detailed study became an unnecessary duplication. Tissue tolerance studies were therefore conducted on powders 100, 101, 103, A (tantalum oxide) and 108, with talcum (104) as a control.

*Method of testing peritoneal reaction.* Dogs were selected as the test animals because actual operating room conditions could be closely approximated and because the peritoneal reactions of dogs more nearly approach human reactions than do those of mice, rats, guinea pigs, or rabbits which have been used in studies heretofore reported by others. In a further effort to duplicate operating room conditions, dry powder was used in open operation rather than by injection in a saline suspension.

In every operation the abdomen was opened through a standard rectus incision. Rigid aseptic technique was employed throughout, except that before beginning the operation both operator and assistant washed their gloves thoroughly under running tap water. In every operation the small bowel was run from Treitz's ligament to the ileocecal valve. When a powder was being tested it was dusted as evenly as possible over the bowel and both mesenteric surfaces as the bowel was run. When the last loop had been handled or treated the abdominal wound was closed in layers with silk.

TABLE II.

Equivalents 1 washing from operating room gloves	Weight in grams	Volume (in teaspoon measures)
2 pairs	0.20	1/4
4 pairs	53	1/4
8 pairs	1.024	1/4
6 pairs	2.01	1

After an interval of 3 weeks each dog was reopened the same technique being used and explored for adhesions. When few adhesions were found a careful count of them was made after the method of Lehman and Boys (13). When adhesions were too numerous to count they were designated +++ or ++++ denoting generalized massive adhesions.

*Quantity of test powder.* In order to arrive at a suitable quantity of powder for test purposes 4 pairs of gloves were drawn from the ready supply in the operating rooms of the University of Virginia Hospital. The outer surfaces of these gloves were washed as thoroughly as possible under a single washing with a fixed quantity of water.<sup>1</sup> The water was then evaporated and the residual powder was found to weigh 0.5262 gram. This was taken as the maximum amount of powder with which the peritoneal cavity might be contaminated by an operating team of four persons, if only one pair of gloves were worn by each and if none of the gloves was punctured.

Since the powders to be studied were of different specific gravities a volumetric measure was considered better for comparative purposes. A set of kitchen teaspoon measures was employed and approximate values were obtained for talc (Table II).

One-half teaspoonful represents the amount of talc from 8 pairs of gloves. On this basis in order to make the tests sufficiently rigorous this amount was selected as the dose to be dusted over the peritoneum of dogs. Certain exceptions to this dosage will be noted under results.

*Bacterial studies.* Although it had already been shown that the physical properties of powder 108 were not impaired by autoclaving it seemed desirable to establish that this

<sup>1</sup>It is of interest that when these washed gloves were air-dried they were still abundantly covered with a fine coating of powder.



Fig. 1. Small bowel of dog treated with talcum powder. The bowel and mesentery have been removed and laid over the end of bucket. Adhesions are so numerous and dense that the cohesed mass hangs together like a cap.

powder (which will be shown to have a high order of tissue tolerance) could in fact be effectively sterilized.

Through the courtesy of Dr. Frank Meleney's laboratory at Presbyterian Hospital, New York, some spore threads were obtained of a highly heat-resistant strain of *Bacillus subtilis*. This strain when the test tube is completely surrounded by the water will withstand boiling for 20 minutes.

A sample of powder 108 as received was autoclaved for 15 minutes at 15 pounds pressure. Culture from this sample was sterile.

A second sample was contaminated with heat-resistant *Bacillus subtilis* spores and then cultured without autoclaving. *Bacillus subtilis* was readily cultured from the sample.

TABLE III.—CONTROL STUDIES—NO POWDER AND TALCUM POWDER

Type of powder	Amount of powder	Equivalent in glove washings	Number of dogs	Average number of adhesions	Greatest number of adhesions	Smallest number of adhesions
None	None	None				
Talcum Powder	1/4 Tsp.	8 Pts.		++++	++++	++++
	1/2 Tsp.	4 Pts.	5	++++	++++	++++
	1/2 Tsp.	Pt.		+++	+++	+++

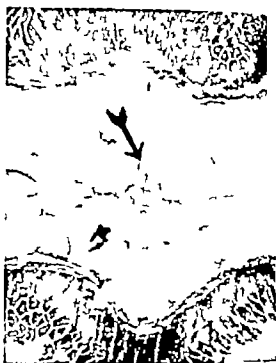


Fig. 3. Section under low power through an adhesion between two loops of bowel.

A third sample was similarly contaminated and then cultured after autoclaving. Culture from this sample was sterile.

#### RESULTS

**Controls (Table III).** No adhesions resulted when no powder was used. When talcum was used dense generalized adhesions were formed. Even when the dose of test powder was reduced to 1/4 teaspoonful or roughly the washings from one pair of gloves the result was the same.

These dogs were sacrificed and at autopsy the small bowel was removed *en bloc* and formed one cohesive conglutinate mass which, when draped over the end of a bucket, sat on it like a cap (Fig. 1). The small spots of agglutinated talc were readily visible in gross under the adhesions (Fig. 2 (frontispiece)). Microscopic sections taken through sample adhesions showed the talc embedded under the adhesions against the serosa (Figs. 3 and 4). Under polarized light the identity of this material was evident (Figs. 5 and 6). The celiac and superior mesenteric nodes were greatly enlarged. Sections of these were taken to de-

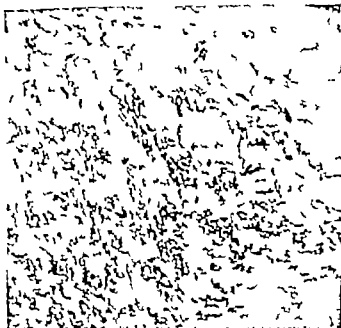


Fig. 4. Higher magnification of the area indicated by the arrow in Figure 3. This shows the inflammatory reaction and the numerous foreign body giant cells.



Fig. 5. The same area as shown in Figure 4, under polarized light with partial rotation of the prisms. This brings out the larger talc particles.

termine whether or not there had been any phagocytosis of the talc with deposit in the regional nodes. Under ordinary light these sections showed only the usual inflammatory lymphoid hyperplasia. Under polarized light exhaustive study showed only an occasional birefringent particle—an average of one to three a section.

*Experiments (Table IV)* Tantalum oxide produced as extensive adhesions as did talc. Further work on this powder was abandoned.

The results with powders 100 and 101 were encouraging and in the case of the latter suf-

ficiently so to suggest testing the effect of an increased dosage. Two dogs were treated with a full teaspoonful of powder 101 equivalent to washings from 16 pairs of gloves. It is of interest that each of these dogs had been used in a previous series and the increased dose had been put in when they showed no adhesions after the first test. One dog showed no

TABLE IV—EXPERIMENTAL STUDIES—TEST POWDERS

Type of powder	Amount of powder	Equivalent in glove washings	Number of dogs	Average number of adhesions	Greatest number of adhesions	Smallest number of adhesions
Tantalum oxide	½ tsp.	8 ps.	3	++++	++++	++++
Starch No. 100	½ tsp.	8 ps.	5	5.7	13 (++++)*	0 (1 dog)
Starch No. 01	½ tsp.	8 ps.	2	4	8	0 (2 dogs)
Starch No. 101	1 tsp.	16 ps.	2	5	5	0
Starch No. 106	½ tsp.	8 ps.	10		0	0

\*One dog had an infected laparotomy wound and showed +++ adhesions. Because of this extraneous factor the average and greatest number of adhesions is taken from the remaining four dogs.

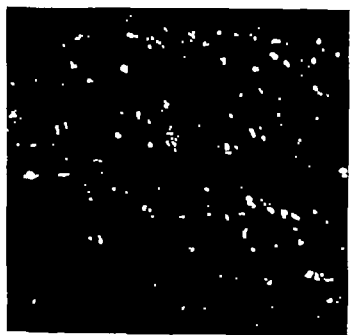


Fig. 6. The same area as in Figures 4 and 5. Here the prisms have been completely rotated blotting out all but the doubly refractive talc particles.



adhesions at his third laparotomy and the other showed only five. Since powder 108 was known to represent a further refinement in processing and since its physical properties were superior the next major series was conducted with this powder. In every case when the dog was opened after 3 weeks not a trace of powder was to be found nor was there a single adhesion present. The bowel when removed *en bloc* was as clean and healthy as if it had never been touched (Fig. 5). These striking results indicate the superiority of powder 108 over every other powder tested and are as good as the controls without powder.

#### CLINICAL EVALUATION

By arrangement with the superintendent of a private hospital in this city powder 108 was installed in the operating room in place of talcum without the prior knowledge of the surgeons working there. The operating room supervisor was asked to take note of any comment they might spontaneously make.

With only one exception every surgeon commented favorably having noticed the improvement in physical quality over the powder previously in use and asked what the new powder was. The single exception made no comment at all favorable or unfavorable and apparently did not notice the change.

In the course of this trial use only one unfavorable feature was observed. It happens that in this particular hospital glove powder is put up in aluminum salt shakers and used throughout the course of a day's operating schedule. Frequently these shakers are not emptied in one day and are reautoclaved and used again the next day. It was noted that while the physical properties of the powder remained unimpaired through one or at most two autoclavings there was some tendency to clump after the third such sterilization. After the fourth or fifth although the clumps were readily shaken out and fine dusting powder could be obtained from the can many residual lumps were left.

This single disadvantage seems trivial in comparison with the many advantages derived from the use of this powder and is easily obviated either by using smaller shakers or by employing the widely used technique of put-

ting up the dusting powder in individual packages with each pair of gloves.

#### DISCUSSION

It has been shown in our control studies that the atraumatic, aseptic manipulation and handling of the small bowel does not produce adhesions in healthy dogs.

When dry talcum powder is dusted over the serosal surfaces massive dense and uncountable adhesions were produced wherever the talc came in contact with the tissues. This indicates that neither trauma nor infection are required in the presence of talc to produce adhesions and the powder alone must here be held responsible. This is in direct contrast to the observations reported by German.

Furthermore our study of the regional lymph nodes indicates that at least after 3 weeks any effort on the part of the body to remove the powder via the lymphatics has been unsuccessful.

Our observations on the test powders indicate that powder 108 is completely absorbed from the peritoneum without any demonstrated inflammatory reaction and that it produces no adhesions whatever.

The fate of this powder does not offer any great pharmacological problem (3). Since it is a corn starch powder it is simply taken up by the peritoneum and metabolized like any ingested starch. Its advantage over raw starch and other treated starches is that its dusting, lubricating and flow qualities are not adversely affected by autoclaving. Its superiority over talcum powder, tantalum oxide or any other mineral, metallic or nonmetabolized powder is obvious.

MacQuiddy, who has investigated the sensitizing propensities of this substance both in human patients and in animals, has failed to demonstrate under experimental conditions any sensitizing or anaphylactogenic properties. However subcutaneous tissue sections obtained by MacQuiddy indicated that in some instances at least complete absorption of the powder had not occurred at the end of 56 days. In such cases, relatively large compacted masses (up to 200 mgm.) had been embedded and under such circumstances absorption might be expected to be slow and

difficult. MacQuiddy's studies are being continued and will be reported in detail at a later date

#### CONCLUSIONS

1 Further evidence is presented that talc is a deleterious substance in living tissue, that it produces a violent peritoneal reaction and dense adhesions and that its use as glove dusting powder is dangerous.

2 A commercially prepared dusting powder is shown experimentally to have

a. Excellent physical qualities of flow and fineness, unaffected by autoclaving

b. Complete absorption by the peritoneum without inflammatory reaction and without the formation of adhesions

c. Complete sterility under standard autoclaving procedure after known contamination with spores of a heat resistant organism.

3 A brief clinical trial of this powder has been entirely satisfactory

#### REFERENCES

1. ANTONIO, WM. Arch. Path., 1933, 16 326-331.
2. BYRON, F. X., AND WELCH, C. S. Surgery 1941 10 766
3. CIANUTTI, ALFRED. Personal communication.
4. EBB, I. H. Surg. Gyn. Obst., 1935, 60 40-44.
5. FEINBERG, ROBT. Arch. Path. 1937 24 36-42.
6. GERMAN, W. M. Am. J. Clin. Path., 1940 10 245-350.
7. Idem. Surg. Gyn. Obst., 1943, 76 501-507
8. LICHTMAN, A. L. McDONALD, J. R., DIXON, C. F. AND MASON, F. C. Surg. Gyn. Obst., 1946, 83 531-546
9. MACQUIDDY, E. L. Personal communication.
10. McCORMICK, E. J. and RAMSEY, T. L. J. Am. M. Ass., 1941 116 817-821
11. OWEN, M. A. Texas J. M., 1936 32 482
12. SKELIG, M. G. South. M. J. 1945, 38 470-472
13. SKELIG, M. G. VERDA, D. J. and KIDU, F. H. J. Am. M. Ass. 1943 123 950.
14. WEEDE, L. A., and GROVES, J. L. Surg. Gyn. Obst. 1942, 75 661-664.

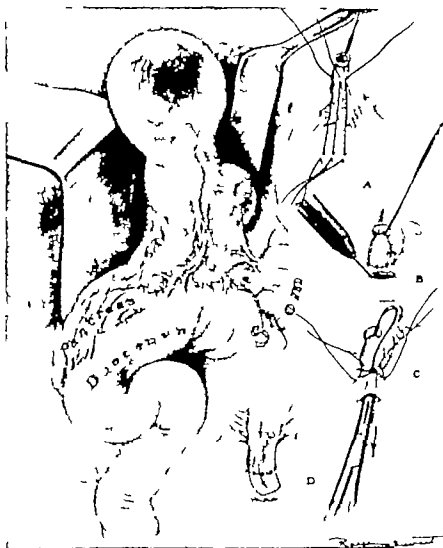


Fig. 1. Simple implantation of common bile duct. The duct is markedly dilated following previous ligation at junction of duct and duodenum. A, Posterior row of sutures placed. B, Incision made into lumen of intestine. C, Second incision made into duodenum. Hemostat placed through two incisions and ligature on duct grasped. D The free end of duct 4 to 5 millimeters in length remains extending into lumen of intestine.

*Experimental Implantation of the Common Bile Duct into the Intestine.*—*Frederick M. Binkley, Robert Palmer and H. J. McCorkle*

# EXPERIMENTAL IMPLANTATION OF THE COMMON BILE DUCT INTO THE INTESTINE

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**C**LINICAL and experimental surgical procedures in which the bile duct is implanted into the intestinal tract have been employed with increasing frequency in recent years. It is desirable that biliary intestinal anastomosis be done in such a manner as to prevent leakage of bile into the peritoneal cavity in the early postoperative period and to avert the later postoperative complication of cholangitis which often is associated with stricture at the site of anastomosis, stasis and infection of bile, and probably with reflux of intestinal contents into the biliary duct system.

In consideration of these points several types of experimental implantation of the common bile duct into the intestine of dogs were performed in an attempt to develop an efficient, simple procedure.

The experiments were divided into four main groups

1 *Simple implantation* Choledochoduodenostomy was done in 13 dogs, 8 of which had a normal common bile duct. In the remaining 5 animals the common bile ducts were ligated at a preliminary operation. Two or 3 weeks later these animals were reoperated upon and the dilated common bile ducts were implanted into the duodenum.

The technique of implantation of the bile duct into the duodenum is illustrated in Figure 1. After the bile duct is ligated and dissected free a single row of interrupted cotton sutures is placed posteriorly approximating the duodenum and the posterior wall of the common duct at a distance of 3 to 5 millimeters from the free end of the duct. The posterior row is tied under direct vision, in

order to insure accurate serosa-to-serosa approximation. Two incisions are then made in the duodenum one just anterior to the suture line and with a curved hemostat which is passed through the two incisions, the common duct is drawn into the lumen of the duodenum. An anterior row of interrupted fine cotton sutures is placed completing the serosa-to-serosa anastomosis. The ligature is cut from the distal end of the duct, leaving a free end from 2 to 4 millimeters in length extending into the lumen of the duodenum. The second incision is closed with 1 or 2 interrupted cotton sutures.

In none of these animals was there evidence of leakage of bile from the anastomosis in the early postoperative period. The postoperative course was not remarkable except for the urinary findings. In most animals daily urinalysis revealed the presence of bile during the early postoperative period but the urine invariably was free of bile by the 10th postoperative day. In order to determine the cause of the transient jaundice 3 animals were sacrificed on the 5th postoperative day. In these animals the common bile ducts were found to be somewhat dilated. There was considerable edema at the site of anastomosis and in the surrounding duodenum. In all cases bile flowed spontaneously into the duodenum.

The remaining 10 animals were sacrificed from 34 to 338 days after the choledochoduodenal anastomosis (Table I). In these animals the anastomosis was found to be well

TABLE I.—SIMPLE IMPLANTATION

	Normal duct	Dilated duct	Total
Number of animals	8	5	13
Postoperative duration—days	5-338	55-313	
Results of anastomosis			
Satisfactory	6	4	10
Unsatisfactory	0	0	0
Mortalities <sup>1</sup>	2	1	3

<sup>1</sup>Causes of death. anesthetic, peritonitis, etc.

From the Division of Experimental Surgery of the University of California Medical School. This work was supported by a grant from the Christine Breon Fund.

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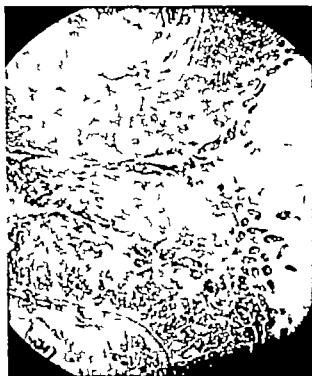


Fig. 2 Photomicrograph of anastomosis demonstrating mucosal junction, common duct and duodenum.

healed and appeared to be functioning satisfactorily. There was no evidence of stenosis. The mucosa of the common duct appeared to be continuous with the duodenal mucosa and the orifice usually lay between mucosal folds. Histological sections showed the ductal and duodenal mucosa to be directly continuous, and several histological sections revealed elevation of the duodenal mucosa about the stoma, forming a papilla like structure. There was a minimal fibroblastic response and no evidence of chronic inflammation (Fig. 2). X ray studies failed to demonstrate regurgitation of barium or free air into the extra hepatic biliary passages (Fig. 3).

TABLE II.—SIMPLE IMPLANTATION INTO BLIND LIMB OF JEJUNUM

	Normal duct	Dilated duct	Total
Number of animals	4	1	5
Postoperative duration—days	5 to 6	67	
Results of anastomosis			
Satisfactory	3		4
Unsatisfactory		0	1
Mortality <sup>1</sup>			2

<sup>1</sup>Causes of death, peritonitis, 1; cholangitis.



Fig. 3 Roentgenogram following simple implantation. Gastrointestinal series consistently failed to demonstrate regurgitation of barium or free air into biliary passages.

There were 3 deaths in this group. Two were caused by an overdose of sodium pentobarbital used for anesthesia. One animal died with peritonitis on the 15th postoperative day but there was no apparent leakage of bile from the anastomosis. The origin of peritonitis in this animal probably was contamination with intestinal flora at the time of operation.

**2 Simple implantation into blind limb of jejunum.** In the second group of 5 animals the common duct was implanted into a blind limb of jejunum (the Roux arm principle being utilized) the same method being used as described for the first group of animals (Fig. 4). In dogs satisfactory fixation of the blind jejunal limb was difficult to obtain and the anastomoses were unavoidably under considerable tension. In 3 of the 5 animals results were satisfactory, and the findings were similar to those described in the first group (Table II). There were 2 deaths. One animal died on the 3rd postoperative day with diffuse peritonitis;



Fig. 4. Simple implantation into blind limb of jejunum. A, Simple implantation of duct. B, Completed procedure showing implantation into blind limb and end-to-side jejunal anastomosis.

the anastomosis was not healed and there probably was leakage of bile into the peritoneal cavity. The other animal died with acute cholangitis on the 5th postoperative day. The anastomosis was found to be healing satisfactorily with no leakage of bile. The bile ducts were filled with thick, mucopurulent exudate.

### 3. Anastomosis using mechanical support

In a group of 5 animals a dilated (previously ligated) common bile duct was anastomosed to the duodenum over a mechanical support (Fig. 5).

In 2 animals the anastomosis was done over a rubber catheter and in 3 a flanged tantalum

metal tube was used. In the cases in which a rubber catheter was used, one dog was sacrificed on the 10th, and one on the 44th postoperative day (Table III). The anastomoses were well healed and appeared to be function

TABLE III.—ANASTOMOSIS USING MECHANICAL SUPPORT

	Tantalum tube	Rubber tube	Total
Number of animals	3	2	5
Postoperative duration—days	12-25	10-44	
Results of anastomosis			
Satisfactory	3	2	5
Unsatisfactory	0	0	0
Mortalities <sup>1</sup>	2	0	2

<sup>1</sup>Causes of death: multiple liver abscesses, 1; pneumonia, 1.

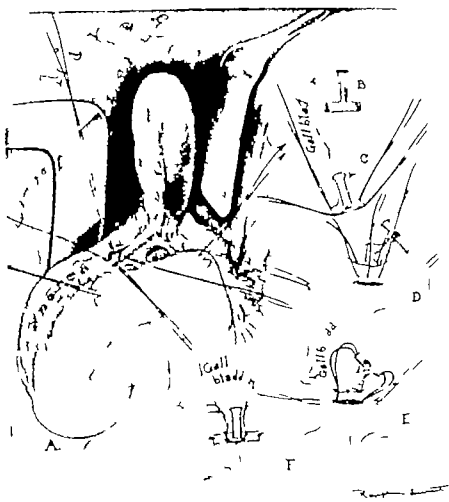


Fig. 5. Anastomosis over tantalum tube. A Common duct dissected free and distal flaps constructed. B, Flanged tantalum tube. C, Duct flaps anchored to flanges of tube. D Posterior row of sutures placed. E, Tantalum tube brought into lumen of intestine and anchored into position. F Completed anastomosis.

ing satisfactorily. In one animal the duct wall was thickened and there were numerous adhesions and an increased amount of scarring about the anastomosis. Histological examination revealed a marked increase in connective tissue reaction and inflammatory response when compared with similar sections from implantations in groups I and II (Fig 6). Two of the 3 animals in which a tantalum tube was used died, one on the 12th and one on the 30th postoperative day. The former was found to have peritonitis resulting from a perforation of one of numerous liver abscesses, and the latter died with pneumonia. In both animals the anastomoses were well healed and appeared to be functioning satisfactorily and the tantalum

tubes had remained in their original position. The third animal was sacrificed on the 20th postoperative day at which time the tube was found to have passed from the site of anastomosis through the intestinal tract. The anastomosis was functioning satisfactorily. However the duct wall was thickened, and histological sections demonstrated an enormous amount of connective tissue about the anastomosis with a moderate inflammatory reaction.

4. *Anastomosis using reinforced fascial tube.* In 3 animals the common bile duct was divided at its junction with the duodenum and the defect was replaced by a tube of rat fascia reinforced with a fine tantalum wire mesh. At a preliminary operation a rectrop-



Fig 6 Photomicrograph of area adjacent to anastomosis performed over rubber catheter demonstrating surrounding connective tissue reaction.

lar flap of rectus sheath was dissected free and folded back over a square of tantalum mesh placed upon the anterior surface of the rectus abdominis sheath and sutured into position (Fig 7). In this manner the sheet of tantalum mesh was covered on its anterior surface by the flap of fascia and on its posterior surface by the anterior wall of the rectus sheath. Two to 3 weeks later this double thickness of fascia, reinforced with tantalum mesh was excised and fashioned into a tube, which was then anastomosed at one end to a dilated common duct, and at the other end to the duodenum. The anastomosis was performed about a rubber catheter which was left extending into the duodenum and portions of omentum were brought about the anastomosis (Fig 8).

These 3 animals were sacrificed at intervals varying from 119 to 251 days postoperatively (Table IV). At necropsy the anastomoses were found to be surrounded by abundant

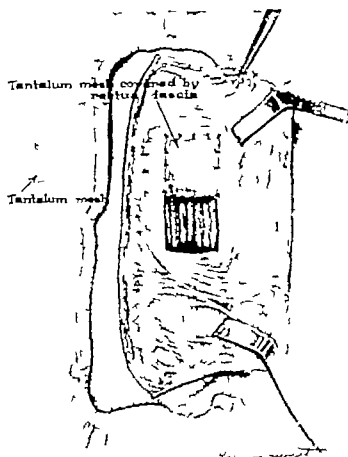


Fig 7 Construction of fascial flap reinforced with tantalum mesh. Flap of rectus abdominis sheath turned back over square of tantalum mesh and sutured into position.

vascular adhesions. In all 3 animals the anastomoses were patent and appeared to be functioning however the extrahepatic biliary system was distinctly dilated. The rubber catheters were noted to have passed into the gastrointestinal tract. The tantalum mesh tube protruded into the lumen of the intestine for a distance of 2 to 3 millimeters and was almost entirely covered with duodenal mucosa. The tubes on being opened were found to be almost completely lined with mucosa, however, there were spotty areas through which the tantalum mesh was visible. A relatively thick fibrous wall surrounded the tube which

TABLE IV —ANASTOMOSIS USING REINFORCED FASCIAL TUBE

Number of animals	3
Postoperative duration—days	119-251
Results of anastomosis	
Satisfactory	3
Unsatisfactory	0
Mortality	0



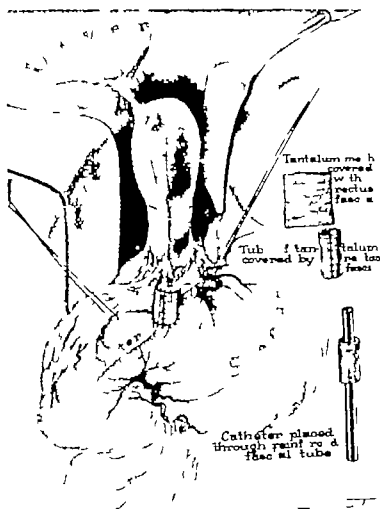


Fig. 8. Anastomosis utilizing reinforced fascial tube. End-to-end anastomosis of dilated common duct and fascial tube. Fascial tube anastomosed to duodenum over rubber catheter.

apparently was not constricted due to the presence of the tantalum mesh.

#### SUMMARY

1. A simple type of biliary intestinal anastomosis has been done in 18 experimental animals. It may be done rapidly and has given good functional results with minimum inflammatory reaction at the site of anastomosis.

2. Anastomoses employing a rubber or metal tube have been done in 5 experimental animals and these anastomoses invariably have exhibited evidence of considerable inflammatory reaction, scarring and stenosis.

3. An experimental method for the replacement of a defect in the common duct of

animals by a graft of fascia reinforced by tantalum wire mesh is described.

4. It appears desirable to use the simplest possible type of anastomosis (as described in group I) in situations where a sufficient length of the common duct remains to permit direct implantation of it into the duodenum. Use of the Roux arm principle may not be required in all instances, and might be limited to situations in which the presence or possibility of cholangitis is a factor.

5. The use of metal or rubber tubes for mechanical support in choledochointestinal anastomosis should be avoided if possible because of their tendency to produce marked scar tissue reaction with stenosis. However it

is acknowledged that there are many situations where such support is essential. In such instances temporary support with a very soft rubber tube appears preferable to more permanent support with rigid metal tubes

# REFERENCES

1. ALLEN, A. W. *Ann. Surg.* 1945, 121, 412-424.
2. COLLE, W. H. BRENNAN, C. JR. and REYNOLDS, J. T. *Ann. Surg.* 1945, 122, 400-521.

3. CUTLER, E. C. and ZOLLINGER, R. *Am. J. Surg.*, 1940, 47, 1-76.
4. ELIOT ELLSWORTH, JR. *Surg. Gyn. Obst.* 1918, 26, 81-103.
5. JUDD, E. S. and PARKER, B. R. *Arch. Surg.* 1928, 17, 1-17.
6. LAHEY, F. H. *Ann. Surg.* 1937, 105, 765-790.
7. LORD, J. W., and CHENOWETH, A. I. *Arch. Surg.* 1943, 46, 245-252.
8. MCARTHUR, L. L. *Ann. Surg.* 1923, 78, 129-138.
9. PEARSE, H. E. *Surgery* 1941, 10, 37-44.
10. Idem. *Ann. Surg.* 1942, 115, 1031-1042.

## PRINCIPLES INVOLVED IN SURGICAL THERAPY OF 'ENCAPSULATED' FIBROSARCOMA OF SOFT TISSUES

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IT is an established fact that success in the treatment of any malignant disease depends to a great extent upon a knowledge of its origin and course. This means that the institution of adequate surgical measures based on this knowledge is just as important as the early recognition of the presence of the malignancy. Even though it is the pathologist's responsibility in the average instance to make the actual diagnosis of malignancy when the surgeon is in doubt, it is the surgeon who has undertaken the responsibility to effect a cure. Having undertaken this responsibility it seems logical that he should be expected to possess as complete a knowledge as is practical concerning the pathological entity at hand. When this pathological entity happens to be a sharply delimited tumor found arising from the soft tissues of the body—that is, from the subcutaneous tissue, muscle or intermuscular fascial planes, the gross appearance of this tumor may lead to the impression of a relatively benign process before the pathologist has had an opportunity to declare himself. It is not too unusual that the same impression may be common to both individuals even after using the time saving device of frozen section technique

for histological study with the result that both are temporarily lulled into a false sense of security. Under such circumstances the definitive surgical extirpation results in a simple enucleation of an apparently encapsulated tumor from its bed of areolar tissue. The postoperative clinical impression in such instances agrees with the preoperative diagnosis of perhaps a fibroma until the permanent sections are examined by the pathologist. If the final diagnosis happens to be 'fibrosarcoma of low grade malignancy,' the surgeon is faced with the problem of considering the original surgery as being adequate or of choosing a waiting game. Since tumors spread in the human body only by actual dissemination of viable cells or are manifest in more than one part of an area through a multicentric origin, the correct decision in this instance will be dependent upon an accurate and full knowledge of the disease process.

# PATHOLOGY

The histological studies of the last few decades have made considerable progress in distinguishing among the various tumors once collectively known as fibrosarcoma. In the course of this differentiation an expected amount of controversy has taken place among pathologists, out of which has arisen a fuller knowledge of the growth characteristics of

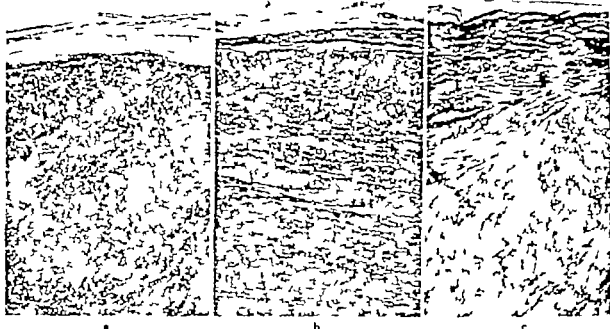


Fig. 1. Three examples of fibrosarcoma each of which presents a well defined fibrous capsule despite the variation

in cellular structure of tumor. a, Highly cellular type; b, fibrous type; c, fibromyxomatous type.

these neoplasms. Many forms of spindle-cell sarcoma now prove on closer investigation to belong to groups of tumors arising from nerve structures, muscle fat or synovial tissue. In other words, it now appears that practically all of the sarcomas of the soft parts are derived from specialized tissue cells and not from the supporting fibroblasts. The fascial sarcomas of Virchow<sup>7</sup> thus remain as one of the few pure forms of fibroblastic sarcoma even though modified by lipomatous or myxomatous degeneration whereas an excellent example of this recent clarification is represented by the synovial sarcoma group. The synovial tissues are generally agreed to have arisen from mesodermal tissue but they normally are composed of an endothelial layer and an outer fibrous layer. The tumors arising from this tissue thus fall into two microscopic types. The first are those arising from the inner layer and are more epithelioid in character while the second are those arising from the outer layer and are usually indistinguishable from the common fibrosarcoma. On the other hand, all gradations of specialized fibroblastic tumor formation now considered as of neural origin may be obtained by a complete study of the pathological possibilities found in von Reck-

linghausen's disease with its significant incidence of malignant degeneration. Such a study reveals that the solitary neurofibroma, the neurinoma and the neurogenic sarcoma all arise from the cells of the sheath of Schwann, that is, from the connective tissue coverings of peripheral and central nerves.

Despite this microscopic differentiation all of the malignant tumors here mentioned manifest sufficiently similar gross characteristics to warrant saying that with few exceptions they present the same common problem to the surgeon. Since they present this common problem we feel justified in discussing them under the common heading of encapsulated fibrosarcoma of the soft tissues.

Most fibrosarcomas arising from soft tissues (except those of retroperitoneal and intraperitoneal origin) usually stem from subcutaneous or intermuscular fascial tissues and even though somewhat low in general incidence their gross appearance of apparent encapsulation is known to surgeons (Fig. 1). It is not uncommon to find them densely adherent to tendinous aponeuroses, this frequently seeming to be the apparent point of origin. We have noticed that these tumors frequently encompass an occasional nerve trunk of moder-

ate size along with the accompanying blood vessel, but whether this could be considered as a demonstration of nerve origin is difficult to state without histological study. The fibrosarcoma and the synovium have in our experience been single tumors sharply outlined from the surrounding tissues, growing expansively and conforming in outline to the area in which they lie. The neurosarcoma on the other hand may be of unicentric or multicentric origin presenting the same encapsulated or circumscribed appearance. When multiple the localized nodules arising from different parts of the same nerve may fuse with one another so that adjacent nerves running in fascia or muscle may become incorporated in the tumor process in such a manner as to give rise to a false impression of infiltration. When nerves are involved primarily or secondarily there is remarkable preservation of function.

There is no one characteristic gross appearance of these tumors as regards color, consistency or size since these qualities depend entirely on the relative cellular or fibrous content as well as on the presence of internal hemorrhage, necrosis or myxomatous change which in turn may be dependent upon the primary rate of growth of the tumor. Ulceration is usually a very late finding unless the tumor growth is of such unusual rapidity that it outstrips its own blood supply.

#### RECURRENCES

It has often been stated by way of definition that fibrosarcoma is a tumor arising from connective tissue characterized by a tendency to recur after excision. Taylor and Nathanson recently reviewed 246 cases covering a period of 25 years. Of this group 62 per cent represented recurrences when first requesting their treatment and of the remaining 97 primary cases local control of the disease was effected in only half the patients. One feels that recurrence or persistence of the disease has become an accepted fact when discussing this type of tumor. It is this tendency toward local recurrences that has limited surgical effectiveness in the therapy of the disease. Were this controlled then an increasing number of patients would be salvaged before the well known blood borne fatal metastasis takes place.



Fig. 2. Fibromyxosarcoma presenting a well defined capsule with attachment to nearby muscle due to tumor cell permeation resulting in partial destruction of the capsule.

Study has shown that in general there are four different microscopic mechanisms, any one two three or four of which may be instrumental in the production of the recurrence. The first and probably most common, mechanism is that of extension of the tumor through its capsule with quite minor involvement of a nearby structure. This is far more obvious to the microscopist than to the surgeon. Although this may be overlooked in the gross specimen it may be noted on careful examination as a point of minor adherence to nearby muscle or it may occur at the apparent point of tumor origin (Fig. 2). In general these tumors grow in the direction of least pressure but despite this advantage to the host, the point of origin or any other point of attachment may present areas in which the tumor has penetrated the capsule, even dissolving it at times to invade the surrounding tissue with the capsule appearing grossly intact (Fig. 3). A pseudocapsule may even form to confuse the gross picture there being a layer of fibrous tissue thrown up in front of the advancing tumor. Such permeation of tumor cells produces a focus which if left *in situ* will be a nidus for local recurrence.

The second mechanism pertains to the factor of lymphatic spread. This is a neglected subject because lymph node involvement typically occurs late in the course of the disease, although in 1926 Hertzler reported a patient with early involvement. It has been noted as high as 8 per cent in a series of 256 cases.

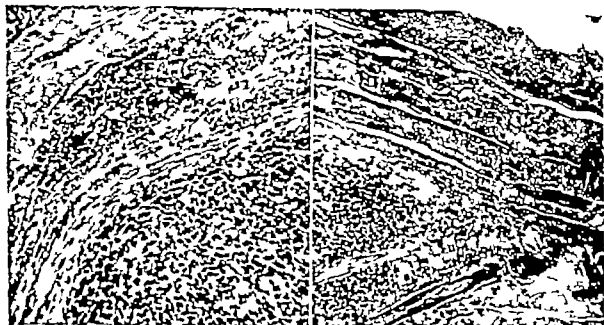


Fig. 3. a, left, Penetration of fibrosarcoma through its own capsule. b, The spread of cells at the apparent

point where the tumor had its origin from the *Soma ponceurosis*.

Long duration large size of the primary tumor local recurrence after excision and ulceration are prominent findings in proven instances of lymphatic metastasis. There is no doubt but that the tumor is slow to reach the larger lymphatic regional collecting depots, but the fact that such does occur must make one realize that involvement of lymphatic channels in the areolar tissue about the tumor at the time of excision is a potential hazard for recurrence. Under such circumstances local as well as distant spread of the tumor becomes more likely during the surgical procedure since many new tissue spaces are laid open to the tumor cells.

The third mechanism concerns the concept of multicentric origin of some of the tumors. This follows from the original observations made by Geschickter (3, 4) and by Stewart and Copeland. Working with neurogenic sarcoma they have noted the frequent development of a tumor after surgery higher up in the nerve trunk. Geschickter concluded that this represented an extension from the original tumor along the perineural lymphatic spaces. In the same manner he implicated the perivascular lymphatics of large vessels which were connected with the main tumor mass. On

the other hand Stewart and Copeland have considered such a neoplasm to be an independent new growth arising in the condensed segment of the same nerve, thus attributing a certain tendency toward malignant degeneration to the nerve structures. In studying the malignant changes in 466 patients with von Recklinghausen's disease, Hosoi has shed light on the problem by stating

In résumé malignant transformation takes place in about 13 per cent of all cases of von Recklinghausen's disease. When this happens, the tumor grows rapidly and tends to recur locally even after repeated operative measures. In some cases the mere extirpation of a malignant tumor or even a benign one appears to stimulate another neurofibroma distantly located to undergo sarcomatous transformation."

The accompanying photomicrographs present an excellent example of multicentric origin of malignant neurinoma arising within the intermuscular fascial planes of the erector spinae muscle group (Fig. 4). The differential identification here lies between a lymphatic metastatic nodule lying in the soft areolar tissue surrounding the primary encapsulated tumor and a second primary neoplasm arising in a nearby branch of the same nerve from which arose the original neurinoma. Close micro-



Fig. 4. a, left, Second primary malignant neurinoma found in areolar tissue surrounding an encapsulated neurinoma of the back. b Higher magnification shows the

mimicry of structure including the slight fibrous capsule. The tumor apparently did not reach within a lymphatic channel.

scopic study makes the latter opinion the more tenable.

The fourth mechanism concerns the now well substantiated phenomenon of autoinoculation or implantation at the time of surgery due to spillage of tumor cells into the wound. The experience of Harrell and Volk is cited in this regard. These men reported an accidental autogenous transplantation of an ulcerated fibrosarcoma of the heel to the left thigh during the application of a pedicle skin graft. This was explained as due either to direct extension of the tumor through the graft or by accidental contamination of the incision at the donor site with tumor cells. The experience of Greene in successfully transplanting human fibrosarcoma to the anterior chamber of the eyes of guinea pigs and carrying it by serial transfer through 14 generations adds further weight to this concept.

#### TREATMENT

Before considering the application of these observations as they might be related to therapy it is of interest first to note the report of Meyerding, Broders and Hargrave covering a 20 year span in which they recorded a 3 year survival rate of 21 per cent in 132 patients afflicted with fibrosarcoma. Since it is now generally agreed that radiation therapy is of little value (1, 12) the obvious conclusion to be drawn from such a pessimistic report as well as our own experience is that the primary surgical attack on these tumors appears to be

inadequate in many instances. For these tumors located in the extremities one might easily conclude that the percentage of cures could be increased by routine amputation but closer examination of a large series of cases reveals that this would result in an unnecessarily large number of amputees without materially lowering the death rate. Thus Meyerding and his co-workers reported that of 28 cured patients in their series only 6 had amputations performed. There is no doubt but that amputation is absolutely mandatory when complete excision is impossible, when deep nerves or vascular trunks appear to be involved or when recurrence has taken place for the first or second time. Even in this last mentioned group where recurrence has taken place, Meyerding reports but five cures in 34 instances where amputation was performed in the absence of demonstrable metastases. We realize that proper evaluation of available statistics on amputation for these tumors is difficult because of the previous inaccurate histological differentiation and also since this maneuver usually has been reserved for the advanced cases, but nevertheless the procedure does not seem to fit all the requirements for the patient requesting primary care.

The answer to this low rate of cure seems to lie in the performance of a more complete local excision at the time of the first surgery. In a negative way this means that the tumor should not merely be shelled out of its connective tissue bed. In a positive way this

means that the tumor and its areolar tissue bed plus any attached muscle, nerve, or blood vessel should be excised *en masse*. Blunt dissection here is not the answer. In reviewing the operative reports concerning the removal of some of these tumors, we have noted that the tumor frequently was shelled from its bed down to an apparent point of origin or at least to a point of attachment from which it was cut free with a scalpel. Because of the lymph drainage within a muscle, it is felt that partial excision of muscle may be inadequate when a muscle belly appears to be invaded. In such instances our experience would lead us to suggest that complete extirpation of the muscle or group of muscles is far superior to a recurrence. Section of nerve trunks and ligation of vascular highways should best be performed as far as possible from the tumor. If involvement of these structures presents insufficient indication for amputation then the least we can advise is wide excision and restoration of nerve continuity with fresh autogenous or homogenous grafts. The logic of such a procedure has been clearly demonstrated. (2) With the more prevalent ability in skin grafting there seems to be no excuse for allowing any possibility of recurrence by cutting too close to the tumor when excising overlying skin.

#### APPLICATION OF SURGICAL EXCISION

From the practical standpoint these generalities, if accepted, must be reduced to terms of procedure for the individual patient. In other words some consideration must be made concerning the incision to be used as well as the part to be played by the pathologist if needed in establishing the diagnosis. These steps must be carried out with sufficient ease and safety to allow for the most efficient surgical extirpation possible. Our feeling at this time is that most tumors found in the areas mentioned eventually are proved to be malignant following microscopic study. Very few instances of purely benign tumors can be found among such a group except for the fibromas with their characteristically long history and small size and the lipoma which is quite easily identified. Willson found that 90 per cent of 111 specimens of fibrosarcoma measured over 5 centimeters in greatest diam-

eter while the same percentage of fibromas measured under 3 centimeters. Such information may be helpful but not unless correlated with duration and rate of growth. Certainly any small subcutaneous nodule which has persisted for years and which suddenly begins to grow rather rapidly will be suspected of malignant change before it reaches the critical size of 5 centimeters.

If the diagnosis is obvious a more vigorous attack can be planned at the earliest phase of the surgical intervention. There is no doubt but that the element of surgical judgment is prominent in such a matter and for the sake of clarity it is logical to liken this problem to that of breast carcinoma. In many instances the experienced surgeon can with the fullest justification proceed with his radical mastectomy without the aid of a frozen section because to him the pathological diagnosis is quite evident while in other instances he will rely upon the microscope following a local excision before going on with the more radical procedure. Unfortunately the pathologist finds himself at a disadvantage with the frozen section technique when attempting to diagnose some of these tumors without the use of special stains. Theoretically this very practical procedure loses some of its utility but this does not mean that it should be omitted from our armamentarium when we are in doubt, for it can establish in a general way the degree of malignancy that an individual tumor may possess. By this we mean that a "mad dog" type of tumor can be differentiated from a "sleeping dog" type irrespective of the cellular origin. The relative proportion of cells to fibrillar intercellular substance is probably the best single criterion for estimating the degree of malignancy in these tumors.

#### SUMMARY

The high mortality rate in patients afflicted with fibrosarcoma presents a severe challenge to the surgeon. Some of these patients probably never will be cured but many can be salvaged by preventing fatal blood-borne metastasis. This form of metastasis appears to be related to the incidence of local recurrence more than to the incidence of the disease. The local extirpation of the disease thus becomes

of paramount importance. Since the tumor frequently occurs in the extremities the question of amputation also must be considered among the methods of obtaining local control of the disease. At the present time we feel reluctant to advise amputation when a satisfactory local excision can be first achieved but on the other hand if a careful evaluation of the speed of growth the size location and histological nature of the tumor would warrant it amputation should be carried out as the procedure of choice. If the tumor presents as a recurrence, it is highly likely that a high amputation should immediately be advised unless a more adequately wide excision could still be performed. In such instances, the size of the resulting defect should not be a barrier for adequate excision as long as proper skin replacement can be achieved. It is not possible to outline typical procedures to be followed for each instance but we are impressed with the

fact that the successful outcome in most instances will be determined by the procedure used at the time of the first surgical intervention

## REFERENCES

1. BICK, E. M. Arch. Surg. 1938, 37 973.
2. DAVIS, L., PERRET, G., and CARROLL, W. W. Ann. Surg., 1945, 121 686.
3. GESCHICKTER, C. F. Am. J. Cancer 1935 25 377.
4. GESCHICKTER, C. F., and LEWIS, D. Am. J. Cancer 1935 25 630.
5. GREENE, H. S. N. Cancer Res., 1942 2 649.
6. HARRILL, G. T., and VOLK, A. Ann. Surg. 1940, 111 285.
7. HERTZLER, A. E. Ann. Surg., 1926, 84 489.
8. HOGAN, E. Arch. Surg., 1931 2 258.
9. MEYERHOF, H. W. Broders, A. C., and HARGRAVE, R. L. Surg. Gyn. Obst., 1936 62 1010.
10. STEWART, F. W., and COPELAND, M. M. Am. J. Cancer, 1931 15 1235.
11. TAYLOR, G. W., and NATHANSON, I. T. Lymph Node Metastases, New York Oxford University Press, 1942.
12. WARREN, S. and SOMMER, G. N. J. Arch. Surg. 1936, 33 425.
13. WILSON, D. O. Surg. Gyn. Obst., 1945 80 500.



# PANCREATIC REFLUX DELIBERATELY PRODUCED

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THE importance of biliary-pancreatic reflux as an etiological factor in the production of acute pancreatitis or acute cholecystitis has been amply demonstrated in recent years (1 3 5 7 8 9)

In the past, pancreatic reflux was demonstrated in about 25 per cent of patients in whom a tube was placed in the biliary tract at operation (2 6) The diagnosis was based on two methods (1) the finding of pancreatic enzymes (notably amylase) in high concentration in the bile recovered from the tube drainage and (2) the visualization of the pancreatic duct when iodized oil was injected into the tube draining the biliary tract

These observations frequently depended on a fortuitous conjunction of events. As a rule pancreatic enzymes could be found in the bili-

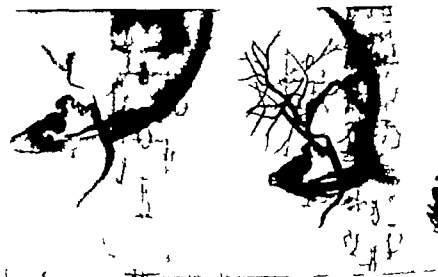
ary drainage only occasionally usually after meals (2) but sometimes only in samples obtained late at night (Table I). Similarly the pancreatic duct could be visualized during the performance of a cholangiogram only during such accidental periods when the pancreas was not secreting and when in addition the sple-

TABLE I — AMYLASE CONCENTRATION (RCE PER 100 C.C. GLUCOSE) IN TUBE DRAINAGE BILE OBTAINED AT 2 HR. INTERVAL FOR 24 HRS

Time of bile collection 1 hr. interval	Days after operation
Noon	0
2:00 p.m.	0
4:00 p.m.	0
6:00 p.m.	0
8:00 p.m.	0
10:00 p.m.	0
Midnight	0
2:00 a.m.	555
4:00 a.m.	950
6:00 a.m.	600
8:00 a.m.	450
10:00 a.m.	450

From the Department of Surgery, New York University College of Medicine.

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Figs. 1 and 2. Before the administration of morphine (Fig. 1) the injection of iodized oil fills out the common duct, then runs into the duodenum. Only the terminal parts of the hepatic duct are outlined. Two minutes after subcutaneous administration of morphine, the continued injection of iodized oil results in the visualization of the whole biliary tract. This is due to the increased resistance of the sphincter of Oddi.

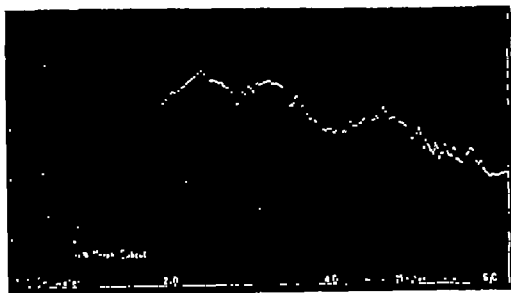


Fig. 3. Kymographic tracing of the resistance of the human sphincter of Oddi. Following the administration of morphine,  $\frac{1}{6}$  grain, the normal resistance of the sphincter (150 mm of water) rises to 300 millimeters and gradually subsides to 200 millimeters in one hour.

ter of Oddi was sufficiently spastic to permit the reflux of iodized oil.

An effort, therefore, was made to determine the optimum conditions under which reflux of pancreatic juice could be routinely obtained and the pancreatic duct could be visualized most frequently during cholangiographic studies.

When the resistance of the sphincter of Oddi is normal (about 150 mm of water) iodized oil passes through the common bile duct into the duodenum without filling the fine bile ducts (Fig. 1). Two minutes after the subcutaneous injection of  $\frac{1}{6}$  grain of morphine (Fig. 2), the whole biliary tract can be visualized. Kymographic tracings (Fig. 3) reveal these pressure changes clearly. (4) One can note however that the resistance of the sphincter which rises

to 300 mm of water comes down to 200 mm at the end of an hour. The intraduodenal injection of hydrochloric acid causes a temporary spasm of the sphincter lasting 10 minutes (Fig. 4). When the sphincter is moderately spastic (Fig. 5) in cases in which the bile and pancreatic ducts join above the sphincter, the iodized oil runs up the main pancreatic duct and out through the accessory pancreatic duct (Santorini) when this duct is present. In the

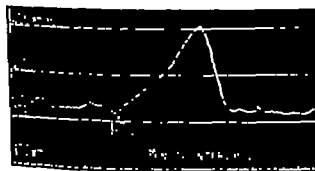
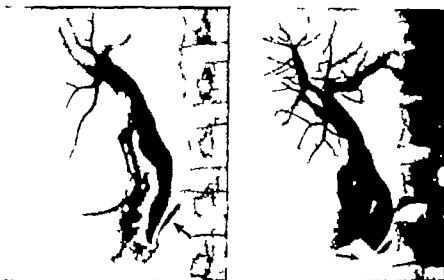


Fig. 4. The intraduodenal installation of tenth normal hydrochloric acid causes immediate spasm of the sphincter of Oddi. The resistance rises from about 150 to 250 millimeters of water and the effect wears off in about 10 minutes.



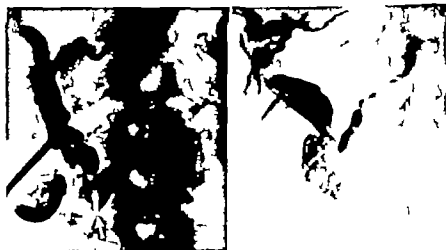
Fig. 5. Visualization of the main (Wirsung) and accessory (Santorini) pancreatic ducts. The iodized oil passes down the common bile duct, meets with resistance from the sphincter of Oddi, and passes up the main pancreatic duct of Wirsung and then through the accessory duct of Santorini into the duodenum.



Figs. 6 and 7. Injection of iodized oil shows considerable spasm of the sphincter of Oddi (Fig. 6, left) since the hepatic ducts are outlined to a considerable extent before the oil passes into the duodenum. At the same time, a portion of the pancreatic duct (arrow) is filled. The junction of the common and pancreatic ducts at the ampulla of Vater is clearly visualized. Following the administration of morphine (Fig. 7) the whole biliary tract is outlined. The increased tonicity of the duodenal wall as a result of morphine action causes compression of the intramural portion of both the common and pancreatic ducts. The ampullary junction of these ducts are, however still clearly outlined (arrow).

following case (Fig. 6) one can clearly see the submucosal junction of the two ducts. Two minutes after the injection of morphine (Fig. 7) the whole biliary tract is outlined due to spasm not only of the sphincter but of the duodenal wall through which both ducts pass.

When the bile and pancreatic ducts are connected by a fully unobstructed passageway as in the following unusual case (Figs. 8 and 9) which Dr. Ralph Colp of The Mt. Sinai Hospital kindly allowed me to study, passage of pancreatic juice into the biliary drainage was



Figs. 8 and 9. Injection of iodized oil reveals a hugely dilated choledochus and markedly dilated tortuous pancreatic duct (Fig. 8). The narrow submucosal junction of the two ducts is clearly seen (arrow). Another view (Fig. 9) outlines the whole dilated pancreatic duct as far as the tail.



Fig. 10. Simultaneous collection of T tube bile drainage (5 tubes on left) and duodenal drainage (5 tubes on right) following the injection of secretin in the case illustrated in Figures 8 and 9. The first tube contains drainage of the 10 minute control period, and the following consecutive tubes drainage of 10, 20, 40, and 60 minutes after secretin stimulation. Note the variations in the density especially of the T tube drainage, due to spurts of almost water clear pancreatic juice mixing with the bile.

of quite frequent occurrence. When secretin was administered intravenously to produce pancreatic reflux under controlled basal conditions, it was found (Fig. 10) that about half the pancreatic juice passed into the duodenum while the other half passed up the common bile duct. Gushes of almost water clear bile (containing pancreatic juice) would

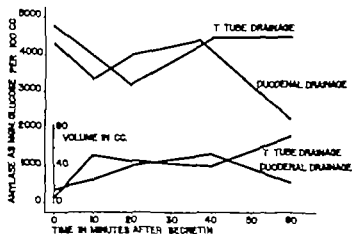
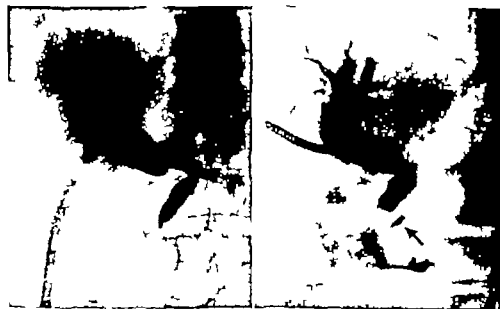


Fig. 11. Concentration of amylase in T tube and duodenal drainage following the intravenous injection of secretin in the case illustrated in Figures 8, 9, and 10. The variations in the amylase content of the two drainage fluids appear to be related to the changes in the volume of secretion.

alternate with darker bile coming unmixed from the liver. Similarly the duodenal drainage contained occasional traces of bile but frequently was water clear. The composite result depended on the resistance of the sphincter and the volume of secretion at various intervals.

When this drainage material was examined for amylase (Fig. 11) it was seen that the concentration of amylase was approximately equal in the biliary and the duodenal drainage the



Figs. 12 and 13. Injection of iodized oil in this case in which amylase was recovered in the T tube drainage, revealed a moderately spastic sphincter and a dilated common bile duct (Fig. 12, left). The pancreatic duct (arrow) was visualized following the injection of morphine, only after two previous failures (Fig. 13).

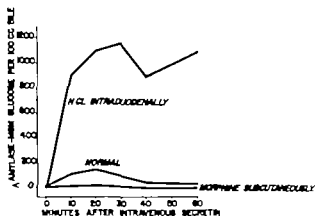


Fig. 14. The optimum conditions for the production of pancreatic reflux. In this case (Table I and Figs. 1 and 3) the injection of secretin was followed by the appearance of amylase in low concentration in the and 30 minute samples only. Morphine stopped all reflux due to spasm of sphincter of Oddi and duodenal wall. Hydrochloric acid intraduodenally produced spasm only of the sphincter and resulted in a maximum reflux of pancreatic juice.

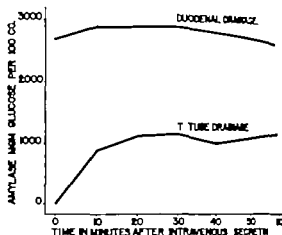


Fig. 15. The relative concentrations of amylase in the T tube drainage and in the duodenal drainage following spasm of the sphincter of Oddi produced by intraduodenal administration of hydrochloric acid (see Fig. 14). This indicates that about one third of the biliary drainage consisted of pancreatic juice.

small differences being due to variable admixtures of bile.

However in most cases of pancreatic reflux, amylase was found in the biliary drainage quite infrequently and the pancreatic duct was visualized only after producing spasm of the sphincter of Oddi by means of morphine.

In the following case (Figs. 12 and 13) the pancreatic duct was visualized by injection of iodized oil only after the third attempt, and amylase was found in the bile after six samples of bile were analyzed.

Accordingly the patient was given intravenously a standard dose (80 clinical units) of



Figs. 6 and 7. The optimum conditions for visualization of the pancreatic duct. Iodized oil was injected into the biliary tract in patient who had been fasted, had all stomach contents aspirated by Levine tube suction for hours previously and had received subcutaneous injection of  $\frac{1}{8}$  grain morphine hour previously—not complete filling of pancreatic duct (arrow). Slight rotation of the patient (Fig. 7 right) clearly reveals the anatomical relationship of the two ducts and their junction above the sphincter of Oddi.

secretin and the biliary drainage collected at 10, 20, 40, and 60 minute intervals (Fig. 14). Amylase was recovered only in the 10 and 20 minute samples. When morphine was given just before the injection of secretin no amylase was recovered due to the fact that the spasm produced by the morphine involved not only the sphincter of Oddi but also the duodenal wall, shutting off any reflux. In a third procedure a duodenal tube was passed and following the injection of secretin intravenously 20 cubic centimeters of one-tenth normal hydrochloric acid was introduced intraduodenally every 10 minutes. This produced spasm of the sphincter but not of the duodenal wall and as can be seen a large amount of pancreatic juice (as represented by amylase) was recovered in the biliary drainage. The concentration of amylase recovered in the bile as compared to the concentration in the duodenal contents (Fig. 15) showed that one third of the biliary drainage consisted of pancreatic juice. There can be no question that such procedures which control both the flow of pancreatic juice and the resistance of the sphincter of Oddi will result in the discovery of the maximum incidence of pancreatic reflux.

Similar principles were applied in the visualization of the pancreatic duct by iodized oil. Since two main factors food and hydrochloric acid, stimulate the secretion of pancreatic juice, the patient was fasted and a Levine tube was passed 2 hours prior to x ray examination

for continuous suction of the stomach contents. To control the resistance of the sphincter of Oddi, morphine,  $\frac{1}{8}$  grain, was given one hour prior to the cholangiographic study. As the kymographic tracing in Figure 3 demonstrates 1 hour after morphine injection the resistance of the sphincter falls almost invariably to about 200 millimeters of water. By this time the spastic effect of morphine on the duodenum has worn off. When iodized oil was injected into the common bile duct under such conditions the whole pancreatic duct was visualized (Figs. 16 and 17).

#### CONCLUSION

Therefore it can be seen that control of pancreatic secretion and control of the resistance of the sphincter of Oddi by various means can be utilized to diagnose pancreatic reflux after operation on the biliary tract. Similar methods are being developed now to diagnose this condition on the operating table.

#### REFERENCES

1. ARCHIBALD, E. *Surg. Gyn. Obst.*, 1919, 28 529.
2. COLP, R. and DOUBILET, H. *Surgery* 1938 4 837.
3. COLP, R., GERBER, L. and DOUBILET, H. *Ann Surg* 1936, 67 103.
4. DOUBILET, H., and COLP, R. *Surg. Gyn. Obst.*, 1937 64 622.
5. ELMAN, R., ANDERSON, N. and GRAHAM, E. A. *Arch. Surg.* 1929, 19 943.
6. LEVINE, N. L. *Proc. Soc. Exp. Biol. N. Y.* 1938 38 808.
7. OBER, E. L. *Bull. Johns Hopkins Hosp.*, 1901 12 182.
8. WOLTER, J. A. *Surg. Gyn. Obst.*, 1931 53 433.
9. WALTER, W., and MARSHALL, J. M. *Surg. Gyn. Obst.*, 1930, 50 627.

## THE EFFECT OF EARLY POSTOPERATIVE RISING ON THE RECURRENCE RATE OF HERNIA

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THE original article on this subject was written by Ries, a gynecologist in Chicago in 1899. He was impressed by the rapid return of strength in the patients who rose early after operation and he noted the lack of unfavorable complications resulting from early rising. Although the practice of early postoperative rising was taken up by many of the European surgeons it was not widely used in this country until interest in the subject was stimulated by Leithauser of Detroit in 1941 when he published a series of 436 cases. Since the publication of Leithauser's first article there have appeared a number of clinical reports on early postoperative ambulation.

In June of 1942 a critical investigation of early postoperative rising was undertaken at the Peter Bent Brigham Hospital (1). This was to study what effect early ambulation has on postoperative complications, and whether it has any effect on the late operative results. Since postoperative complications are most common among patients having major intra-abdominal surgery this group was used to test the effect of early postoperative rising on postoperative complications. Two hundred and thirty-eight such patients who had risen on the first or second postoperative day were compared with 443 patients who got up after the seventh postoperative day. Our pertinent conclusions of that study were that the incidence of atelectasis was slightly lower in the early rising group (4.6% compared with 6.3%) and that the incidence of deep-leg vein thrombophlebitis however was slightly higher in the early rising group (2.9% compared with 1.8%). With respect to the incidence of postoperative wound disruption there was a slight reduction in the early rising group (1.3% against 2.7%).

From the Peter Bent Brigham Hospital, Surgical Service.  
Presented in the forum on Fundamental Surgical Problems before The Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-30, 1940.

Today we present the results of a controlled study to determine the influence of early postoperative rising on the recurrence rate of hernia. The control group consists of 301 various herniorrhaphies on 177 patients. These patients got out of bed on the seventh to the fifteenth postoperative day. They were followed from 6 months to 7 years. The test group consists of 174 herniorrhaphies in 139 patients. The majority of the test group rose on or before the first postoperative day; 11 patients rose on the second day. They were all followed from 6 months to 4 years. Interrupted, fine silk technique was used in all cases of both groups.

The technique of getting the patient out of bed is essentially the same as Leithauser's. On the morning following operation the patient is turned on the side operated upon. He flexes his hips and knees so that his lower legs are at the edge of the bed. The nurse holds her elbow in the patient's elbow and the patient pushes his feet off the side of the bed as the nurse assists him up sideways to a sitting position. As the patient sits on the side of the bed slippers with heels, or shoes, are put on before he stands on the foot stool. While standing he is encouraged to breathe deeply and to cough several times. The patient then walks around the bed and sits in his chair for about 20 minutes. As he returns to bed, the walking and coughing are repeated. He is assisted out of bed in this manner twice daily until he can get up himself which in cases of herniorrhaphy is usually on or before the third postoperative day. If the patient wishes to get out of bed on the day of the operation, he is allowed to do so unless there is some specific contraindication. Many of the patients who had had herniorrhaphy performed under local nerve-block anesthesia, got out of bed to eat lunch on the day of operation.

There was no selection among the patients who rose early following herniorrhaphy. The

TABLE I.—THE RECURRENCE RATE OF INDIRECT INGUINAL HERNIAE

Type of operation	Non-early risers		Early risers	
	Number	Recurrence	Number	Recurrence
Halssted	27	3	30	3
Bassini	85		7	
Other	Ferguson 1 McVay 1 Other		Ferguson 1 McVay 7 Orchidectomy 1 Others	
Totals	112	(3.6%)	37	(4.3%)

TABLE II.—THE RECURRENCE RATE OF DIRECT INGUINAL HERNIAE

Type of operation	Non-early risers		Early risers	
	Number	Recurrence	Number	Recurrence
Halssted	7	5	22	4
Bassini	18		20	
Others	McVay 1 Gallie		McVay 1 Orchidectomy	
Totals	25	(6.4%)	42	(4.8%)

group includes older patients patients with poor abdominal wall structures, and patients who had all types of anesthesia and operative repairs.

As a group, the early risers were somewhat older because the younger patients were in the Army during the period when most of the early rising patients were operated upon. As we review the two groups we are again impressed by the rapid postoperative recovery which is found to be present among the group of early rising patients.

In comparing the recurrence rates in the two groups, the results are classified with respect to the method of operative repair<sup>1</sup> and the type of hernia, that is indirect direct femoral incisional and umbilical. Indirect inguinal hernia according to Watson's monograph, carries a recurrence rate of 5 to 10 per cent. Shelley in an exhaustive study of over 1600 indirect inguinal herniae at the New

<sup>1</sup>The Halssted repair refers to Halssted's modified repair in which both the conjoint tendon and the external oblique fascia are sutured below the spermatic cord so that the cord is transplanted into the subcutaneous tissue and the external ring approximates the internal ring in position.

TABLE III.—THE RECURRENCES IN FEMORAL, INCISIONAL, AND UMBILICAL HERNIAE

Type of hernia	Non-early risers		Early risers	
	Number	Recurrence	Number	Recurrence
Femoral	8		6	
Incisional				
Umbilical	3		7	

TABLE IV.—TOTAL RECURRENCE RATE OF INGUINAL HERNIAE

Type of hernia	Non-early risers			Early risers		
	Number	Recurrence	Per cent	Number	Recurrence	Per cent
Indirect	13	5	38	24	5	4.3
Direct	40	6		36	4	
Totals	180	6		30	0	0

York St. Luke's Hospital found a recurrence rate of 7.2 per cent.

Table I gives a tabulation of the recurrences in indirect inguinal herniae. It shows that in the non-early rising group there were 5 recurrences in 131 operations and that in the early rising group there were 5 recurrences in 114 operations. This is a recurrence rate of 3.8 per cent in the non-early risers and 4.3 per cent in the early risers.

For direct hernia, Watson gives the recurrence rate as between 10 and 20 per cent. It may even be higher. As recently as 1942 Page reported a recurrence rate for direct hernia of 35 per cent.

Table II presents a tabulation of the recurrences for direct inguinal herniae which shows that, in the non-early rising group there were 6 recurrences in 49 repairs. In the early rising group there were 4 recurrences among 36 repairs. This is a recurrence rate of 12.2 per cent in the non-early risers and 11.1 per cent in the early risers.

The recurrences in the few femoral incisional and umbilical herniae are listed in Table III. This shows no appreciable increase in recurrences in this small group as a result of early rising.

Table IV gives the total recurrence rate in inguinal hernia. It is seen that the recurrence rate in 180 inguinal herniorrhaphies treated



by postoperative bed rest is 6.1 per cent whereas, the recurrence rate in 150 inguinal herniorrhaphies treated by early rising is 6.0 per cent.

#### CONCLUSION

We conclude from these data, that early postoperative rising exerts no significant effect on the recurrence rate of hernia.

#### REFERENCES

1. BLODGETT J. B., and BRATTLE, E. J. *Surg. Gyn. Obst.*, 1946, 82, 485.
2. LEITHAUSER, D. J. and BERGO, H. L. *Arch. Surg.*, 94, 42, 1936.
3. PAGE, C. M. *Proc. R. Soc., Lond.* 1943, 36, 125.
4. RIES, E. J. *J. Am. M. Ass.*, 1899, 33, 454.
5. SHELLEY H. J. *Arch. Surg.* 94, 41, 747.
6. WATSON, L. F. *Hernia*. 2nd ed. St. Louis C. V. Mosby & Co. 1938.

# THE USE OF THE MALE SEX HORMONE IN WOMEN WITH BREAST CANCER

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WE have now arrived at the point where it has become profitable to pursue the use of hormone therapy in certain types of human cancer. Huggins made one of the most important contributions that have been made in many years in the field of cancer when he was able to produce 25 per cent cures in prostatic cancer—a disease widely recognized to have an extremely high mortality. His study of the hormone influence in this disease naturally suggested exploration of other fields where cancer is either produced or materially influenced by the sex hormones. Beside the prostate it is patent that other organs such as the breast, uterus, ovaries, adrenal testes and thyroid should each receive serious attention and experimentation.

I recently made a study of 5000 cases of early breast cancer relative to their ages at the time of the development of their cancer.

The peak of the greatest number developing cancer was 45 years. This age probably represents the time when certain chemical changes are present deviating somewhat from the normal ovarian hormone. The ovaries are undergoing at this age certain changes leading up to the menopause which comes on at an average of 46½ years.

On the other hand, the year when next to the greatest number develop breast cancer is age 60 years and here we probably have a patient who has practically no ovarian hormone output. It is possible that the 13 or 14 years since having a definite ovarian function as evidenced by menstruation may represent a complete lack of ovarian hormone output and may represent a possible cause for the production of breast cancer in the older age group. This theory fits well into the fact that

the women of 60 years and older with breast cancer are improved by the use of the estrogens.

During the past several years my department has been making a clinical experimental study on approximately 200 cases of cancer of the female breast in which testosterone propionate has been employed.

In the beginning the results of this therapy when using small amounts seemed to be of no value (Farrow and Woodward). I next treated 48 patients in my private practice employing a daily dose of 25 milligrams intramuscularly to each patient (175 mgm weekly). It soon became obvious that in certain cases of advanced breast cancer and more particularly in those metastatic to bone, that we were dealing with a very potent agent capable of producing striking clinical improvements as well as changes some of which were demonstrable by x ray films.

Up to this time we had been hampered in our clinical research by the high cost of testosterone propionate, and at this juncture Dr. Henderson of the Schering Corporation generously made it possible for us to commence our new attack employing large doses.

Dr. Julian Herrmann and I then began by giving some patients as much as 100 milligrams daily by intramuscular injections of the agent in oil. We varied the dose using in some instances the testosterone pellets placed subcutaneously in order to obtain a more prolonged absorption of the agent. After much trial and error we arrived at our present dose of 100 milligrams by intramuscular injection three times weekly for a period of 8 to 10 weeks making a total dosage of 2400 to 3000 milligrams. We freely admit that we have not come to a final conclusion as to what should be the exact dose, how much total should be delivered and how long it should be continued. Obviously many of these factors must be determined and will be influenced by whether or not the patient

The studies were made possible by a grant from Mr. Louis Marx to the Breast Service of the Memorial Hospital, New York. Presented in the symposium on Cancer before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.

still menstruates, on whether or not her ovaries have been made functionless by x ray or surgical castration as well as many other factors.

At the present time the work is being pursued by my associates and myself not only in the advanced cases but also in the new cases of early operable breast cancer.

It has now gotten almost beyond the point where it is necessary to demonstrate the value of testosterone therapy by giving case reports as we have already placed ample cases in the literature which show the value. We are now at the point where we can draw general conclusions of what may be anticipated by this therapy.

Our experience has shown that in only a small percentage of cases is improvement to be anticipated when the cancer involves the soft tissues such as liver, lungs, brain and local skin recurrence. It is true that in a few instances there have been striking improvements where an advanced ulcerating breast cancer with surrounding skin nodules, axillary nodes and neck nodes were involved where masses were metastatic to the lungs and in one instance where the patient was having convulsions from metastatic disease in the brain. However I fear it must at present be taken for granted that most such cases receive no benefit aside from the temporary general improvement which frequently comes as a result of testosterone injections.

On the other hand a most striking improvement is obtained in most of those cases having bone metastasis. There is some specificity or predilection for the agent to do its work of repair in the bone cases—and as yet we do not understand the reason. It is probable in the metabolism of bone repair under the influence of testosterone that the billions of cancer cells are 'snowed under' by the copious deposit of calcium precipitates especially in areas of bone destruction—a locking in process where cell reproduction is difficult. Similar to prostate cases, the cancer cells will still be present after testosterone therapy. We do not yet know whether the improvement of the bone destruction by the invading cancer is confined to cases of breast cancer alone or whether metastasis to bone from some other

type of cancer may also be improved by testosterone such as from thyroid or ovaries. It is important that this study be pursued and that a study in cases of primary bone sarcoma also be carried out.

After approximately 2 weeks of testosterone therapy the relief of pain from bone metastasis is usually very real. Lack of sleep due to pain is replaced by a natural sleep. It is usually possible to cease giving narcotics which may have been given in large amounts. Some of our patients who had such pain that it was not possible to continue their work, were able to return to their jobs in comfort by the end of a month of therapy. The areas of bone destruction as evidenced by absorption of the calcium salts by collapse of vertebrae, and by fracture of ribs are filled in with dense callus similar to that seen following x ray therapy. How long this improvement in the osseous tissue persists is not yet known. However we have 3 cases in which disease was confined to bone having no ascertainable soft tissue involvement living free of evidence of disease or symptoms for a period of 1½ to 2 years after commencing the testosterone therapy.

A brief example of one of these cases was a woman aged 71 years who had been confined to her bed for a period of 10 months, with widespread bony metastases to the spine, pelvis and ribs several of the latter being fractured. After 4 weeks of testosterone therapy she was able to leave her bed. At the end of 3 weeks of therapy she developed as is common the feeling of elation and well being. By the end of 6 weeks she was walking all over the city free from symptoms. The only symptom which bothered her was the annoyance and the irritation of the enlarged clitoris. This patient started on her testosterone therapy in July 1944 and up until December 1, 1946 a period of 2 years 4 months, was living in good health. Three weeks ago she began to have nausea which has persisted, and it may be suspected although not demonstrable that she may have metastases to the liver or to the abdominal lymph nodes. It is not unusual for a patient with metastasis to bone to keep the disease confined there for some time before finally spilling over into soft tissues such as the lungs or abdomen.



Fig. 1. Demonstrating destruction of a large area of frontal bone by metastatic cancer from breast.

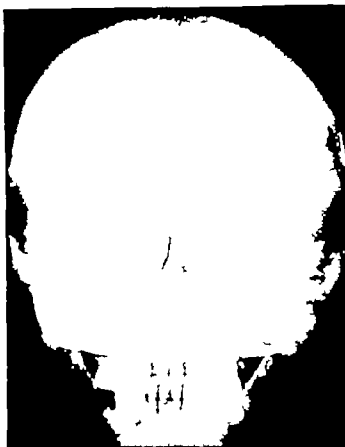


Fig. 2. The same patient 10 weeks later following 24 injections, 100 milligrams each, of testosterone propionate, totaling 2400 milligrams. The area of destruction has been filled in by callus and the mass protruding from the forehead has disappeared.

In cases of widespread bony metastasis the use of testosterone propionate seems more efficacious longer lasting and more practical than x ray therapy. When it becomes necessary to treat multiple widespread areas of metastatic bone disease, with the x rays it becomes a matter of great difficulty to deliver so many doses over so many areas not only because of the nausea which frequently accompanies such treatments but there is also the practical problem of bringing a patient who suffers intensely from bone metastasis to the hospital or x ray laboratory furthermore such a large number of x ray treatments may produce an anemia in the face of which x ray therapy itself becomes ineffective.

We have had many instances in which the skin of the patient had been so damaged by x ray therapy that it was not possible or practical to deliver further x ray treatments to the bones. Fortunately it is usually possible in such a case to commence with the testosterone therapy and still obtain some degree of clinical improvement.

In the advanced cases of bone metastasis the blood chemistry is fairly consistent. As a rule such a patient has a blood calcium well above the normal of 10 to 12 milligrams per 100 cubic centimeters. The blood calcium at times goes up as high as 17 milligrams. Under testosterone propionate therapy the rule is that the blood calcium slowly comes back into normal limits theoretically being redeposited in the areas of bone destruction.

The alkaline phosphatase also acts characteristically, it is an enzyme necessary for bone repair. The normal limits are 3 to 5 milligrams. During bone repair under testosterone this figure at times reaches as high as 15 milligrams indicating that bone repair is taking place.

Most of our work to date has been on advanced breast cancer cases. However we have recently started to work on the early operable cases of breast cancer using the radical mastectomy supplemented by large doses of testosterone implanted into the latissimus

dorsal muscle or into the subcutaneous tissues near the wound at the time of the operation. Although we have used this combination in 135 such cases to date we have nothing to report as yet. Two months after the operation we will again implant further doses of testosterone on the theory that possibly recurrence and metastasis may be influenced or lessened by subjecting any remaining cancer tissue to the unhealthy environment of testosterone bearing blood and serum. It is obvious that such a human experiment should be undertaken and evaluated.

It may be of some interest to note that in two pregnant patients with breast cancer receiving testosterone that repeated Aschheim-Zondek tests were negative up to 5 months of pregnancy when the patients could feel life.

It is scarcely necessary to state that the patient receiving testosterone therapy develops unpleasant masculinizing sequelae as evidenced by a deeper husky voice hair on the

face, pimples on the face and body and an enlarged clitoris which in certain cases becomes a source of great annoyance.

On the other hand under testosterone therapy there is usually at least temporarily a gain in weight, a feeling of well being, a loss of bone pain and a repair of the bone destruction caused by the metastatic disease.

As a rule the *clinical* improvements by the use of testosterone are far more striking than the x ray improvements reveal.

Testosterone may be employed on female patients with breast cancer at any age, while the estrogen therapy must be strictly confined to patients of 60 years and older.

It must be here emphasized that we are not stating that testosterone is a cure for breast cancer however its effects are very profound and gratifying but indicate that much more clinical research must be carried out in this field before we can fully evaluate dosage or final results.

# RESECTION OF INTRA-ABDOMINAL CANCER THAT HAS INVADED THE ANTERIOR ABDOMINAL WALL

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**I**NVASION of the anterior wall by carcinomas primary in the abdominal viscera or invasion of the anterior abdominal wall by metastases from such growths does not constitute a situation in which radical surgical excision is necessarily contraindicated. The primary growth together with its parietal extensions may be excised *en masse* to removal in some instances of all macroscopic evidence of tumor. Such procedures were carried out in a limited group of patients the histories are briefly as follows

**CASE 1** J C no 283119, male aged 66 years was subjected to a right hemicolectomy resection of the lower half of the stomach and elliptical portion of the abdominal wall about the umbilicus to remove a large carcinoma of the transverse colon which was spreading to the adjacent structures mentioned. Patient is living and well 4 years and 5 months after operation.

**CASE 2** G P no 332661 male aged 63 years, had a resection *en masse* of 16 centimeters of sigmoid

colon an elliptical segment of the parietal peritoneum and deep fascia in the left lower quadrant and segment of the lower jejunum 10 centimeters in length for carcinoma of the sigmoid which was infiltrating the jejunum and anterior abdominal wall. End-to-end enterostomy and double barrel colostomy were performed and the latter was subsequently closed. Patient is living and well 2 years 5 months after operation.

**CASE 3** J W no 274690, female aged 34 years. Laparotomy was performed for removal of many peritoneal metastases from a pseudomucinous cyst—adenocarcinoma of the right ovary in 1941. A second laparotomy was done for resection of numerous metastases over the peritoneal surfaces of bowels and in the mesentery of the small intestines. A half fist size mass infiltrating the abdominal wall in the right lower quadrant was excised together with portions of the rectus muscle. Patient is living and well 2 years 2 months after second operation.

**CASE 4** J L no 332684 male aged 39 years. Resection of the abdominal wall of the left upper quadrant and subjacent recurrent colon for carcinoma with descending colon spleen containing 4 metastases and tail of pancreas. Double-barrel colostomy was done and was later subsequently closed. Patient is living 7 year 2 months after operation. He has an enlarged nodular liver due to metastases.

**CASE 5** P W no 379472 male aged 58 years. A right hemicolectomy was done and 20 centimeters of

From the Department of Surgery, University of Chicago. These studies were aided by the Chas. H. and Mary F. S. Worcester Fund, University of Chicago.

Presented in the symposium on Cancer before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.

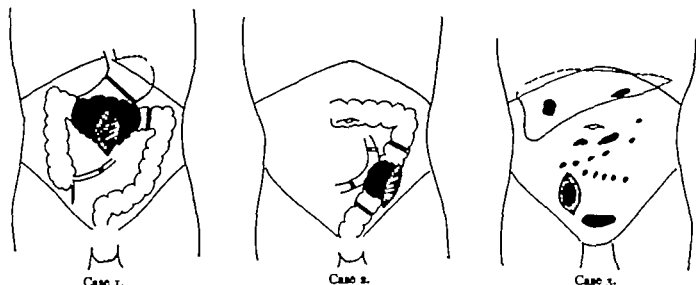


Fig. 1. Diagrammatic representation of operations performed in Cases 1 to 3. Black areas indicate carcinoma.

shaded areas indicate extent of anterior abdominal wall involved by neoplasm and resected.

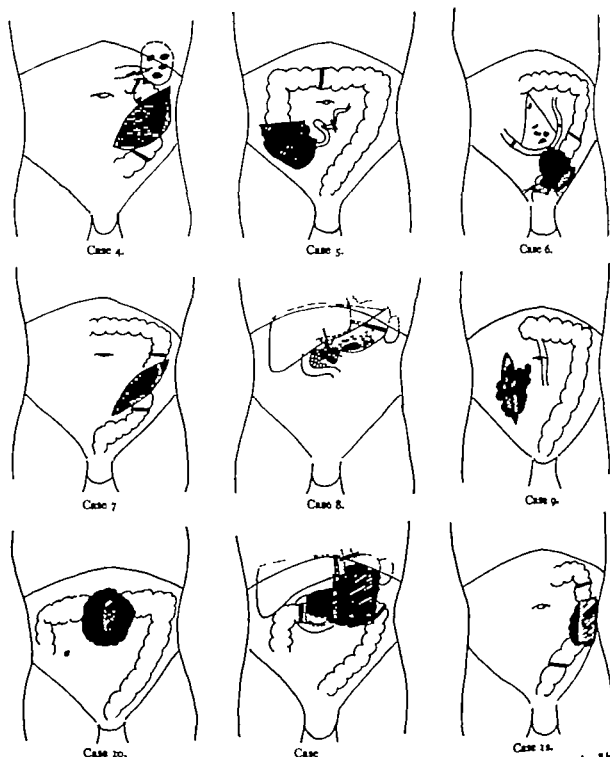


Fig. 2. Diagrammatic representation of operations performed in Cases 4 to 12. Black areas indicate carcinoma, shaded areas indicate extent of anterior abdominal wall involved by neoplasm and resected.

the lower ileum was resected *en masse* with the abdominal wall of the right lower quadrant for carcinoma primary in the cecum and infiltrating the ab-

dominal wall. Ileo transverse colostomy was made. This patient is living and well 5 months after operation.



Fig 3. Photograph of surgical specimen from Case 5 showing A large segment of lower right quadrant of abdominal wall including skin, subcutaneous fat and musculature infiltrated by C underlying carcinoma arising in cecum, B ascending and transverse colon, I lower ileum.

CASE 6 P. H. L. no 319547 male aged 49 years. An exteriorization excision was done of the sigmoid bearing carcinoma, together with a long loop of the upper ileum invaded by carcinoma, as well as the mesentery of the ileal loop the dome of the urinary bladder and the deeper portion of the anterior abdominal wall in the left lower quadrant. The colostomy was subsequently closed. Patient lived 14 months returned to work for 8 months, but died of recurrences.

CASE 7 E. R. no 160578 female aged 48 years. An elliptical incision 11 by 7 centimeters was made in the left lower abdominal wall to include the mass of recurrent colon carcinoma (previous Mikulicz resection for primary growth) and the involved subjacent descending colon. A double barrel colostomy was made. Patient lived 10 months then died of recurrences.

CASE 8 C. P. no 325186, female, aged 55 years. Resection was done of the lower two thirds of the stomach, body of pancreas, spleen, periumbilical region of the abdominal wall, the falciform ligament for carcinoma primary in the body of the pancreas, with local spread and metastases to structures mentioned. Patient lived 4 months. She died of carcinomatosis.

CASE 9 E. L. no 350135 female, aged 68 years. Resection *en masse* was done of previous lower right rectus incision scar with underlying mass infiltrating abdominal wall. Multiple small metastatic masses over the peritoneum also were excised. Patient lived 4 months received palliation.

CASE 10 Gomol no 306534 female, aged 52 years. June, 1943 a supracervical hysterectomy and salpingo-oophorectomy for bilateral cyst-adenocarcinoma of ovaries were done. October 1943 the peri-

umbilical region of abdominal wall *en masse* with underlying and attached tumor 15 centimeters in diameter was excised. The latter was a large metastatic mass, the site of extreme pain. Patient survived 2 months. She died of carcinomatosis.

CASE 11 E. B. no 339809 male aged 28 years. Operation was carried out as follows: total gastrectomy partial hepatectomy partial pancreatectomy transverse colectomy splenectomy resection *en masse* with the above, of the abdominal wall in the left upper quadrant for round cell sarcoma (radio-resistant). Patient survived 3 months died of rapidly developing sarcomatosis.

CASE 12 C. B. no 255457 male aged 48 years. Resection *en masse* was carried out of cecum ascending colon right kidney and ureter 70 centimeters of ileum and abdominal wall in the right lower quadrant for recurrent carcinoma of the cecum.

TABLE I.—SUMMARY OF RESULTS

Case 1	Living and well	4 yrs. 5 mos.
Case 2	Living and well	2 yrs. 5 mos.
Case 3	Living and well	2 yrs. 2 mos.
Case 4	Living but has hepatic metastases	1 yr. 2 mos.
Case 5	Living and well	5 mos.
Case 6	Lived	1 yr. 2 mos.
Case 7	Lived	10 mos.
Case 8	Lived	4 mos.
Case 9	Lived	4 mos.
Case 10	Lived	3 mos.
Case 11	Lived	3 mos.
Case 12	Lived	12 days
Case 13	Lived	5 days†
Operative Mortality—3 Patients		15.4%

\*Death from coronary occlusion.  
†Peritonitis.



Patient died twelfth day postoperative. Necropsy revealed coronary occlusion.

CASE 13 C F no 297424, male, aged 77 years. Exteriorization resection was done of the descending colon and the musculature of the left flank for carcinoma of the former invading abdominal wall musculature with abscess formation

#### DISCUSSION

In all instances it was possible to close the wounds tightly following resection of portions of the abdominal wall. There were no wound disruptions. Soft rubber drains were inserted in some cases when suppuration associated with the parietal invasion was obvious. No definite recommendation may be made for these repairs since each procedure represents a special situation. The generally accepted principles of fashioning full thickness (skin, fascia, and sometimes muscle) sliding flaps are followed.

Three patients have survived over 1 year and are living well, and returned to their usual occupations for an average of 36 months since operation. One patient Case 4 received palliation for a year having returned to his usual occupation but at this writing exhibits deterioration due to obvious multiple hepatic metastases.

The results in the series of 13 patients are summarized in Table I. One patient survived 1 year and 2 months dying of metastases, but had returned to work for a period of 8 months. One is living and apparently well 5 months after operation. The patients who survived for shorter periods appeared to have received palliation although this was brief. Operation was performed in these patients because of pain and obstructive symptoms referable to the mass that was excised together with its parietal extensions. Some of the best results were achieved in patients with cancer of the colon which had invaded the abdominal wall. It has long been recognized that such carcinomas may evolve by local spread to adjacent tissues and viscera before distant metastases occur and these results are in accordance with this principle.

#### SUMMARY

Invasion of the anterior abdominal wall by carcinoma primary in an abdominal viscus does not necessarily indicate that the lesion is inoperable. Palliation and prolonged survival of the patient may follow extensive resections of such neoplasms with their parietal involvements.

# OBSERVATIONS ON THE GENETIC NATURE OF GASTRIC CANCER IN MICE

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THE practice and science of medicine being based exclusively or even predominantly upon the science of bacteriology the conclusion is inevitable to some investigators that a cell or an individual is incapable of doing anything without being impinged upon by some external force. The science of genetics, stemming from the study of embryology teaches differently. Genetics teaches that a zygote that is the fertilized egg when placed in a suitable environment of temperature and humidity, given a few specific chemical entities such as the essential amino acids and the vitamins and a source of energy is capable by development from spatially related internal nuclear entities or genes of giving rise to an adult plant or animal. This determination is so precise that many racial, familial, and individual characteristics are handed down from one generation to the next. This process of heredity has undoubtedly been going on from immemorial time and it probably will go on in the future subject to change only by the sporadic appearance of mutations from time to time. It is the present intention to see whether this concept of biologic determination can also be applied to cancer particularly to cancer of gastric origin.

In the first place all cells of the body are derived by cell division from the zygote. Since cells and tissues reproduce physiological and morphological characteristics of their species in each and every generation they must, of necessity retain many potentialities from their zygotic origin. Superimposed upon this background of intrinsic determinations are many variations necessitated by environmental changes which are not of necessity hereditary. Now cancer is derived by cell division from some somatic tissue and therefore must

retain some potentialities derived from the zygote.

The production of gastric carcinoma in mice was the result of the practical application of genetic principles by which the attempt was made to duplicate or to simulate in mice the variable biological state of the human population. For this purpose the genetic processes of hybridization and selection were used. In addition however each mouse received the subcutaneous injection of 1 milligram of methylcholanthrene dissolved in 0.1 cubic centimeter of sesame oil at 60 days of age. This procedure of injection has been followed for both parents for many generations. Beginning with the early hybrid generations the tendency to give rise to local tumors at the site of the injection of the carcinogen has been suppressed by keeping the descendants of the most resistant to cancer pair of mice in each generation. Due almost exclusively to this regimen of selection toward resistance to induced cancer there has been produced an increased latent period for the appearance of not only locally expected tumors but also of other types of tumors which appeared due no doubt to the fact that the selected hybrid mice with increased biologic variability lived longer than they normally would following the injection of methylcholanthrene. Four stages or classes of mice based upon the classification of induced tumors have appeared in this selection experiment as follows: (1) the appearance of tumors such as epidermoid carcinoma and fibrosarcoma at the site of injection of the carcinogen; (2) the surface spread of tumors over the entire body such as carcinoma of the mouth, the rectum, etc.; (3) the appearance of tumors in the thoracic cavity such as adenocarcinoma of the lung, bronchiogenic carcinoma and mesothelioma; and (4) the occurrence of tumors appearing in the abdomen such as primary carcinoma of the liver, liposarcoma of the uterine mesentery, leiomyosarcoma of the uterus and gastric

This experiment has been made possible by grants from The Jane Coffin Childs Memorial Fund for Medical Research and The Anna Fuller Fund. Presented in the symposium on Cancer before the Clinical Congress of The American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.

carcinoma. Beyond these four stages where specific types of tumors occurred there was obtained a period, of short duration in which no tumors appeared in spite of the fact that an overwhelming dose of a very powerful carcinogen had been injected. Even with continued selection toward greater resistance to all types of induced tumors, there occurred a reversal of susceptibility to induced cancer in which tumors appeared earlier and earlier in the succeeding selected generations. For the present purpose however we shall confine ourselves to the gastric carcinomas which began to appear in stage 4 enumerated above. These gastric lesions showed histological variability some growing as polyps, while others grew invasively through the underlying muscular layers of the stomach. Metastases into the surrounding viscera have also been obtained from these adenocarcinomas of gastric origin. When a suitable genetic experiment had been performed, it was demonstrated that the susceptibility to give rise to this gastric lesion showed linkage relationship with the gene that underlies brown hair pigmentation. Thus it is clear that a mutation has occurred on the brown chromosome sometime during the extent of the injection of methylcholanthrene into mice and that this mutation is responsible in part, for the development of gastric carcinoma following the subcutaneous injection of methylcholanthrene. Another point of genetic interest is the fact that the untreated descendants of these mice which had developed gastric carcinoma following the subcutaneous injection of methylcholanthrene continued to develop gastric carcinoma spontaneously and they have continued to do so through eight untreated generations. At periodic times during the experiment of injecting both parents at sixty days of age with methylcholanthrene a group of 120 mice have been separated off and kept under standard laboratory conditions without being subjected to any experimental procedure. In the succeeding groups of 120 mice referred to above the incidence of spontaneous gastric lesions and carcinomas increased in frequency and, at the same time appeared earlier and earlier in life. Now there is available a strain of mice in which all individuals develop gastric lesions or carcinomas

or some closely related biological entity spontaneously the males, however showing a greater susceptibility to gastric lesions than do females.

In addition to these gastric lesions of unusual origin there has also been obtained several adenocarcinomas and squamous carcinomas of the forestomach which may serve as a source of material for other types of neoplasia induced by a subcutaneous injection of methylcholanthrene. In the gastric lesion, some of which are undoubtedly adenocarcinomas, it is clear that we have produced a hereditary disease or an inherited susceptibility to a disease by chemical means.

In his very excellent book on the "Foundations of Zoology" Professor W. K. Brooks has said this to say "if like Paley I kick a stone I may change its position, raise its temperature, and bring about other changes that might all be computed from a few simple data. What happens if instead of a stone, I kick a dog? What a difference between a kick against a dog and one against a stone! In one case the simple conditions may be stated in a few words, and the result may be computed while in the other, a book would not suffice for the statement of all the facts, and the best science of our day is powerless to compute the result." This illustration is used to discuss the theme of the entire book of the relation of stimulus to intrinsic constitution in biologic response or behavior. Perhaps it is not too far fetched to apply this concept to cellular physiology especially to cancer. One may insult a cell by a multiplicity of agents such as bacteria, viruses, hormones and vitamins, but, in the last analysis, how the cell responds or even acts or fails to respond is due to no small degree to its intrinsic genetic constitution determined, in part by its origin from the zygote. It is this genetic concept of the nature of intrinsic biologic variability together with chemical induction, that is making possible the development of many benign and malignant tumors in mice. A concept to be of value should not only explain the contributions of the past, but should pave the way for new contributions. It is not out of place to point out to an assembly of surgeons that the cancer problem has not been solved and therefore we should not expect to find the

solution in the literature. Rather should it be desirable to advance in the study of cancer by producing more and more malignant conditions in experimental animals that duplicate or even approach the types of tumors that are killing more and more men and women at an ever increasing rate. For this purpose the genetic concept of cancer has justified itself and

should be of more than an academic interest.

In conclusion it may be pointed out that if genetic principles of hybridization, selection and inbreeding are capable of giving rise to a great multiplicity of tumor types then the reverse of these same genetic principles should lead to the building up of a biologic state that will refuse to give rise to cancer in any form.

## CORRELATION OF THE USE OF ANTIBIOTIC AND CHEMOTHERAPEUTIC AGENTS WITH GENERAL PRINCIPLES OF SURGERY

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THE introduction of potent chemotherapeutic and antibiotic agents challenged many traditional concepts in the surgical management of infections. A new group of nonsurgical specialists has arisen from the ranks of internists to concern themselves with the drug treatment of infections previously considered as surgical diseases. Paradoxically this trend has not been correlated with a diminishing surgical responsibility for the treatment of impending or established infections. In fact the net impact of this challenge has been the visualization of new fields for surgical exploitation. Entirely apart from the generally acknowledged necessity for the surgical drainage of pus there are four major problems of clinical concern: (1) treatment of impending wound infection; (2) treatment of mixed infections due to both gram-positive and gram-negative bacteria; (3) treatment of the intravascular complications of bacteremic infections; and (4) rôle of antibacterial agents in surgical management.

It is interesting that the dramatic accomplishments of the era of antibacterial therapy have so little altered the integrity of estab-

lished and fundamental principles of surgery. Controversy has attended problems requiring surgical judgment, but control of the capricious quality of bacterial invasiveness has made more clearly evident the violation of fundamental biologic laws. The broad diagnosis of infection can no longer absolve errors in diagnosis, judgment or technique. It is the purpose of this discussion to summarize the basic surgical principles validating this viewpoint.

### TREATMENT OF IMPENDING WOUND INFECTION

Experience in wound management among military surgeons in World War II crystallized much opinion about matters apparently still controversial among civilian and experimental surgeons. The major point at issue is the logic of local chemotherapy. Military experience justifies the abandonment of local chemotherapy in all wounds except occasional complicated wounds of serous cavities or major joints. Included in this philosophy of wound management is abandonment of the concept of prophylactic use of chemotherapeutic and antibiotic agents. Prevention of infection is an exercise in surgical technique. Antibacterial agents are reserved for the treatment of impending infection upon indications derived from clinical appraisal of the wound. Thus, chemotherapy is solely an adjuvant to surgical competency in wound management.

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Wound infection may be subdivided into two major components: invasive infection and wound suppuration. The invasive bacteria, capable of destroying living tissue, are the hemolytic streptococcus, toxigenic clostridium and staphylococcus. All are susceptible to penicillin therapy with occasional strain exceptions. Wound pathogens, responsible for wound suppuration, are a more heterogeneous group and relatively resistant to currently available chemotherapy. In addition the wound pathogens demand a nutritional pabulum other than living tissue within the wound. Devitalized tissue, blood clot and serous exudate in an open wound are removed naturally by septic decomposition; hence, the existence of such a pabulum is of greater clinical importance than the identity of the bacteria concerned with its liquefaction. The initial surgical care of the wound and the use of splints and pressure dressings are far more practical than attempts to sterilize residual dead tissue or exudate within the wound. In other words, the surgically clean wound requires no local chemotherapy and no amount of chemotherapy can sterilize an imperfectly debrided wound.

The living tissues of the wound are best protected from the ever present hazard of invasive infection by perfusion with a blood borne antibacterial drug. Systemic therapy achieves this objective. It has been learned that the surgically clean soft part wound risks invasive infection only by the hemolytic streptococcus and that sulfonamide therapy adequately anticipates this danger. However residual blood clot has been found as potentially acceptable as dead muscle as a nidus for clostridium infection. The greater antibacterial potency of penicillin for clostridium and staphylococcus makes it the drug of choice for wounds with residual hematoma or devitalized tissue. Such wounds are the complicated soft part wounds and compound fractures.

Again clinical expediency has dictated the abandonment of routine bacteriologic culture of wounds as an index of infection. The gross pathologic appearance of the wound 3 to 10 days after initial surgical treatment is the best evidence of the adequacy of the initial excision and the presence or absence of infection. It is

this general principle which underlies the two-stage technique of wound management. A further development of importance is the segregation of reparative and reconstructive phases of wound management. Postponement of reconstructive procedures to an elective schedule during convalescence and after wound healing has yielded greater success in ultimate rehabilitation.

#### TREATMENT OF MIXED INFECTIONS DUE TO BOTH GRAM POSITIVE AND GRAM NEGATIVE BACTERIA

Evidence for the minor rôle as wound pathogens of the gram-negative bacilli of the coliform group is gradually appearing. Even in peritonitis and bronchopulmonary suppuration penicillin appears to be optimally effective when used in dosage adequate to control the gram-positive components of the infection. A similar conclusion has been reached in the study of wound infections.

This reasoning does not extend, however, to infections of the urine, bile or cerebrospinal fluid. These body secretions contain an abundance of essential metabolites for bacterial growth and are deficient in sulfonamide inhibitors. Under the circumstances of wound infection of the urinary, biliary or cerebrospinal system, the combination of penicillin and either sulfonamide or streptomycin may be desirable. To be effective chemotherapy must be combined with restoration of normal flow for these systems.

#### TREATMENT OF THE INTRAVASCULAR COMPLICATIONS OF BACTEREMIC INFECTIONS

The reduced mortality rate in bacteremic infections offers the most convincing proof of the potency of presently available antibacterial agents. A consequence of this improved survival rate is an increasing incidence of residual complications of previously infrequent occurrence. Many unusual abscesses, such as the gas abscess of the retroperitoneal space as a complication of gas gangrene of the thigh, have been noted. Such abscesses rarely present problems in diagnosis or management. However, there are certain residual lesions of the vascular bed which are important for recognition and merit discussion as to principles

of treatment. These may be considered in two major categories: first the intravascular foci of suppuration and, second, the metastases therefrom.

The intravascular foci of suppuration may be surgically accessible or surgically inaccessible. That surgical excision of all septic thrombi is not mandatory may be deduced from the experience with endocarditis and cavernous sinus thrombophlebitis. That conservative management is not uniformly successful is apparent from the experience with pyelophlebitis. In the treatment of these lesions it is important to record the gradual abandonment of concomitant anticoagulant therapy in consequence of hemorrhagic complications.

The septic thrombi amenable to surgical attack are those associated with endophlebitis of the peripheral veins. Most frequently involved are the veins of the pelvic, jugular and saphenofemoral systems. The essential pathologic changes of septic endophlebitis render unlikely the detachment of a sufficiently large embolus to produce immediately fatal pulmonary infarction. Most commonly progressive septic infarction of the lung and subsequent focal pneumonitis result. More rarely there is an extending thrombosis of a major venous trunk. Such a process in the inferior vena cava with ultimate occlusion of the renal veins is associated with renal shut down and death from uremia. The life endangering qualities of these complications justify surgical intervention for any accessible focus of septic endophlebitis.

The possibility of septic endophlebitis is suggested by recurrent chills, spiking fever and persistent leucocytosis. The early diagnosis of progressive thrombosis or septic pulmonary infarction is not always easy. The septic emboli in the lung are usually microabscesses and cast no shadow in the roentgenogram. The characteristic radiologic evidence of multiple rounded areas of lightly increased density is dependent upon the development of pneumonitis around the areas of embolism. It is characteristic of these lesions that the process of suppuration is quite of the fibrinous chemotherapy. Tension pneumothorax, pyelonephritis, empyema and abscesses of the liver are features of this suppura-

tive phase demanding appropriate consideration and treatment. Although the ultimate healing of multiple pyogenic abscesses of the lung is remarkably complete in the survivors, early venous interruption is the preferred method of treatment. Local tenderness over a likely venous pathway may be the only clue to the particular site of venous involvement. More rarely, the differential diagnosis of septic endophlebitis and endocarditis of the right side of the heart may require consideration.

Ascending septic thrombophlebitis of the inferior vena cava is usually a complication of an obvious focus of inflammation or abscess of the pelvis or lower extremity. The clue to caval extension of the septic thrombus is massive edema of the extremity at the time of iliac involvement.

As a general principle it may be stated that excision of the affected segment is preferable to proximal ligation. Suppuration of the distal stump such as occurs spontaneously in the veins of the face may demand venotomy for drainage of pus. On the other hand, technical considerations dictate simple ligation of the inferior vena cava. This is readily accomplished through a rightsided retroperitoneal approach unless the necessity for concomitant interruption of the ovarian veins dictates a transperitoneal approach.

Another complication and a little emphasized feature of the successful treatment of endocarditis of the left side of the heart is the occurrence of mycotic aneurysms. Early diagnosis of these lesions is mandatory if surgical treatment is to be successful. No method of aneurysmorrhaphy is applicable to the septic and necrotic wall of these aneurysms. The only practical method of treatment is proximal ligation. Fortunately many of these patients are sufficiently youthful so that adequate collateral circulation will develop after such an arterial interruption.

#### ROLE OF A THROMBOTIC AGENT IN THE OVERALL PROGRAM OF CLINICAL MANAGEMENT

The chronically ill patient depleted by persistent infection can rarely be cured by chemotherapy alone. This has been especially emphasized by the experience with actinomycetosis in which the recurrent nature of the disease



# PHYSIOLOGIC ASPECTS OF SURGICAL INFECTIONS

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THE direct attack on the bacteria involved in surgical infections has been increasingly effective during the past 10 years. Scarcely a year has elapsed without bringing forth a new chemotherapeutic weapon better for some bacteriological purpose than those hitherto available. However there is ample evidence to indicate that the proper management of infections calls for much more than the ritualistic administration of the right drug for the right organism. It seems appropriate in this symposium to recall attention to three primary reservations which should temper the purely bacteriological approach in the management of surgical infections (1) Chemotherapeutic agents and antiseptics are only useful when they aid rather than interfere with the natural defense and recovery mechanisms of the body in infection the process which Fleming calls 'physiological antiseptics' (2) Effective management of many wounds infested with bacteria requires correction of an unhealthy physiological condition rather than a direct attack on the bacteria (3) In severe infections of almost all types there usually occur profound toxic functional derangements of organs and systems not immediately involved in the infectious process and the chemotherapeutic agents administered will not of themselves serve to remedy the consequences of such disorders.

It is the purpose of this paper briefly to discuss these three aspects of surgical infections and to indicate that the use of our new found weapons against bacteria must be handled with an understanding of their limitations so that we may at all times recognize the ultimate importance of guarding and implementing the physiological mechanisms of recovery from infection whether the infection be in a wound or a systemic invasive infection. The

principles to be discussed are by no means new in fact some of them were clearly recognized long before the discovery of the sulfonamides and penicillin. First will be considered some of the physiological aspects of treatment of localized tissue infections, or infected wounds, and next will be taken up the subject of toxemia in infection.

Sir Alexander Fleming writing of the investigations on wounds during World War I, performed by himself and other members of a research team led by Sir Almroth Wright, made the following significant statement "In view of the observations I have made, and which are quoted above I venture to suggest that the antiseptics at present in use will only exercise a beneficial effect in a septic wound if they possess the property of stimulating or conserving the natural defensive mechanism of the body against infection. If such a thesis be true, then it brings the antiseptic and the physiological treatments on to the same basis and it also makes it necessary in the estimation of the value of an antiseptic, to study its effect on the tissues more than its effect on the bacteria.

The evidence in support of these assertions was largely drawn from a series of laboratory experiments on wounds *in vivo* or on wound exudate *in vitro* with conditions which simulated as closely as possible the actual conditions existing in the wound. It was demonstrated that the ability of bacteria to multiply in wounds is conditioned to a very large extent by (a) the reaction of the exudate loss of alkaline reserve being conducive to bacterial proliferation and (b) the antitryptic capacity of the serum or lymph the presence of a low degree of antitryptic power tending also to encourage bacterial growth. Many bacteria lack the equipment of enzymes necessary to break down complex proteins into assimilable amino acids and peptides and the presence of active proteolytic enzymes in the bacterial environment presumably permits organisms of low

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chronic empyema of pleural decortication under the protection of penicillin demonstrates how a chemotherapeutic agent may aid the surgeon in attaining a physiological objective. In many long-standing leg ulcers the factor of superficial infection contributes to their chronicity, but success in eliminating the hemolytic streptococci staphylococci or colon bacilli will not alone allow the ulcer to heal if the poor circulation in the fibrous ulcer bed cannot sustain the growth and continued vitality of an epithelial covering. Permanent healing may await restoration of normal blood flow in the affected extremity, removal of scar tissue, and application of grafts of healthy skin. There is now ample evidence that chemotherapy and other forms of local treatment of large decubitus ulcers are gestures of futility unless the nutritional debility of the afflicted patient is first corrected and when that has been done and all dead tissue removed plastic closure of the ulcers can be performed successfully in the face of a very considerable amount of bacterial contamination.

The large scale clinical investigation of the use of topical sulfonamide applications in prevention of infection in civilian accidental wounds, which was carried on under the OSRD during the war served to bring out very clearly the primary importance of the physiological condition of the wound and emphasized the limitations of chemotherapy in meeting this problem. Conclusions from this study (3) were recently summarized

"1 Factors tending to delay or interfere with wound repair such as extensive tissue trauma incomplete débridement, or improper or ill advised closure with tension residual dead-space or implantation of foreign materials, will always predispose to the development of infection in accidental wounds.

"2 The use of chemotherapeutic agents in any combination and by any route does not prevent local infection of the wound when these predisposing factors exist.

3 Chemotherapeutic agents are probably of great value in preventing invasive sepsis and death from infection following accidental wounds."

Therefore the surgeon who attempts to lean heavily on the crutch of prophylactic

topical sulfonamides in the performance of reparative surgery will sometimes be disappointed, and many of his good results will have been obtained in spite of rather than because of the application of the drug. However, there appears to be a valuable place for the local use of penicillin, and perhaps streptomycin as well in the treatment of many established infections of wounds, in localized abscesses, acute empyema suppurative arthritis and perostitis meningitis, mastoiditis, and bronchiectasis. This practice is in keeping with physiological management if the antibiotic is also given intramuscularly in full doses to control such invasive aspects of the infection as may be present, and if the topically applied drug is dissolved in a suitable vehicle. The vehicle which has given the best results in cases under my own observation has been normal saline, containing 1000 to 5000 units of penicillin per cubic centimeter administered either by intermittent aspiration and injection as in acute arthritis and empyema or in the case of infected wounds, by intermittent irrigation through a very small indwelling tube which is held in place by the dressing or by loose gauze packing. In order to achieve the maximum effect, the drug must be applied so as to maintain a high concentration continuously in all parts of the wound.

Therefore, to summarize this initial phase of our discussion the primary concern of the surgeon in the care of the localized infectious lesion should be to conserve and augment the natural mechanisms of the body for combating infection. Surgical procedures can be of great value in removing tissues which have lost their capacity to react to infection in improving blood supply, and in providing physiological conditions favorable to healing. Penicillin streptomycin and the sulfonamides will display their greatest value if used with proper discrimination in conjunction with surgery directed toward these ends.

The need for constant attention to the physiological mechanisms of infection is even greater in the management of severe invasive infections, such as peritonitis septicemia, and gas gangrene where their derangement seriously threatens the life of the patient. As one studies these infections at the bedside and in

the experimental laboratory one is increasingly impressed with the similarity between the physiological condition of patients with severe infection and that of patients in shock due to blood loss, to crush syndrome to intestinal obstruction or to severe burns. Much of what has been learned about the prevention and treatment of shock during the last war may properly be applied to the treatment of patients with severe infections.

As used here the term shock connotes an acute maladjustment in the distribution of sufficient available oxygen in the blood to meet the needs of critical organs of the body particularly the liver adrenals, kidneys, and heart muscle. Shock as so defined may be initiated not only by reduction of blood volume below that required for maintenance of circulatory dynamics but also by loss of peripheral vascular tonus by failure of proper oxygenation of the blood and by a pathological alteration in the composition or physical condition of the blood.

Pentonitis perhaps illustrates the various aspects of shock in infection better than any other surgical infection because it brings into simultaneous interplay a number of factors which contribute to development of shock as it has been here defined. During the past 2 years I have had the opportunity of studying this subject extensively in dogs in the experimental laboratory in collaboration with Doctors John H. Kay and Donald G. C. Clark (3, 9, 10). During the critical period of the disease salt and water are lost externally in vomitus, or in decompression of the paralyzed bowel and internally into the edematous peritoneum and intestinal wall. Plasma protein is taken out of circulation in the process of formation of peritoneal exudate. Many red cells are destroyed by hemolysis and others are lost from effective use as oxygen conductors by stagnation in the engorged vessels of the peritoneum and by the formation of sticky conglutinated masses of what Knisely has aptly called sludge. All of these factors unless corrected, contribute to the development of a progressively falling blood volume. However replacement of the lost volume of blood does not necessarily relieve the shock state in peritonitis, a fact which was demon-

strated during the war by Emerson and Ebert. One reasonable explanation of this is that the lysis of Gram negative bacteria present in the exudates of peritonitis permits the liberation of endotoxins into the portal and systemic circulations, which specifically impair the functions of capillaries and of cell membranes not only in the liver to which these toxins are presumably carried in their most concentrated form but in other essential organs as well (14, 15). Therefore, the shock state in peritonitis is probably compounded of reduced blood volume, plus the direct toxic action of products of bacterial and tissue origin. An interesting practical sidelight on the activity of endotoxins of Gram negative bacilli is the evidence now available from several sources (16) that the sulfonamides exercise a nonspecific protective action in animals against the lethal effects of such toxins. The beneficial use of sulfonamide prophylaxis and treatment of peritonitis may be attributable as much to this antitoxic action as to the repression of bacterial growth in the peritoneal cavity. We should therefore not be hasty to abandon entirely the use of sulfonamides in peritonitis in favor of the newer antibiotic agents, such as penicillin and streptomycin until opportunity has been afforded to study more fully the comparative usefulness of these agents in combatting the factor of toxemia.

Still another physiological system which appears to be thrown out of balance in peritonitis is the equilibrium between the plasma proteolytic enzyme and its respective inhibitor. This is essentially the same system which Fleming was concerned with in his study of wound exudates, to which reference was made in the first portion of this paper. The proteolytic enzyme which is normally available for activation in plasma and which is most readily demonstrated through its lytic action on fibrinogen and fibrin, presumably exists for the most part in the form of an inactive precursor. However just as is the case with pancreatic trypsin which it resembles, the plasma protease may become converted to its active form through contact with activators of bacterial and tissue origin. The so called fibrinolysin of the hemolytic streptococcus is, in fact, merely an activator of the

plasma proteolytic enzyme system and in conformity with conventional terminology, has been renamed 'streptokinase' (12). The action of the plasma protease is normally counterbalanced by a circulating inhibitor factor corresponding to and closely resembling the pancreatic trypsin inhibitor. However it was found (10) that in the crisis of peritonitis in the dog this equilibrium is thrown out of balance and the 'escape' of the lytic principle is evidenced by an increase in the lytic activity of plasma against both fibrinogen and fibrin. Lysis of circulating fibrinogen and perhaps of prothrombin as well appears to explain why the blood of animals and patients in shock from peritonitis and from other causes sometimes fails to clot. The work of Grob suggested a method of determining the significance of increased plasma proteolytic activity in the pathogenesis of peritonitis. He had shown that increasing the titer of protease inhibitor by repeated intramuscular injections or oral feeding of trypsin is accompanied by a marked increase in the ability of animals to withstand the local digestion of tissues caused by subcutaneous injection of proteolytic enzymes of animal and bacterial origin. My colleagues and I therefore undertook to evaluate the protective influence of repeated trypsin injections against the lethal sequences of appendiceal peritonitis, and obtained an interesting result. Peritonitis was produced in 18 pairs of dogs by appendiceal ligation; one of each pair had received daily intramuscular injections of crystalline trypsin for 12 days and the other was a control. The management of the animals was in all respects identical and the healthier looking dog of each pair was always selected to be the control. The end-result was the survival of 15 trypsin prepared animals and of only 6 controls. The animals which had received trypsin preparation failed to display many of the morbid clinical and laboratory signs which were conspicuous in the controls. It may be added that efforts to influence the morbidity and mortality of the experimental disease in dogs were far less successful when chemotherapeutic agents were employed. The mortality rate in 15 dogs treated with large doses of penicillin was 33 1/3 per cent (10). These experimental studies are

mentioned here in order to indicate that there are important aspects in the morbid process of an established infection which are not likely to be countered solely by the administration of bacteriostatic chemotherapeutic drugs. We must continue to recognize that the infected patient is a more complicated system than a laboratory culture and that recovery from infections requires the stabilization or readjustment of many physiological disturbances which the infection has created.

Therefore in treating the toxemia of severe infection, all possible use should be made of penicillin, sulfonamides, and streptomycin but the fundamental physiological disorders that derive from bacterial infection must also be kept in mind, so that adequate supportive treatment, as well as chemotherapy may be given. The following aspects of supportive treatment deserve particular emphasis.

1. Patients with serious invasive infections including peritonitis, bacteremias of all types, gas gangrene, and meningitis should be handled with the same concern for maintenance of blood volume as is employed in modern treatment of severe burns, and of hemorrhagic or postoperative shock. This will require generous use of whole blood, of plasma and of saline and glucose solutions guided by frequent estimations of hematocrit, serum proteins and electrolytes and urinary output.

2. These patients should not be permitted to suffer from even temporary protein starvation. The patient with an acute infection is undergoing very active protein catabolism; the quantity of nitrogen excreted in the urine reflects a utilization of protein which is equivalent to three or four times the normal daily requirement. Still more is being continuously lost in the formation of inflammatory exudates. For example a patient with empyema may be losing the equivalent of a pint of plasma each day in the form of purulent thoracentesis fluid. Unless an equivalent amount of protein is supplied in the diet or by parenteral injections, a rapid depletion of liver and muscle protein is bound to occur, thereby undermining the resistance of the patient and aggravating the problem of his convalescence. All patients with infections should be maintained on a high protein, high caloric intake and a

record should be kept of the amounts of food actually ingested. If oral feeding is contraindicated protein should be given parenterally by a suitable hydrolysate, with glucose. The average adult patient should receive at least 125 grams of protein and 2500 calories, daily.

3 The utilization and excretion of several of the vitamins is much increased during acute and chronic infections. After studying the requirements of patients in shock from various causes Levenson and his associates have recommended the following daily doses of vitamins during the period of acute stress

Ascorbic acid	.50 gram
Thiamin	50 mgm.
Riboflavin	50 mgm.
Nicotinic acid	500 mgm.

After the period of critical illness has passed these doses may be reduced to approximately one fifth of the above figures.

In view of the possibility that some of the physiological derangements in severe infections are related to inadequate storage of these vitamins, this aspect of balanced supportive treatment should not be neglected.

4. Since the absorption of toxic breakdown products of bacteria and tissue is still the basis of toxemia in infection much caution should be exercised before abandoning to chemotherapy exclusively the treatment of conditions in which surgical intervention has been our principal life-saving weapon in the past. The evidence may now justify the nonoperative treatment (1) of acute hematogenous osteomyelitis and other invasive infections where the susceptibility of the causative bacteria to penicillin may in most cases be assumed, but it is doubtful that chemotherapy will ever be more than a valued adjunct to surgery in the treatment of conditions such as appendicitis and its complications, and chronic pulmonary suppuration and gas gangrene. Penicillin in large doses may be of definite value in established peritonitis following neglected appendicitis, as the recent report of Crile has shown but it will not compete with surgery as the principal treatment of choice in acute appendicitis.

#### SUMMARY AND CONCLUSIONS

1 Chemotherapeutic agents should be selected, and used, with a view toward aiding in the natural resistance of the body to infection.

2 Although it is important, wherever possible, to employ treatment directed specifically against the bacteria involved in an infection, the treatment of associated disorders should not be neglected. In certain conditions the persistence of the infection is entirely dependent on an underlying physiological lesion, and in these cases, chemotherapy is of only secondary importance.

3 Rational treatment of severe infection characterized by toxemia demands supportive measures as well as administration of chemotherapeutic agents. Particular attention must be given to maintenance of blood volume, provision of an adequate intake of protein, calories and vitamins, and surgical removal of the cause of the toxemia.

4. Study of the pathologic physiology of the toxemia of infections should be encouraged, in the hope that mortality from these conditions may be still further reduced.

#### REFERENCES

1. ALTMAYER, W. A., and HEDENSTAM, J. A. *Surg. Gyn. Obst.*, 94, 8, 238.
2. CHRISTENSEN, L. R., and MACLEOD, C. M. *J. Gen. Physiol.* 94, 23-35.
3. CLARK, D. G. C., and LOCKWOOD, J. S. Unpublished data.
4. CRILE, G. JR. *Surg. Gyn. Obst.*, 94, 8, 250.
5. ECKERSON, C. P., and ECKER, R. V. *Ann. Surg.* 1945, 22, 745.
6. FLEMING, A. *Brit. J. Surg.*, 19, 0-50, 750.
7. GROSS, D. *J. Gen. Physiol.*, 1942-1943, 26, 405. *Ibid.*, p. 43.
8. HOWER, E. L. *Surg. Gyn. Obst.*, 94, 8, 27.
9. KAY, J. H., and LOCKWOOD, J. S. *Surgery*, 94, 20, 91.
10. *Ibid.*, (in press).
11. KIRKELY, M. H., ELBOT, T. S., and BLOOM, E. H. *Arch. Surg.*, 94, 57, 230.
12. LEVENSON, S. M., GIBBER, R. W., TAYLOR, F. H. L., ROBINSON, P., PAGE, R. C., JORDON, R. E., and LUND, C. C. *Ann. Surg.*, 1946, 24, 840.
13. LOCKWOOD, J. S. *Ann. Surg.*, 94, 24, 314.
14. MORGAN, H. R. *Am. J. Path.*, 93, 9, 35.
15. PROCTOR, A., and BERGMANN, A. *J. Exp. Med.*, 1944, 70, 371.
16. ZAST, P. A., HUTNER, S. H., and COOPER, F. S. *Proc. Soc. Exp. Biol.*, N.Y. 94, 53, 4. *Ibid.*, 94, 154.

# SYMPATHETIC INTERRUPTION IN CASES OF TRAUMA AND IN POSTTRAUMATIC STATES

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THERE can be no doubt that an erroneous impression has persisted from the past concerning the favorable influence of war upon medical progress. Actually the period of war must be recognized as having resulted in retardation of progress as compared with what might have come from a period of peace whether measured by the health and longevity of the world population the adequacy of undergraduate and graduate training of physicians or the advancement of fundamental and applied knowledge. It behooves us then to salvage from the war effort all accomplishments which may be useful in the conduct of any future military engagement and more particularly those contributions which may aid in peacetime practice.

In the recent conflict not only was military medicine on a higher plane than in any preceding war but circumstances permitted a better evaluation of the preventive diagnostic and therapeutic means which were utilized. Of especial importance in this regard was the creation by the Surgeon General of special centers for the care of certain types of injuries and disease, a plan which made possible careful study of these disorders and of their treatment under favorable circumstances by a group of medical officers competent for this task by special interest and professional preparation. Their study was however necessarily limited more or less to the later manifestations of these conditions, although prompt evacuation sometimes placed in their hands patients ill or disabled for only a few weeks. In addition, in spite of the difficulties resulting from the necessity for prompt evacuation of patients certain deficiencies in facilities and other cir-

cumstances arising from military demands a considerable number of very informative reports have come from the Forward Areas. Such contributions naturally are attributable primarily to the proficiency and scientific interest of those who conducted them. Great credit must be given however, to the Surgeon General's Office and to the consultant system utilized in the various theaters of command and to their earnest, if not always successful efforts to assign duties to medical officers according to their training and ability, to support them whenever possible with adequate equipment and to stimulate the careful recording of case records.

The segregation of patients with vascular disorders and abnormalities involving sympathetic function in the Vascular and Neurosurgical Centers permitted a study of many of the problems for which sympathetic interruption has been recommended as beneficial in numbers rarely if ever before approached. This information has been supplemented by observations of these and allied conditions in Forward Areas. It is the purpose of this communication to inquire into the rôle of temporary and permanent interruption of the sympathetic nerves in the care of patients who have sustained trauma. No detailed analysis will be attempted but rather a general presentation of the problem as it developed in my own experience and as it has been presented by other medical officers in the current American literature. For the sake of brevity I shall omit reference to the valuable work of numerous investigators whose contributions before the war established the principles and fundamental background for the application of sympathetic interruption in the surgery of warfare. One cannot emphasize too strongly the value of these investigations. Certain personal observations from the recent war have already been recorded in more detail elsewhere by my associates and me (26-29) and other reports

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covering sympathetic interruption in such conditions as the post traumatic vasomotor disorders, cases of injury to major arteries, causalgia, and frostbite will be reported subsequently. The problems under consideration will be discussed primarily from the standpoint of the efficacy and the limitations of these procedures in therapy whereas consideration of the often poorly understood underlying physiopathological mechanisms by which the sympathetic nervous system is involved as a component in these various states will be omitted.

In an effort to clarify the matter the various traumatic conditions will be presented under several headings although it is realized that in any given patient the condition may not be a pure one fitting precisely into any one of these categories but may have features common to several of them.

#### ARTERIAL STUPEUR OR SEGMENTAL ARTERIAL SPASM

It has long been recognized that trauma which actually inflicts no direct injury to an artery may initiate a reflex spasm of such degree that blood flow through this vessel may be interrupted with resultant gangrene or ischemic paralysis in certain instances. Specific directives were issued giving proper instructions for the management of this condition. No large group of such cases is available for study. Presumably they were handled in the following manner: by periarterial sympathectomy when the artery was exposed in the course of débridement, and in all instances by prompt and repeated use of sympathetic blocks and other efforts to release vasoconstriction until permanent restoration of normal blood flow had been achieved. It is likely that a significant number of cases of segmental arterial spasm involving major arterial stems must have occurred among the thousands of cases of trauma to extremities. The best index of the efficacy of treatment is the fact that only a few instances of ischemic difficulties arising from this condition were seen in the Vascular Centers into which were funneled most of the patients with vascular injuries. These exceptional cases—tragic examples of loss of limb and of function without

direct arterial injury—likewise serve as a stern warning for the necessity of prompt and proper treatment.

From the war experience it would appear that the following points are important in the management of this condition. Physicians must be aware of its existence and trained in its recognition. It must be considered a possibility in any case of injury in which the peripheral pulses in the limb have disappeared with resultant evidence of ischemia, and particularly when there is no significant external bleeding or hematoma and no sign of an arteriovenous shunt. It is important that operators be trained to recognize the spastic artery and differentiate it from other conditions following trauma, such as compression by hematoma or intra-arterial thrombosis. In general, the artery will be found to be pale and narrowed in caliber with good pulsation above the area of constriction and with weak or absent pulsation below. Generally there will be no hemorrhage in the artery wall. There will be no firm intra-arterial mass or distention of the lumen, conditions which are commonly observed in embolism or thrombosis.

Once the condition has been diagnosed or is suspected every effort should be made to release vasoconstriction. If the artery is exposed at operation its outer wall should be infiltrated with procaine and it should be carefully stripped of its adventitia. Warming of the body but not of the involved limb should be carried out. A sympathetic block or a spinal anesthesia should be done promptly. If vasodilatation and return of pulsations follow the block or spinal anesthesia but last for only a short while sympathetic blocks should be repeated at frequent intervals. Should the benefit following each block be of short duration, one should not hesitate to proceed with operative sympathectomy or with alcohol block if the patient's condition makes operation ill-advised. The limb itself should be protected from trauma and infection and should be left exposed to room temperature. Local warmth should never be applied unless there is conclusive evidence that one is dealing purely with a remedial condition of arterial spasm without any organic interruption of the continuity

of blood flow. If sustained return of normal blood flow is difficult to achieve promptly and there is no associated injury or disease contraindicating such treatment, anticoagulant therapy should be instituted without delay in order to inhibit thrombosis in the affected artery and in its collaterals.

No data are available as to the incidence of failures in patients who have been treated promptly and adequately; it may be anticipated that success will accompany such a program of treatment.

#### TRAUMATIC INJURY OF MAJOR ARTERIES

Though they did not constitute a considerable proportion of battle casualties, cases of direct trauma to major arteries presented a difficult therapeutic problem. Odom reported that there were 837 vascular injuries to major arteries among the 92,030 battle casualties sustained by the Third Army during a 9 month campaign in Europe, an incidence of 0.9 per cent. Four hundred and twenty three of the 1833 amputations performed were necessitated by injuries to blood vessels (23 per cent). De Bakey and Simone stated that 0.96 per cent of 163,980 battle casualties were wounds of arteries and 618 of the 3177 amputations from the Mediterranean and European Theatres were carried out because of arterial injury (19.5 per cent). In a smaller series of cases, Kirtley found that 20 per cent of major amputations were done because of inadequate blood supply. Bradford and Moore reported that 0.7 per cent of 16,000 surgical admissions to their hospital had injuries of important arteries. It may be concluded that slightly less than 1 of each 100 soldiers wounded in combat sustained an arterial injury and that approximately 20 per cent of all major amputations were performed because of trauma to blood vessels.

Medical officers were instructed by directive to utilize sympathetic blocks in all injuries of major arteries in which the circulation was definitely or questionably jeopardized. The results of this procedure for obvious reasons, are difficult to analyze. The additional therapy in cases of arterial injury was never dependably identical. In some the concomitant vein was ligated while in others it was left intact.

Although ligation and division of the artery were recommended in certain cases ligation in continuity was performed. In some, an effort to maintain the continuity of the blood flow by suture or nonsuture methods was attempted while in the majority no such efforts were made. In most instances adequate control of any attendant shock was promptly accomplished but not in all. There was not uniformity in the application of measures to prevent infection and additional trauma nor in regard to the temperature to which the limb was exposed. Indeed, adequate sympathetic anesthesia was undoubtedly not always obtained by efforts to block the chain. Of equal import is the fact that sympathetic blocks were carried out as often as necessary in some cases and too few blocks spaced over too wide intervals in others. Of perhaps even greater importance in making evaluation of this procedure difficult is the varying character of the injury incurred.

In order to arrive at valid statistical conclusions one would not only have to segregate treated and untreated cases according to the location of the arterial injury but would have to be certain that the two groups were comparable from the standpoint of the character of the local lesion, the associated trauma and the general state of circulation. Actually the extent of local trauma varied. In certain patients the artery was thrombosed without laceration in others simply lacerated or severed in still others badly damaged over a considerable extent. Sometimes there was extensive local trauma with injury to collateral vessels, extravasation and edema, as well as associated fractures of varying severity or injuries to peripheral nerves. In contrast some patients had no associated lesion of any significant extent. Furthermore in spite of efforts to the contrary case records of patients were often deficient with regard to important factors concerning the character and the extent of the local and general injury and in regard to the therapeutic means employed. It must be remembered too that analysis of the results of sympathetic interruption solely on a basis of the incidence of gangrene necessitating major amputation as is sometimes done omits consideration of possible effects of this treatment upon subsequent





the exercise tolerance was not strikingly altered

The results of sympathetic interruption in cases in which blood flow through a major artery was interrupted by trauma indicated this procedure to be of definite benefit, in my opinion at the same time they clearly demonstrated that this procedure offered no guarantee against ischemic difficulties. With regard to civilian practice I believe the military experience would suggest that every lacerated artery be repaired if this were possible that sympathetic blocks be used promptly and as often as necessary, that when improvement with blocks is only transient permanent sympathectomy be performed by operation if feasible otherwise by alcohol injection. If sympathectomy is not carried out all additional aids in vasodilatation should be utilized such as reflex vasodilatation and the oral administration of alcohol. The limb is to be left exposed to room temperature and to be protected from injury and infection.

It is my impression that early sympathectomy will often prove helpful when procaine blocks are of little permanent help due to their transient benefit. In selected cases seen later after injury sympathetic blocks and more often sympathectomy will be found to be of considerable aid.

#### ARTERIAL ANEURYSMS AND ARTERIOVENOUS FISTULAS

Before the war sympathectomy or alcoholic infiltration of the sympathetic nerves had been used sufficiently often in cases of aneurysm and arteriovenous fistula to establish its usefulness as an adjuvant in their operative treatment. A number of surgeons during the war had occasion to employ sympathetic blocks or sympathectomy in such cases and held the opinion that they were useful aids. In the three Vascular Centers sympathectomy and sympathetic blocks were utilized in varying degrees. In general, these procedures were not employed at the Ashford General Hospital, and the brilliant results obtained there by Elkin and his associates furnish striking proof that large numbers of patients can be treated successfully without resorting to sympathetic interruption, though those of us who

have studied patients after sympathectomy have been convinced of its usefulness. At the De Witt General Hospital sympathetic interruption was used fairly extensively and was thought to be very helpful in selected cases (11). At the Mayo General Hospital a great many sympathectomies were performed. This experience has permitted me to evaluate the procedure carefully and to formulate certain concepts concerning its benefits and its limitations.

Sympathectomy tends to render the collateral circulation more efficient by elimination of vasoconstriction in the collateral vessels. Though sympathectomy may also contribute to improvement in circulation by fostering growth of new collaterals and though certain observations suggest that this may be true, convincing proof has not been demonstrated. When the collateral circulation appears insufficient according to carefully performed tests when a sufficient time has elapsed to have ordinarily brought about adequate collateral circulation and when such means as intermittent occlusion of the artery appear to be achieving little or no improvement, sympathectomy is indicated. It is also indicated in all cases with poor collateral circulation in which intense pain, infection or threat of rupture make the necessity for early operation a real possibility. In the majority of cases the collateral circulation will be found to be adequate immediately or shortly after sympathectomy. In a number however the tests for collateral circulation may show improvement but may not become adequate over a period of months. Because sympathectomy has been accomplished one can in no sense assume that the collateral circulation will be invariably satisfactory or that gangrene or ischemic paralysis will always be prevented.

Sympathectomy is indicated in any case in which an aneurysm or fistula is associated with a peripheral nerve lesion and in which the collateral circulation is precarious indeed in any case with severe peripheral nerve injury and obviously impaired circulation regardless of whether tests for collateral circulation are satisfactory or not. It appears wise to do everything in these cases to make possible

early surgical treatment of the aneurysm or fistula in order to avoid delay in operating upon the damaged nerves. Occasionally one will find it advisable to perform sympathectomy as a safeguard in cases of vascular lesions of important main stem arteries when the location of the lesion makes accurate compression of the artery and testing of the collateral circulation impossible. It appears rational to perform sympathectomy in those cases with ischemic lesions distal to an aneurysm or fistula. It is indicated when there is significant vasospasm in the affected extremity. The procedure may occasionally be advisable when one or more of the important arteries in a limb have already been ligated or thrombosed and in which cure of aneurysm may entail ligation of other important arteries or collaterals. Sympathectomy may sometimes be required because of associated causalgia.

Sympathectomy need not necessarily be performed before operation the two procedures can often be carried out in one session. In every instance however one should retest the collateral circulation after sympathectomy and make certain that it is satisfactory before proceeding with the surgical treatment of the aneurysm or fistula.

After operation, sympathectomy will also be found to be an adjuvant in correcting certain difficulties which sometimes follow extirpation of an aneurysm or fistula. It is clearly indicated when there is annoying or incapacitating sensitivity of the hand or foot to cold in a patient whose place of residence and work or avocation make such exposure necessary and when improvement in symptoms is noted on exposure to cold during a period of procaine sympathetic anesthesia. It is useful in cases of persistent edema which have not improved upon conservative treatment. It is generally helpful and often dramatically so in cases of ischemic paralysis. It appears to foster return of nerve function in cases of peripheral nerve injury in which the circulation is impaired. It is also useful in the treatment of associated causalgia which is improved temporarily but not cured by sympathetic blocks. When a limb is found to be cold and pale or cyanotic after operation or

when gangrene is definitely threatened, sympathectomy should be utilized in some cases it brings about gratifying restoration of good circulation though it will not always prevent gangrene. In regard to the two commonest circulatory disorders which may follow sympathectomy sensitivity of the limb to cold and decrease in exercise tolerance, the procedure has a very beneficial effect upon the former but rarely has a striking effect upon the latter.

It is my feeling that when sympathetic interruption appears to be indicated, permanent sympathectomy is generally preferable to procaine blocks, though blocks undoubtedly have a place in the treatment of certain cases. Sympathetic interruption seems justified for the indications which have been enumerated where no clear indication exists there seems to be no point in performing the procedure. It must be looked upon as a valuable adjuvant in the surgical treatment of aneurysms and fistulas. It cannot be relied upon as a certain guarantee against ischemic difficulties, nor can it be relied upon as a sure corrective for all functional disorders which may be present.

To have performed a sympathectomy does not relieve the surgeon of responsibility for utilizing carefully performed tests for collateral circulation for exercising every care to prevent destruction of collateral vessels at the time of operation and for preserving the continuity of the artery if possible.

#### THE POSTTRAUMATIC DISORDERS

The posttraumatic vasomotor disorders comprise a number of conditions about which many divergent opinions are held. Some would include only those cases with edema, pain, weakness, disability, atrophy, osteoporosis, and either vasoconstriction or vasodilatation. Others would include in this category various vasomotor disturbances following trauma, infection and such vascular disorders as thrombophlebitis. The discussion here will be limited to the difficulties following trauma or to trauma and associated infection. It has been my experience that these disorders may be characterized by various complaints and physical findings. In some

pain is present either at rest or more commonly with activity and weight bearing in others pain is absent. In some edema is massive, in others moderate or mild, and some have no edema at all. Some have evidence of vasodilatation the majority of vasoconstriction. Cyanosis, coldness sensitivity of the part to cold and hyperhidrosis may be present in varying degree. Some have marked weakness of muscles some virtual paralysis. Sensory changes may be present.

In a group of disorders so varied in their manifestations there is little wonder that treatment cannot be stereotyped and that results of therapy are not uniform. Those who have utilized sympathetic blocks and sympathectomy have been favorably impressed with the results of such treatment (32) as have my associates and I. It is not my feeling that such treatment should invariably be applied or that it can ever be utilized as the sole means of therapy. It is difficult to outline concisely one's views of treatment for such a complex problem but to do so as succinctly as possible the following suggestions are made.

In any case of trauma which is unassociated with injuries contraindicating such treatment early active use of the part should be instituted. Obviously wounds must be debrided fractures properly reduced and immobilized and every precaution taken to prevent infection. Whenever edema is present proper elastic support, elevation and gradually increasing use of the limb in dependency should be utilized. One must be sure to encourage the patient and to do everything to prevent development of an attitude of invalidism. If a real neuropsychiatric factor exists, it must be recognized and suitable treatment instituted.

Whenever there are signs or symptoms suggesting a reflex disturbance such as is under consideration and these manifestations prevent active use of the limb or do not improve rapidly with such activity and with proper associated treatment, sympathetic blocks should be tried without delay and should be repeated as frequently and as often as necessary. If they bring about transient improvement but appear to have no permanent

benefit, one should not hesitate to proceed with sympathectomy. In certain cases it will be preferable to employ local procaine infiltration first before performing sympathetic blocks. If such local infiltration brings about temporary benefit but no cumulative improvement and an irritable trigger zone seems to exist which can feasibly be excised such a procedure may be indicated. In connection with local infiltration it is proper to introduce here the technique of procainization in the early treatment of sprains and strains which was found very effective in army personnel (20). That at least part of this benefit results from blocking the sympathetic impulses is suggested by the fact that such injuries have been treated with equal success by sympathetic blocks (32).

In the treatment of the late sequelae we have found that many patients obtain an excellent result from active use of the limb physiotherapy and elastic support when needed. It was found that in a small number of patients manifestations very similar to those generally observed were either initiated or perpetuated by neuropsychiatric factors. In such cases psychiatric therapy is obviously required. In some a brilliant result is quickly achieved others are very refractory. In rare cases responding unsatisfactorily to psychiatric treatment, sympathetic interruption may be a useful adjuvant in correcting certain manifestations such as persistent massive edema. When the simpler means of treatment show no promise sympathetic blocks should be carried out. Occasionally a patient is helped decidedly by blocks but ordinarily any beneficial effect is transitory. In general sympathectomy is the procedure of choice for such cases. Except for cases in which a fundamental psychiatric problem has been unrecognized before operation, the results are gratifying. The manifestations of vasospasm and sympathetic overactivity respond dramatically. Cyanosis, coldness hyperhidrosis are relieved and sensitivity to cold is cured or improved. Edema is generally lessened sometimes dramatically. Pain is generally improved and is sometimes completely eliminated. Sympathetic interruption can never be regarded however as the sole

form of treatment. Whether it is used or not, the patient must be encouraged active exercise must be enforced and edema must be dealt with by elastic support, rest, and gradually increasing dependency.

No data have been made available in regard to possible usefulness of sympathetic interruption in the healing of fractures. It has been demonstrated however that sympathectomy may be extremely useful in reducing edema and in eliminating marked vasospasm before bone grafting and other plastic restorative procedures.

#### CAUSALGIA

The war afforded an unparalleled opportunity for studying large numbers of cases of causalgia and their treatment (2, 12, 18, 24, 31, 33). In general excellent results from sympathectomy were obtained. The majority of patients obtained complete relief and improvement was almost invariably noted in the remainder. It has been the common observation that the results were better in the upper extremity than in the lower. Certain observations suggest that the poorer results in the lower extremity may be due in part to incompleteness of the ganglionectomy—that it may be necessary to sympathectomize completely the area of the nerve lesion as well as that to which the pain is referred (2, 33). The series of Rasmussen and Friedman suggests that postganglionic operations for the upper extremity are inferior to the commonly employed preganglionic operation in the treatment of causalgia. Although such observations have not been uniformly made it has been my experience that the more severe the pain the more apt one is to obtain complete relief following sympathectomy. Since the pain is generally more severe in the upper extremities this may be an additional factor in the somewhat higher incidence of complete cures in these cases as contrasted with those having involvement of the lower extremities. In general it is thought that the results are more favorable the earlier treatment is instituted.

Some surgeons have utilized sympathetic blocks only as diagnostic and prognostic tests and some (33) have never obtained permanent

relief from any number of procaine sympathetic blocks. Though we found that sympathectomy was necessary in the majority of cases, my associates and I observed permanent relief from sympathetic blocks in numerous instances. It is our feeling that one should proceed with sympathectomy if relief of pain is limited to the period of sympathetic block and that a series of blocks should be tried in patients who experience prolonged relief after a procaine block. If the relief does not become progressively more prolonged as additional blocks are carried out, they should be abandoned and operation should be carried on. It is apparent from the experience in the war that a rare patient with causalgia may be cured by neurolysis or neurectomy or by artificial fever therapy. A rare case, too, may be associated with definite neuropsychiatric features and respond favorably to psychiatric therapy (16). In general, however, sympathectomy is required. Altogether the results are brilliant.

#### PHANTOM LIMB PAIN AND AMPUTATION STUMP PAIN

Few wartime observations have come to my attention concerning the use of sympathetic interruption in the distressing phantom limb syndrome and in amputation stump pain. To be sure, a few cases of pain and vasospasm in minor amputation stumps with improvement or relief following sympathectomy have been recorded (12) and I have made similar observations. In addition, Pool has used sympathectomy in conjunction with cordotomy in a few cases of phantom limb pain and has the impression that sympathectomy may be helpful in relieving the burning pain seen in this syndrome. In general, however, no studies have been made of sympathetic interruption in the complex amputation stump pain following major amputations nor in the phantom limb syndrome—in all likelihood a reflection of the infrequency with which these difficulties have occurred in military personnel. I believe the primary lesson to be learned from the experience in the recent war deals not with the treatment of amputation stump pain and phantom limb pain but with their prevention by proper operative technique, by early active

use of the stump and by careful conditioning of amputees to the normal physiological sensations of a phantom limb which they almost invariably experience (19). I have had occasion to observe in patients in whom such procedures were performed for other reasons that the normal phantom limb sensations may be temporarily but not permanently relieved both by sympathetic blocks and by sympathectomy. My own small experience would lead me to believe that sympathectomy rarely has a place in the treatment of amputation stump and phantom limb pain.

#### THE INJURIES DUE TO COLD

Opinions are at wide variance in regard to the rôle of sympathetic interruption in the injuries due to cold—frostbite, trench foot, and immersion foot or hand. Elsewhere (28) I have attempted to review this subject. It appears clear that although other factors may have a part, thrombosis of arteries and arterioles is the primary factor concerned in the production of gangrene—the most disastrous sequel to injuries from cold. It is further well established that vasoconstriction is the primary response of the body to exposure to cold, and that, although a transient period of reactive hyperemia may follow vasoconstriction is one of the commonest sequela. These facts would suggest that efforts to block sympathetic impulses and combat vasospasm might be fruitful in the treatment of the acute and later manifestations of these disorders.

Numerous students have advised against sympathetic interruption in the early stages of trench foot, immersion foot, and frostbite, perhaps on insecure grounds. There is little information from our own war experiences concerning the effect of these procedures in the early treatment of frostbite although some of our allies and opponents reported good results with sympathetic blocks and peripheral sympathectomy. Davis and associates, who felt that it was important to release vasoconstriction as rapidly as possible, found that direct blocking of the sympathetic pathways was the only means of accomplishing this end in severe high altitude frostbite. Southworth has treated a few cases of early frostbite by sympathetic blocks with apparent

benefit. Berson and Angelucci noted no improvement with sympathetic blocks in a few early cases of trench foot with massive edema, but obtained temporary diminution of pain and tenderness in milder cases. Leigh reported that sympathetic blocks were of no aid in the early treatment of trench foot. Edwards and his co-workers in a small group of cases, found that sympathectomy gave good results in the early treatment of trench foot with gangrene but that it was not helpful in cases with tender painful and aching feet. No studies have come to my attention concerning the use of sympathetic interruption in the treatment of the acute phases of the immersion injuries.

With regard to treatment of late manifestations of these disorders, the rôle of sympathetic interruption has been more clearly defined. The results of sympathectomy are good in properly selected cases of frostbite. The procedure is useful in cases of gangrene, excessive hyperhidrosis, persistent marked vasospasm, sensitivity of the hand or foot to cold and sensory changes. Southworth reported some observations suggesting that repeated procaine blocks, alcohol blocks, or sympathectomy may be helpful. Berson and Angelucci reported that sympathetic blocks were useful in late cases of trench foot with vasospasm, and that the improvement in treated limbs was faster than in the non-treated contralateral extremities. Although my associates and I were not impressed with the usefulness of sympathetic blocks in the late treatment of trench foot, we obtained conclusive evidence of the benefit of sympathectomy in selected cases. Sympathectomy unfortunately rarely is of aid in alleviating the pain which is so commonly experienced on weight bearing. It is particularly helpful in cases of gangrene, in marked hyperhidrosis, especially if associated with maceration of the skin and secondary infection in reducing the severity of symptoms in patients with sensitivity of the extremity to cold and in certain cases in which there is disturbance of sensation. Patterson found that sympathetic blocks improved temporarily the peripheral pulses, decreased numbness and pain, and abolished hyperhidrosis in the Attu casualties,

but observed that the beneficial effect was limited to the duration of sympathetic anesthesia. Southworth felt that sympathectomy produced beneficial effect upon the late manifestations of immersion foot although it had little effect upon deep pain.

Because such contradictory opinions are held by different observers it is exceedingly difficult to summarize any lessons which may have been learned in the recent war concerning sympathetic interruption in the treatment of the early stages of the injuries due to cold. I think it is fair to say that at least no harm has resulted from the use of such procedures and that their use for further evaluation is warranted. There is much to suggest that they may be very helpful especially if applied early and particularly in cases in which gangrene is threatened or existent. It is my feeling that if transient improvement without permanent benefit is noted following blocks, especially in cases with marked ischemia, one should seriously consider early sympathectomy. With regard to the later stages of these injuries, it is clear that sympathectomy has a definite though limited place in therapy. Though repeated sympathetic blocks may occasionally result in benefit, sympathectomy is generally required. Sympathetic interruption cannot be looked upon in any case as the sole means of therapy. One must, under all circumstances, protect the injured limb from trauma, infection and from external heat in the acute phase. There is much to suggest that anticoagulants should be employed in early cases. Conservatism should be practiced with regard to gangrene and necessary amputations. Physiotherapy and active exercise should be utilized after the acute phase is passed. Shoe corrections, psychotherapy and other means should be used when indicated. It is my opinion that further experiences will confirm the usefulness of sympathetic interruption in alleviating certain complaints late in the course of these disorders and that they may well prove of value in the early stages.

#### SUMMARY AND CONCLUSIONS

The experiences during the recent war have in general confirmed pre-existing impressions concerning the usefulness of sympathetic

interruption in cases of trauma and in the posttraumatic states. Certain new applications of these procedures have been established. The war experiences have been particularly valuable in providing large numbers of cases for study with consequent better evaluation of the specific indications, the merits and the limitations of sympathetic interruption. It would seem that permanent sympathetic interruption may yield gratifying results in some instances in which previous blocks give unsatisfactory results. With regard to certain types of injury there are differences of opinion concerning the usefulness of these procedures. In the presentation of this problem an effort has been made to take into consideration the studies of various investigators, though the views expressed concerning controversial issues have necessarily been influenced by personal experiences.

#### REFERENCES

1. ALBRIGHT, H. L., and VAN HALE, L. A. *Surgery*, 1944, 30: 453-477.
2. ALLERTON, F. F. JR., and MALLET, O. L. *Surgery*, 1945, 10: 497-514.
3. BERSON, R. C., and ARZUELO, R. J. *Bull. U. S. Army M. Dep.*, 1944, 77: 91-99.
4. BRADFORD, H., and MOORE, M. J. *Surg. Gyn. Obst.*, 1945, 83: 667-673.
5. CONWAY, H., and PLAIN, G. *Surgery*, 1945, 10: 383-400.
6. DAVIS, L., SCARFF, J. E., ROGERS, N., and DECKARD, M. *Surg. Gyn. Obst.*, 1943, 77: 56-575.
7. DE BAKET, M. E., and SCHMIDT, F. A. *Ann. Surg.*, 1945, 23: 534-579.
8. EDWARDS, J. C., SHAPIRO, M. A., and RUTINS, L. I. *Bull. U. S. Army M. Dep.*, 1944, 83: 55-66.
9. ELKIN, D. C. *Bull. U. S. Army M. Dep.*, 1944, 5: 57-62.
10. FRIEDMAN, NORMAN E. *Ann. Surg.*, 1945, 61: 448.
11. FRIEDMAN, N. E. Personal communication.
12. GOODMAN, E. N., MEININGER, W. J., and WHITE, J. C. *Ann. Surg.*, 1945, 24: 304-317.
13. HARRISON, S. P. *Surg. Gyn. Obst.*, 1945, 81: 54-67.
14. KIRTLLEY, J. A., JR. *Ann. Surg.*, 1945, 22: 313-324.
15. LEIGH, O. C. *Ann. Surg.*, 1945, 21: 30-33.
16. LIND, T., and PATTER, R. L., JR. *Arch. Neurol. Psychiat.*, 1945, 53: 2-5.
17. MARSH, J. M. III, and GINSBERG, W. P. *Surg. Gyn. Obst.*, 1945, 8: 69-76.
18. MATTHEW, F. H., and DEVLIN, J. W. *Surg. Gyn. Obst.*, 1945, 80: 63-635.
19. McKEEVER, F. M. *Surg. Gyn. Obst.*, 1945, 81: 497-511.
20. MURPHY, F. C., and POSTLEWAIT, *Surg. Gyn. Obst.*, 1943, 77: 397-402.
21. ODOM, C. B. *Surgery*, 1945, 9: 563-566.
22. PATTERSON, R. H. *Bull. U. S. Army M. Dep.*, 1944, 75: 63-70.
23. POOL, G. L. *Ann. Surg.*, 1945, 24: 336-357.

- RAEMURDEN T B and FREEDMAN H. J Neuro-  
surg 1946, 3 165-173
- ROSE, C. A., HESS, O. W., and WELCH, C. S. Ann.  
Surg 1946, 123 161-179.
- SHUMACKER, H. B. JR. Sympathectomy as an adju-  
vant in the operative treatment of aneurysms and  
arteriovenous fistulas. I. Sympathectomy per-  
formed before or at time of operation. Surgery (In  
press.)
- Idem. Sympathectomy as an Adjuvant in the Opera-  
tive Treatment of Aneurysms and Arteriovenous  
Fistulas. II. Sympathectomy Performed after  
Operation. Surgery (In press.)
28. Idem. Injuries Due to Cold, with Particular Reference  
to Frostbite and Trench Foot. Wisconsin M J  
(In press)
29. SHUMACKER, H. B., JR. and ABRAMSON D. I.  
Ann. Surg 1947 125 203-215.
30. SOUTHWORTH J L. N England J M, 1945 233 676
31. SPEIGEL, I J and MILOWSKY J L. J Am M Ass.,  
1945 127 9-15
32. TYSON M D and GAYTOR, J S. Surgery 1946  
19 167-176
33. ULMER J L, and MAYFIELD F H. Surg. Gyn.  
Obst. 1946 83 789-796
34. WARREN R. Arch Surg 1946 53 86-99



# THE TRANSPORTATION OF SOLDIERS WITH FRACTURES

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THE transportation of a soldier with one or more fractures usually compounded was one of the major medical problems encountered in the European Theater of Operations. In general most of the patients, immediately after wounding were transported by ambulance from the aid stations to the forward hospitals and then by train boat or airplane to the rear echelon hospitals.

The past standard practices of transporting patients with fractures recommended by the Army Medical Corps were reviewed by the consultants and somewhat modified before the advent of major hostilities on the continent. The major modification was made in regard to the transportation of fractures of the upper extremities.

Almost everyone consulted agreed that the Murray Jones arm splint was an awkward device to apply and it was felt by most doctors that this awkwardness, combined with certain dangers of excessive pressure in the axilla offset any good factors about the splint. Accordingly the medical officers were not encouraged to use it. Most upper extremity injuries were very simply and easily handled by simply binding the affected arm to the trunk with a sufficient number of triangular bandages. This provided good comfortable immobilization and obviated the necessity of applying a cumbersome piece of apparatus. In addition transportation by litter in an ambulance was a much simpler procedure than it would have been if this splint had been used widely.

Upon arrival at a field or evacuation hospital, or any hospital where surgery on the injured upper extremity was performed a plaster velpeau or modified plaster shoulder spica dressing was applied after surgery and was termed a transportation plaster splint for the next stage in the evacuation of the patient.

This splint was either removed and the wound was inspected and the splint then was reapplied or else it was left intact by successive medical officers in the line of evacuation, according to their best judgment. Eventually the patient reached a general hospital where he was to be hospitalized for the next stage in his treatment. At this hospital the "transportation plaster" was removed and appropriate therapy usually skeletal traction was instituted to care for the fracture.

The first splint applied for the transportation of fractures of the long bones of the lower extremity was almost universally the army half ring splint. This was applied at the forward dressing station and remained in place until the patient was received at the field or evacuation hospital for his initial definitive therapy. The ambulance drivers and others responsible for his care during transportation from the aid station to the forward hospital were instructed to release the traction provided by the army hitch which was, in most instances, applied over the patient's shoe of the affected extremity. In the event the foot had been injured together with the long bones of the lower extremity the extremity was simply held in place in the half ring splint by means of triangular bandages, usually five in number and no attempt was made to apply traction. I observed a few individuals arriving at evacuation hospitals who had had undue pressure caused by the army hitch, or who had had the hitch in place many hours without release, but I cannot recall a single instance where any permanent damage was done by this procedure. I was favorably impressed by the comfort with which most soldiers with extensive fractures were transported from forward aid stations to evacuation hospitals in the army half ring splint.

After initial definitive treatment—definitive, etc.—at the field or evacuation hospital, these patients, for the most part were encased in one and one-half plaster hip spicas for a

single extremity, or double spicas when both legs were involved and removed to the next hospital in the line of evacuation. These spicas were very well padded affairs. Plaster and padding were split and cut down to the skin throughout the entire length of the extremity up to the hip joint on the affected side. The legs of the plaster were joined with one or more plaster ropes or wooden struts to provide for stability. The patients who were received at rear echelon hospitals in all of these transportation plasters both for the upper and lower extremities, were for the most part remarkably comfortable. Shock was minimized, pain was not an outstanding complaint, and dressings over the operative areas were retained in place, requiring minimal attention and inspection.

Before the advent of major hostilities in Europe the American Army Medical Corps was given the experience of the British in regard to transportation plasters. The British recommended the use of a hanging plaster for fractures above the elbow joint and the use of Tobruk splints for lower extremity injuries.

The hanging plaster was found by most American medical officers to be unsuitable because it did not immobilize the fracture during a long rough ride on a litter in an ambulance. Most patients complained of pain. The Tobruk splint was not regarded favorably by American medical officers because of the lack of immobilization of a fracture of a femur unless it happened to be just at, or immediately above, the knee joint, and because of the consequent pain the patient experienced.

I myself tried on many occasions to demonstrate a Tobruk splint to American medical officers and had a most difficult time applying it, much more trouble in fact than was experienced in applying the large one and one half or double plaster transportation hip spica.

There were many modifications of the Tobruk splint but, in general it consisted of adhesive traction straps applied to the skin along the full length of the extremity with padding over the malleoli.

1 An overlying snugly applied long leg plaster splint encasing the foot to provide support and minimize rotation of the extremity.

3 Slots in this plaster in the region of the malleoli through which the traction straps were passed.

4. An army half ring splint supporting the whole extremity in plaster with the traction straps tied over its end.

5 The incorporation of a windlass arrangement in these straps theoretically to provide skin traction to the injured extremity.

Undoubtedly, the British transportation plasters, namely the hanging plaster and Tobruk splint, used less material than did the American army spicas and velpeaus, and also could be applied with the aid of less personnel but the patients were definitely not as comfortable as in the American devices. The British medical units had less material and fewer personnel than did the American counterparts and it is my own feeling that these transportation splints were developed to meet the material and personnel shortages of the British Army.

The Tobruk splint was used upon occasions by American medical officers and an attempt was made by one of the army consultants Lieutenant Colonel John Manning to follow up all of these cases in the Ninth Army. The number of cases that he was able to contact was nowhere near as impressive as the British figures but the conclusions reached by Lieutenant Colonel Manning substantiated the general belief that (1) There was no uniformity in the types of splints used (2) the transportation of such patients was accomplished with much more pain and discomfort than those encased in plaster spicas (3) the probability of retaining dressings in place in the upper spica was much more difficult then when a

Translating these lessons to civilian life it seems to me perfectly logical to recommend the abandonment of the use of the Murray Jones arm splint as a first aid appliance. I believe civilian patients can have upper extremities particularly when the humerus is involved bound rather snugly to the trunk by gauze or elastic bandages and can be transported in comfort. I should certainly recommend the use of a plaster velpeau type of dressing if a compounding wound has been suffered which has been debrided or closed in

a patient who must be transferred to some other hospital for long term care. When civilian injuries involving the long bones of the lower extremities are encountered the army half ring splint with foot piece and army hitch reasonably well padded over the dorsum of the foot provides an excellent device for transportation. In the event a compounding wound has been encountered which has been debrided or closed a well padded plaster spica applied to the extremity without regard to the problem of reduction of the fracture serves as an excellent transportation device.

#### CONCLUSIONS

1. The Murray Jones arm splint was felt to be cumbersome and difficult to apply. Much more comfortable and efficient immobilization

was obtained by binding the injured upper extremity to the patient's trunk.

2. The plaster velpeau and modified shoulder spicas were preferred to hanging plasters in transporting patients after initial surgery.

3. The army half ring splint with army hitch is an excellent device for transporting fractures of the lower extremity.

4. One and one-half or double hip spica plasters are recommended after initial surgery and are much to be preferred to the British transportation devices labelled Tobruk splints.

5. The above devices, consisting of padded body immobilization plaster velpeaus & shoulder spicas, army half ring splints with foot rest and army clove hitch, and plaster transportation spicas can well be recommended for civilian use.

# PENICILLIN IN EXPERIMENTAL INTESTINAL OBSTRUCTION

## A Summary of Observations with Reference to Their Clinical Application

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THE mechanism of death in intestinal obstruction is only poorly understood. Previously death in all types of obstruction was ascribed to a tox

It is now known that the vomiting associated with high obstructions produces profound chemical changes in the body and that these may be alleviated by the parenteral administration of salt and water. The studies of Wangenstein and others have shown that the relief of intestinal distention does much to reduce associated shock and the hazards of operative intervention. In spite of the advances of recent years in the management of bowel obstructions we still find 1 patient out of every 5 or 6 dying after operation for acute mechanical obstruction of the small bowel (5).

It is thus obvious that more must be learned concerning the pathology of intestinal obstructions in order that new surgical adjuncts can be developed to diminish the hazards associated with such lesions.

When penicillin became available for experimental purposes, we were given the opportunity to restudy certain phases of the intestinal obstruction problem. The factors of bacterial infection and toxemia in the pathogenesis of death from experimental obstruction particularly were reinvestigated.

It is the purpose of this report to summarize our studies on the effect of penicillin in experimental types of intestinal obstruction and to show why the conclusions reached demand

new clinical emphasis on the phases of the problem which were investigated

### PENICILLIN IN ISOLATED LOOP EXPERIMENTS

Prior to our experiments with penicillin in closed obstructed intestinal loops (12) it was known that animals with such lesions would die usually within a week after the creation of the loops in a manner which could best be explained on the basis of a toxemia. The pioneer studies of Stone, Bernheim and Whipple had demonstrated that death in such experiments could not be explained on a basis of vomiting and that septicemia was not a factor. The numerous experiments to prove or disprove the elaboration of toxic substances within isolated loops have been critically reviewed by Cooper (1928), Morton (1929) and Besser (1940). Some investigators, notably Davis and Stone, Murphy and Brooks, Dragstedt and Firor (10) believed that lethal toxins did develop in isolated loop experiments and furthermore that the source of these toxins was bacterial. This latter belief was based on a process of exclusion as there was no positive way to rule out sources other than bacteria for the production of toxins.

In Dragstedt's experiments the isolated loops were washed with ether. The dogs having washed loops survived much longer than did the controls. The possibility was never ruled out in his experiments that the ether might alter the loop mucosa thus interfering with the absorption of toxins of any origin. Firor (10) demonstrated with U shaped loops having both ends open at the surface of the dog's abdominal wall so that periodic through and through cleansing with saline solution could be accomplished that life was prolonged for considerable periods of time after the loops

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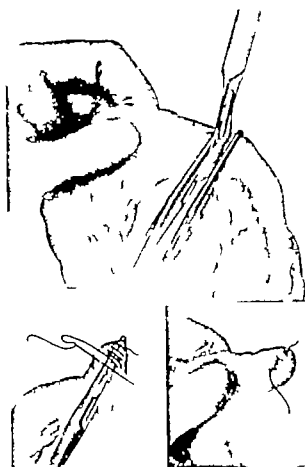


Fig. Occlusion of bowel lumen by transection just above termination of antimesenteric artery of ileum and closure of proximal and distal ends.

were finally closed. The fact that in his experiments the animals eventually died of inanition obscured the mechanism of death in these experiments but again suggested the elaboration of lethal toxins of bacterial origin.

Firor's original suggestion (11) that a modern chemotherapeutic agent (sulfasuxidine) be employed in isolated loop experiments, was, I believe, the greatest contribution to the study of intestinal obstruction since the introduction of the Miller Abbott tube by Abbott and Johnston. Firor and Poth (11) demonstrated that sulfasuxidine when placed in closed isolated loops, would protect animals with such obstructions for long periods of time. The work was confirmed (13). We had one such animal which was sacrificed over a year after operation. The objection to the sulfasuxidine experiments was that the mucosa was altered

by being covered with a thick paste which could theoretically have interfered with the absorption of toxins of any origin. The observations of Firor and Poth led to the important studies of Sarnoff and Poth (18) and Sarnoff and Fine (19) who reported that sulfasuxidine had a protective effect in dogs with ileal lesions, produced by occlusion of the mesenteric veins, but in which the bowel lumen was unobstructed. Their studies established the important rôle played by bacteria in such lesions, but showed that sulfasuxidine must be present for some time for effective bacterial depopulation of the bowel to occur.

In 1945 it was shown (12) with the use of penicillin either placed in isolated loops or administered parenterally in dogs having isolated loops, that bacteria or bacterial products were responsible for the death of animals in such experiments. Furthermore, the lives of dogs having isolated obstructed jejunal loops could be prolonged for significant periods of time when penicillin was placed in the loop or was given intramuscularly. Thus, in 100 per cent of 15 control dogs with isolated jejunal loops, death occurred within 6½ days. 87 per cent died in 3½ days or less. In 100 per cent of 15 dogs, in whose isolated loops penicillin was placed, protection was afforded for 9 days, in 93 per cent for 13 days and in 60 per cent for over a month. One hundred per cent of 5 dogs treated parenterally with penicillin were protected for over 18 days. One dog lived over 2 months.

It was widely held at that time that penicillin was not effective against the gram-negative bacilli. This study demonstrated that for all practical purposes, penicillin in large doses was effective *in vivo* against all of the intestinal tract bacteria.

It was found that marked distention of the loop occurring in the presence of bacteremostatic agents was compatible with life. In the absence of distention of the loop, an abundance of bacterial flora uninhibited by bacteremostatic agents was compatible with life. The experiments indicated that distention must be present before infection of the intestinal wall by the normal intestinal flora can occur. Microscopic and bacteriological evidence was presented to show that penicillin given prophylactically



Fig. 2. Method of tying off mesenteric veins to ileal segment. a, Proximal turned in end; b, distal turned in end; c, rent in mesentery at distal extremity of segment to be strangulated. (Courtesy *Bull Johns Hopkins Hosp*)

lactically in large doses, whether in a loop or parenterally, can prevent infection of the distended intestinal wall by the normal intestinal flora. Recently in experiments employing streptomycin in rabbits with closed loops (created by tying off the base of the large appendix) a similar protective action was demonstrated (9).

#### PENICILLIN IN STRANGULATED LOW ILEAL OBSTRUCTION

In an attempt to produce an obstruction more like that occurring in man and to test a treatment which might be effective for a similar type of obstruction in man Dr John D. Kennedy and the author (3) created strangulated low ileal obstruction in dogs by first completely occluding the bowel lumen (Fig. 1) and then tying off the mesenteric veins to a 60 centimeter segment of the obstructed bowel (Fig. 2). The resulting obstructions were characterized by severe strangulation (Fig. 3). The control dogs' intestines all showed mucosal ulceration and massive bacterial invasion superimposed on the venous infarction which would often be accompanied by perforation. In the first 24 hours following

the production of such lesions there would not always be peritonitis unless perforation had occurred. Later peritonitis developed whether or not there was perforation. The lesions in



Fig. 3. Strangulated low ileal obstruction showing gross appearance of the resulting hemorrhagic infarction of the bowel wall. The proximal turned-in end is in center of photograph. In this particular case this lesion was resected 72 hours after its production in a dog treated with massive doses of penicillin. The animal was cured.

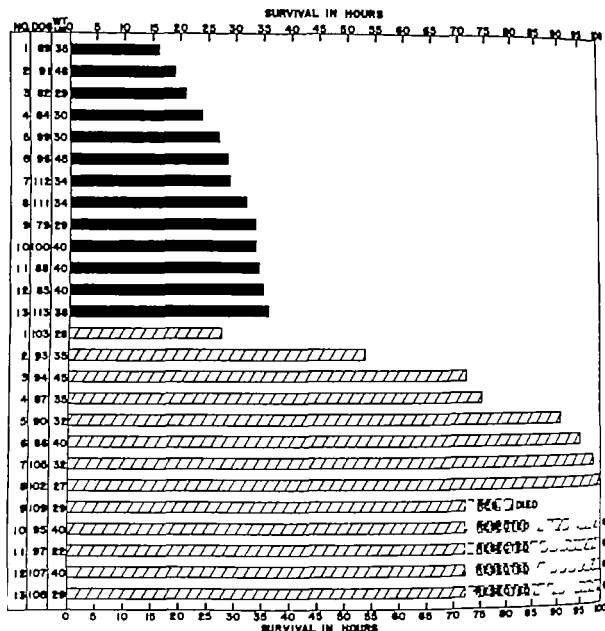


Chart. Diagram showing relative survival times of dogs with strangulated ileal obstructions not treated with penicillin as contrasted with the survival times of dogs with strangulated ileal obstructions treated with penicillin. It can be seen that 4 of the 5 penicillin treated dogs having late resections of their strangulated obstructions were

cured. Both groups were treated equally for hemorrhagic shock, chloride and water loss. Black, postoperative survival time of control dogs with strangulated ileal obstructions. Cross hatch, postoperative survival time of dogs with strangulated ileal obstructions, given massive doses of penicillin parenterally. Black dot, cures.

similar experimental obstructions which had been treated with massive doses of penicillin (100,000 units every 2 hours for 24 hours, 50,000 units every 2 hours during the next 48 hours, and 50,000 units every 4 hours during the remainder of the survival of these dogs whose weight averaged less than 16 kilo-

grams) always showed a well marked bacterial invasion microscopically but this was appreciably less than that which occurred in the controls.

Thirteen dogs, with this type of obstruction treated with whole blood and gelatin solution intravenously and with physiological

saline solution subcutaneously to combat hemorrhage, shock, chloride and water loss died within 36 hours. Seven dogs treated similarly but with massive doses of penicillin in addition survived between 50 and 100 hours (Chart 1). Six dogs lived 70 hours or longer 4 90 hours or longer. In addition in 2 other penicillin treated dogs resection of the strangulated obstructed bowel was performed at 72 hours (a period twice the survival of any control dog) with a cure in each animal. Later in 3 more penicillin treated dogs, resections were carried out at 72 hours, with cure in 2 of the 3 dogs. Thus, there were 5 late resections performed at a time which was twice as long as any dog not treated with penicillin lived. Four of the dogs in which late resections were performed were cured. Drs. Robert J. Calihan and Henry N. Harkins aided us in these latter experiments and we reported the resection experiments with them (4).

In all cases, the control dogs and the dogs treated with penicillin were treated with equal vigor for shock hemorrhage chloride and water loss. In 2 of the penicillin treated dogs and 1 of the controls, volvulus of the strangulated bowel converted simple strangulated obstructions into strangulated closed loop obstructions. Thus it was demonstrated that penicillin in the doses employed (which were massive) in the study, could prolong the lives of experimental animals having the type of strangulated obstruction chosen for the study. It was also demonstrated that this prolongation though striking was limited. Whether the limit was set by (1) the final inability of the penicillin in the doses employed to control bacterial infection (2) fatal alterations in metabolic processes and body chemistry (the serum NPN phosphorus and potassium were elevated the sodium and chloride were normal to high and the carbon dioxide combining power was low) (3) the presence within the peritoneal cavity of necrotic strangulated bowel, or (4) some combination of these factors, could not be definitely established on the basis of this study. Because of the effect of penicillin in experiments with nonstrangulated closed loops, however it would appear that the effect of penicillin would be much more striking in obstruction in which the de-

gree or amount of strangulation was less marked.

These studies demonstrated that bacteria play an important rôle in the 'toxemia' and death in dogs with strangulated ileal obstructions and that aggressive antibacterial therapy in the form of frequent, massive doses of penicillin is effective to a significant extent in treating such lesions.

#### THE FIELD FOR PENICILLIN THERAPY IN HUMAN INTESTINAL OBSTRUCTION

In a study of 204 cases of acute complete mechanical obstruction of the small bowel, in which patients were operated upon at the Johns Hopkins Hospital during the 10-year period 1936-1945 there was an overall mortality of 20 per cent (5). When this mortality rate was corrected for deaths due to cardiac, pulmonary, and other causes not directly related to the intestinal obstruction the mortality rate was 15 per cent. Of the 41 deaths in the series, over half were due to peritonitis. In 27 per cent of all cases the bowel was strangulated at operation. In an additional 5 cases although the bowel was considered viable by the surgeon at operation gangrene and necrosis were found at autopsy. The strangulated cases accounted for over half of all the deaths due to peritonitis. The study confirmed the statement of McKittrick and Sarris that 'the factor of strangulation is the greatest single factor determining the outcome of a case of intestinal obstruction and showed that there is a fertile field for an adjunct against bacterial infection in intestinal obstruction. Indeed it would seem that no further great reduction in the present mortality rate can be made until bacterial infection and 'toxemia' are combated.

#### DISCUSSION

Evidence has been presented which demonstrates the important rôle played by bacteria in death resulting from the types of obstruction studied. Furthermore it has been shown that the lethal effects of bacterial growth can be significantly obviated by massive doses of penicillin. It should be stated here that the exact mechanism by which bacteria produced their lethal effects in our experiments is not



clear. We feel that the ascribing of all deaths in experiments of this nature to peritonitis is an over-simplification of the problem (14). At any rate it would seem that the beneficial results of penicillin therapy noted in our experimental animals, could be applied directly to man. Human studies have revealed that the problems of strangulation and infection are grave ones and also that the presence of strangulation is often impossible to diagnose, especially in patients with early cases short of direct visualization of the affected bowel wall.

When these factors are combated in experimental animals life is prolonged and significant protection is afforded.

#### CONCLUSIONS

1. A clinical trial of massive antibacterial therapy for acute mechanical small bowel obstruction in man is warranted.

2. It is believed that such a trial would significantly lower the present intestinal obstruction mortality.

3. Penicillin should be regarded as an adjunct to early and adequate surgical intervention in acute obstruction and not as a means to delay operation.

#### REFERENCES

1. ABBOTT W O., and JONHSTON, C. J. *Surg. Gyn. Obst.*, 1938, 66 691-697.
2. BRASSER, E. L. *Arch. Surg.*, 1940, 41 970-993.
3. BLAIR, A., III, and KENNEDY J. D. *Bull. Johns Hopkins Hosp.*, 1946, 79 -80.
4. BLAIR, A., III KENNEDY J. D. CALIHAM, R. J. and HARRISON, H. N. *Arch. Surg.*, 1946, 53 378-386.
5. CALIHAM, R. J., KENNEDY J. D. and BLAIR A. III. *Bull. Johns Hopkins Hosp.*, 946 79 1 33.
6. COOPER, H. S. F. *Arch. Surg.*, 948, 7 9 9-967.
7. DAVIS, D. M. and STUCKE, H. B. *J. Exp. M.* 9 7 26 687-69.
8. DRAGSTEDT L. R., MOOREHEAD, J. J. and BURCKE F. W. *J. Exp. M.*, 19 7 25 4 490.
9. FARRIS, J. M. and ROMACK, H. H. *Univ. Hosp. Bull.*, Ann Arbor Mich. 946, 12 90-92.
10. FINE, W. M. Personal communication.
11. FINE, W. M. and POTTS, E. J. Unpublished data.
12. HARRIS, W. H. and BLAIR, A., III. *Bull. Johns Hopkins Hosp.*, 945, 76 1-244.
13. Idem. Unpublished data.
14. KENNEDY J. D. and BLAIR, A., III. *Irish J. M. Sc.*, (in press).
15. McKITTRICK, L. S. and SARRIS, S. P. *N. England J. M.*, 940, 2 6 -612.
16. MORRIS, J. J. *Arch. Surg.*, 949, 18 19-1 39.
17. MURPHY F. T. and BROOKS, B. *Arch. Int. M.*, 1915, 5 397-412.
18. SARKOFF S. J. and POTTS, E. J. *Surgery* 944, 6 9 7-93.
19. SARKOFF S. J. and FINE, J. *Ann. Surg.*, 945 74-82.
20. STUCKE, H. B. BERGER, B. M., and WHITPLE, G. H. *Bull. Johns Hopkins Hosp.*, 9 2, 23 157-65.
21. WANGSWERTER, O. H. *Intestinal Obstruction*, 2d ed. Springfield Ill. Charles C. Thomas, 942.

## MAJOR AMPUTATIONS

RUFUS H ALLDREDGE M D F A.C.S New Orleans, Louisiana

THE changes which have come about in the surgical treatment of amputations due to the recent war effort and which are adaptable to use in civilian life have been chiefly the result of good planning and organization for the care of these cases. The early establishment of the use of sound surgical principles and practices for the early and immediate care and transportation of war amputations and implementation of these policies by authoritative directives was an important part of this planning. This together with the establishment and organization of special centers for definitive care and rehabilitation contributed more than anything else to whatever changes for the better there may have been in surgical treatment. The modern advances in medicine, medical education and graduate education played the rôle of making a higher standard of practice of medicine and surgery available, but all these would have amounted to very little had it not been for proper organization (5). This brought the patients together under the direction of highly specialized surgeons who had the responsibility for not only organizing the whole functioning of the center with all its different departments but for all of the complete care of the whole patient and all of his problems. Even here in the amputation centers the value of organization could hardly be overestimated. For truly surgery is not the end but one of many means to the end in this field. Besides organization it was chiefly due to the fact that the surgeons were in complete charge of all of the amputee's problems from the time of his amputation until he was fitted with a limb and trained to use it that better surgery was done with better results than ever before (1).

These are the important lessons learned from the War and herein lie the hints for the wise if service is to be improved for civilians in the future. It is of course impossible and

unnecessary to duplicate the war services in civil life but it would be a simple matter indeed to establish organized amputation services in the larger civilian hospitals, just as fracture and other special services were developed in the past. The management of amputations would then improve just as fracture treatment has. There is no obvious reason why existing limb makers could not co-operate completely with the surgeons in this matter just as brace makers always have. There can be no quarrel between surgeons and limb makers. The ultimate aim of both should be to give the patient the best possible care. If either or both fail in this important task they may find someone else doing their work for them. For if something is not done to improve the care of civilian amputees the federal agencies may justifiably take over the whole problem including especially the manufacture and fitting of artificial limbs.

### SURGERY

The strongest trend in the surgery of amputations has been toward more conservatism. This has been true both in the immediate surgical treatment and in the definitive surgery. The general use of the modified guillotine amputation at the lowest possible level resulted in the saving of more of the limb than ever before in war or civil life both at the time of primary amputation and finally when definitive surgery was done. The more complete understanding of the problem of the amputation stump in its relation to the prosthesis by the surgeons has resulted in a more conservative surgical attitude with a marked tendency to leave as much stump length as possible and to fit the remaining stump with a prosthesis regardless of its length. The chief exception to this is amputations below the knee of more than 7 inches in length. One of the truly great lessons learned was that the problems of the surgery of the stump are so closely related to those of the prosthesis that it is impossible to completely understand one without under-

Presented in the symposium on Fractures before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.

standing the other and that they cannot be separated from one another. Since the surgeon is the only one who can understand all of the problems, particularly these two, he is the only one who is or ever will be qualified to properly supervise and direct the whole care of the amputation stump and the patient.

The important changes that have come about in the surgical treatment of amputations, then, have not been due to the development of new operations, techniques, or methods. Rather they are due to organization, good judgment, good surgery, and most important, the complete responsibility of surgeons for the whole patient and all of his problems. The problem is an arduous one and nothing has been found which will take the place of hard work and the greatest attention to details.

1. *The open or modified guillotine amputation.* The routine use of this method of amputation in the United States Army has again proved to be the safest and best method for use in war notwithstanding some opinions to the contrary. Although long skin flaps which tend to close the wound prematurely are undesirable, it is important that viable skin be conserved at least equal in length to the bone. The use of the modified guillotine amputation at the lowest level consistent with proper débridement without regard to the final site of amputation with proper skin traction until the stump is ready for final revision or reamputation has proved to be of such great value in the war that it must find greater use in contaminated civilian cases. The stump is ready for revision or reamputation in from 3 to 8 weeks post-operatively depending upon the case. Reamputation at a higher level when indicated can be done much earlier than revision at or near the stump end. This is one of the reasons why the original open amputation should be done at the lowest possible level. The stump is ready for revision when the skin has been pulled well down over the stump end, drainage has ceased, swelling has subsided and the remaining open wound is clean. Routine bacteriological examination of the stump wound is advisable before the final operation is done. It is not necessary or desirable in the majority of cases to wait for complete healing to take place (6).

The use of skin grafts on amputation stumps is mentioned only to be condemned. They are distinctly disadvantageous in that they stop the whole normal healing process and they are poor substitutes for the normal skin which can easily be drawn down over the stump-end by traction. When skin grafts are used they interfere with the function of the stump in the prosthesis by breaking down to such an extent that they should routinely be removed and traction applied until the skin can be closed. The removal of skin grafts from stumps for use elsewhere is equally to be condemned as the donor area causes difficulty when the prosthesis is applied.

2. *Essential points in amputation.* (a) The operation should be done with the use of a tourniquet whenever possible. The use of the tourniquet can be extended by the use of Wyeth pins on short thigh stumps.

b. Definitive operation should be done in a clean field and under careful aseptic precautions.

c. Except in end bearing stumps, the skin flaps should be cut equal in length so that they meet in the center of the end of the stump without redundancy. A general rule for estimation of the length of the skin flaps is to cut each flap approximately two-thirds of the length of the radius of the limb. The stretching of the flaps, which then results after under cutting, permits them to lengthen sufficiently for closure.

d. The deep layer of fascia is reflected with the skin flap in primary amputation whenever possible. The muscles are divided slightly distal to the saw line so that after retraction has taken place the end of the muscles will be at the level of bone section.

e. The periosteum is sharply divided at the level of bone section.

f. The main nerves are gently pulled down, smoothly divided and allowed to retract out of the stump end. Nerves are not ligated, cauterized, injected, or otherwise treated by any fancy technique.

g. The tourniquet should be removed after the main vessels have been ligated and complete hemostasis obtained. The skin flaps are closed by simple interrupted skin sutures. The use of subcutaneous and stay sutures is not

only unnecessary but contraindicated in that they further traumatize already ischemic flaps.

**h Drainage** should be used more or less routinely for 24 to 48 hours in all amputation stumps because of the tendency for postoperative drainage from the mass of sectioned muscle and from the bone.

**3 Postoperative care** There is no substitute for complete bed rest, elevation and proper splinting in amputations below the knee until complete wound healing has taken place. A period of at least 3 to 4 weeks is required for proper healing of these cases. Other amputations may heal in less time. Postoperative splinting is preferable to skin traction even in cases in which the skin flaps are tight. Amputations through, or above, the knee should not be elevated as this causes flexion contractures. These patients particularly bilateral above the knee amputees should be turned face down at intervals whenever possible to prevent contractures. The routine use of elastic bandages for compression dressings has been found to be of great value.

Exercises designed to overcome contractures and to strengthen the muscles of the stump are started as soon after wound healing as possible. Wrapping of the stump with elastic bandages for stump shrinkage when properly carried out has proved to be of great value. Exercises and wrapping are the only two forms of physiotherapy which are of value. Massage is always contraindicated as it may be harmful and is of no value.

Occupational therapy has proved to be important both in keeping the patient's mind occupied while he is waiting and also in the training of the use of the arm prosthesis.

**4 Extension grafts** The extension of the bone length of certain stumps when the normal soft tissues were present but were devoid of a considerable length of bone proved to be a practical and valuable procedure in certain cases particularly in amputations above the elbow. The fibula has been successfully used as an intramedullary extension graft in the medullary canal of the humerus.

The use of extension bone grafts on amputation stumps where any type of skin graft is required to extend the length of the stump is probably not justified in most cases in view of

the disappointing results obtained. This is true of arm stumps as well as various types of amputations of the hand, thumb and fingers.

**5 Homogenous bone and bone bank** The successful use of freshly transplanted homologous bone grafts in a number of patients with multiple injuries and amputations who had no bone graft donor site led to the limited use of a bone bank at the Thomas M. England General Hospital. The bone was collected from clean reamputations and stored in an ordinary electric refrigerator in glass jars containing normal saline solution saturated with sulfanilamide. The use of bone preserved in this manner was not great enough to warrant conclusions as to its value but the experience was sufficient to suggest further experimentation with the method. This experience did prove beyond doubt that freshly transplanted homologous bone gave good final end results in a high percentage of the cases. These results will be published in a subsequent paper.

**6 Sulfu drugs and penicillin** The use of medication of this type has undoubtedly been helpful in combating serious infections and has saved time in some cases. The routine preoperative and postoperative use of medication of this type however has not been proved to be of outstanding value.

#### SITES OF MAJOR AMPUTATIONS

**1 Amputation of all digits at or near the metacarpophalangeal joints** Phalangization of the metacarpals, with complete removal of the second and third and sometimes the fourth metacarpal bones, and plastic closure of the remaining defect with the formation of a deep cleft was found to be the best solution to this problem type of amputation. The remaining digits thus formed have the advantage of sensation, active motion and prehension. They were so capable of function that all patients operated upon were completely satisfied with the results. The function thus obtained is in some ways similar to that of a Krukenberg stump. This type of stump is very satisfactorily fitted with a cosmetic hand which is used on occasions when active function of the stump is secondary to cosmetic appearance. The technique of this procedure will be described fully in a subsequent article.

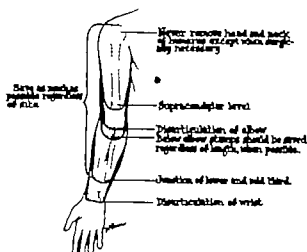


Fig Sites of major amputations i upper extremity

2 *Amputation at the wrist joint* Amputation at the wrist joint has been revived both in this country and in Europe. The carpal bones should be conserved if possible, but if not disarticulation without them is satisfactory. Amputation at this site conserves length and when properly fitted with a prosthesis there is some useful pronation and supination. The prosthesis does not extend above the elbow. Amputation at the wrist is somewhat more difficult to fit with a prosthesis than amputation at the junction of the lower and middle third of the forearm but this can usually be overcome by effort and experience. There have already been many improvements in the prosthesis for amputations at the wrist both here and in England (4).

3. *Amputation at the junction of the lower and middle third of the forearm* If amputation through the wrist is impossible the next level of choice is at this level or approximately 2 inches above the styloid process. Before the war this was the standard site of amputation in the forearm and was preferred by most surgeons and limb fitters. All possible length should be saved above this level.

4 *Short below elbow stumps* All length possible should be saved below the elbow since improved methods of fitting have resulted in greater ability to fit these short stumps than ever before. It is possible to fit satisfactorily below the elbow stumps as short as one-half inch in length. The relative stump length may be slightly increased by resection of the biceps

tendon at the time of final operation. This can easily be done by reflecting the anterior flap without the necessity of making a separate incision (3a).

5 *Disarticulation of the elbow* Amputation at this level was found to be more useful than it had previously been thought to be. It is preferred to amputation at the supracondylar level wherever possible as it gives the stump longer leverage and when properly fitted the patient has better control of the prosthesis, particularly in performing internal and external rotation movements. The prosthesis is fitted with side joints and the type of prosthesis is similar in principle to that used for end bearing thigh stumps.

6 *Amputations at the supra-condylar level.* This is still the standard site of amputation above the elbow. The supracondylar amputation should be left as long as possible. The site of bone section is immediately above the condyles of the humerus. Above this level all possible stump length should be saved.

7 *Short above elbow stumps* A stump at least 2 inches in length below the axillary fold is necessary for the active use of a prosthesis. If the stump is shorter all possible bone should be saved including the head and neck of the humerus, despite the fact that amputations at this level will be fitted as disarticulations of the shoulder. Attempts to increase the relative length by section of muscles and tendons have proved disappointing.

8 *Disarticulation of the shoulder* Disarticulation of the shoulder should never be performed except where surgically necessary. The head and neck of the humerus should be conserved wherever possible for contour and normal appearance. This surgical conservatism also results in better prosthetic fitting and improved prosthetic accomplishment.

#### SPECIAL METHODS FOR USE IN UPPER EXTREMITY<sup>1</sup>

*The Krukenberg operation (or stump)* The Krukenberg method consists of surgical separation and phalangization of the radius and

<sup>1</sup>The basis for the statements used in connection with the Krukenberg and disepiastic methods was personal observation in the American Occupied Zone in Germany, besides the author was member of the Army Surgeon General's European Commission on Amputations and Artificial Limbs (1946).

ulna so that the resulting claw shaped stump is capable of some prehension and has the advantage of sensation. The use of this procedure is limited to amputations below the elbow of at least 11 centimeters in length from the lateral epicondyle. Although the method has been widely used in Germany particularly on bilateral amputees with or without eyesight, it probably would not meet with general acceptance in this country. The use of the Krukenberg method however, should be valuable in the surgical treatment and rehabilitation of all blind bilateral amputees.

**The cineplastic method** The only form of cineplasty still in use is the muscle tunnel type of Sauerbruch. It is still widely used by some surgeons in Germany and the surgical technique has recently been improved considerably. The use of this method has been limited in this country and discontinued in most others chiefly because of inadequate prosthetic facilities. There has recently been considerable renewed interest in cineplasty but extensive use of the method must await further prosthetic research and development which is being carried on by the Committee on Artificial Limbs of the National Research Council. When this work has been completed the method may well be subjected to more extensive trial use when its true value in this country can be finally determined.

#### LOWER EXTREMITY

**1 Amputations through the foot** Partial amputations of the foot up to the Chopart level can usually be fitted with shoe corrections and appliances so that they will give very satisfactory function. One of the important lessons learned in the recent War was that the Chopart amputation could not usually be fitted with anything in the way of a shoe correction or a prosthesis which was satisfactory. The Syme amputation is therefore almost always preferable to the Chopart. Much time worry and dissatisfaction can be prevented on the part of the patient and surgeon by the early and immediate application of the Syme amputation to almost all of these cases. Attempts to improve the function of the Chopart amputation by subastragalar and ankle joint fusion have usually been unsuccessful.

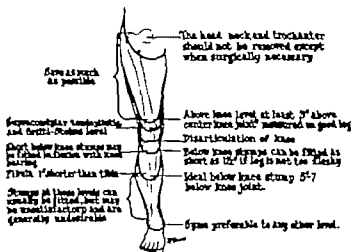


Fig. 2 Sites of major amputations in lower extremity

Center of knee joint is the center of axial motion which is located in the center of the femoral condyle,  $\frac{3}{4}$  inch above the joint line.

**2 The Syme amputation** The Syme amputation when properly performed under the proper circumstances is preferable to any other major amputation in the lower extremity. It is the only amputation recommended at the ankle. The use of amputation at the ankle was greatly revived in this country during the recent war although it had previously been used only to be generally forgotten. Details concerning the Syme amputation during the War have been published in two previous articles (2, 3).

**3 Amputations below the knee** Although amputations in the lower third of the leg above the Syme level may be satisfactory in some cases they are not generally favored, because of poor circulation. The ideal level of amputation below the knee is generally accepted to be five to seven inches below the knee joint. Most surgeons, who have had the greatest experience, prefer a length of not over 5 to  $5\frac{1}{2}$  inches below the knee joint. The use of partial or complete ischial weight bearing has been found to be useful in fitting many imperfect below the knee stumps.

**4. Short below the knee stumps** The fibula should be completely removed in all below the knee stumps shorter than  $3\frac{1}{2}$  inches and these may be fitted as short as  $1\frac{1}{2}$  inches below the knee joint if the leg is not too fleshy. Success in fitting these short stumps depends upon the proportion of length to width. Stumps with little soft tissue covering there

fore are more favorable at this level. Some of these short stumps are advantageously fitted with considerable end weight bearing. Section of the hamstring tendons may give additional relative length to the stump in some cases (3a).

5 *The flexed leg stump (bent knee)* Below the knee stumps, which have for any reason definitely proved to be unsatisfactory or are too short for fitting as below knee stumps, may be flexed to 90 degrees and fitted very satisfactorily with a prosthesis with full weight bearing on the bent knee. If sufficient stump length projects posteriorly in this type of fitting it has the advantage of full end bearing without the necessity of any type of belt or suspenders for suspension of the limb. This is one of the oldest methods of prosthetic fitting in the lower extremity the use of which has been revived in the War.

6 *Disarticulation of the knee* Amputations at this site may give excellent results in some cases. It is important that the greatest care be exercised in performing amputations at this level. Unless good healing and full end bearing are obtained the results may be disappointing.

The patella is left in position without removal of the cartilage unless more length is desired in the anterior flap. Removal of the patella in such cases may result in considerable additional relative length of the anterior flap. The cartilage of the femoral condyles is not removed. It is important that the hamstring muscles be sutured to the patella tendon in the intercondylar notch to prevent separation of the skin flaps. When properly fitted with a prosthesis most of these cases need no pelvic or shoulder suspension of the limb since accurate fitting of the socket to the bulbous end of the stump secures it in place.

7 *Supracondylar amputation of the thigh.* The supracondylar tendoplastic amputation apparently gives equally as good results as the Gritti-Stokes. The only difference in these two amputations is that the patella is excised in the supracondylar tendoplastic procedure, whereas it is fixed to the end of the femur in the Gritti Stokes. The supracondylar tendoplastic amputation has the advantage of being

a simpler surgical procedure than the Gritti Stokes. The former was more commonly used in the Army amputation centers than the latter.

8 *Amputations above the knee* In amputations above the supracondylar Gritti-Stokes level the end of the stump should not be longer than 3 inches above the center of the knee joint.<sup>1</sup> Many surgeons of great experience prefer an ideal length of not over ten to twelve inches from the trochanter. If amputations of the thigh are longer than 3 inches above the center of the knee joint, it will be necessary for the prosthetic maker to make the thigh piece longer than the normal thigh, and the shin piece shorter than normal so that the knee joint of the artificial limb can be incorporated. All possible length should be saved above this level.

9 *Short above the knee stumps* It is possible for above the knee stumps as short as 2 inches, measured from the crotch to be fitted as above the knee amputations. Here again this depends somewhat on the proportion of length to width the thinner ones being preferable. If a short thigh stump proves to be too short to be fitted as an above the knee amputation it may be fitted with a tilting table as a hip joint disarticulation when the stump is flexed to 90 degrees. The head, neck, and trochanter should never be removed except when absolutely necessary as the presence of this structure helps to stabilize the prosthesis and it conserves the normal contour of the pelvis.

#### REFERENCES

- ALLREDGE, RUFUS H. N. York State M. J. 944, 44 765-770.  
Idem. Surg. Clin. N. America, 946, 26 4 2-431.
- ALLREDGE, RUFUS H., and THOMPSON, T. CAMPBELL. J. Bone Surg. 946, 28 4 3 426.
- BLAIR, HARRY C., and MORRIS, HARRY D. J. Bone Surg. 946, 28 437-433.
- McKINNEY, F. ARNOLD M. J. Bone Surg., 944, 26 660-69.
- PETERSON, LEONARD T. J. Bone Surg., 944, 26 635-38.
- THOMPSON, T. CAMPBELL, and ALLREDGE, RUFUS H. J. Bone Surg. 944, 26 639-644.

<sup>1</sup>Center of the knee joint is the center of axial motion, which is located in the center of the condyle of the femur about three-fourths inch above the knee joint.

# ADVANCES IN BONE GRAFT SURGERY ATTRIBUTED TO WORLD WAR II

GEORGE K. CARPENTER, M.D. F.A.C.S. Nashville, Tennessee

BONE graft surgery as performed by the military surgeons during the early months of World War II was little different from that performed in civilian life. Sound civilian surgery became good military surgery. The advances derived from war experience should now be applied to present day civilian practice.

Experience has shown that better end results are obtained when both the patient as a whole and his extremity are effectively prepared for bone graft surgery. The patient's general condition should be at its best prior to surgery. Blood transfusions are often indispensable in rendering the patient in optimum condition for surgery. It has been well shown by Brown, Shaw, Mech and others that existing scar tissue must be appropriately treated prior to bone graft surgery. Once nonunion is accepted, the extremity is subjected to a well supervised preoperative program of physical therapy which is outlined to improve circulation and muscle tone and to mobilize the joints.

Presented in the symposium on Fractures and their Trauma before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.

Chemotherapy plays an important rôle in bone graft surgery. This is particularly true since nonunion so frequently follows a compound fracture. Chemotherapy will not permit bone graft surgery in the presence of infection. It is our practice to delay bone graft surgery until approximately 3 months following complete wound healing. The time interval between complete wound healing and bone grafting may vary somewhat depending upon the character and duration of the infection but it is safer for the patient if the surgeon waits longer than was necessary rather than to operate too early. It is our practice to employ adequate penicillin therapy for 2 days prior to surgery and for approximately 5 days following surgery.

It is believed that nonunion is too often not recognized and accepted in an early stage and as a consequence bone grafting is frequently unnecessarily delayed. So called delayed union usually progresses to nonunion. To treat delayed union for 3 months and at the end of this time find that bone graft surgery is necessary is most time consuming to the patient. Prolonged immobilization is detrimental to restoration of function. The morbidity of a

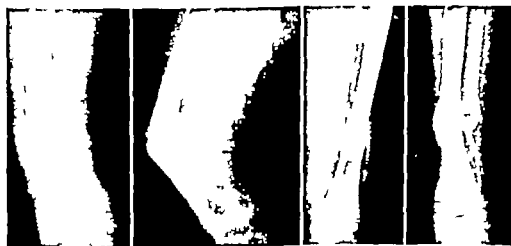


Fig. 1 Case 1: Nonunion of 6 1/2 years duration in an 8 year old child  
Fig. 2 Case 1: Three and a half months after bone graft with iliac bone



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#### REFERENCES

- ALLREDGE, RUFUS H. N. York State M. J. 944, 44 763-770.
- Idem. Surg. Clin. N. America, 946, 26 4 3-43.
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- BLAIR, HARRY C., and MORRIS, HARRY D. J. Bone Surg., 946, 38 487-493.
- McKEEVER, F. LUCAS A. J. Bone Surg., 944, 26 660-669.
- PETERSON, LEONARD T. J. Bone Surg., 944, 26 635-38.
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Fig 1

Fig 2

Fig 1 Case 1 Nonunion of 6½ years duration in an 8 year old child  
Fig. 2 Case 1 Three and a half months after bone graft with iliac bone.

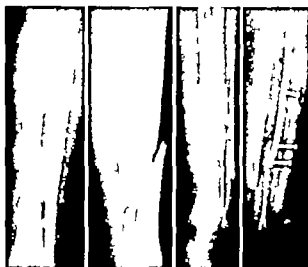


Fig. 3.

Fig. 4.

Fig. 3. Case 2. Nonunion 6 months following injury.  
Fig. 4. Case 2. Three months following inlay bone graft.

fracture is in direct proportion to the extent and duration of the disability and its associated economic sequelae.

In cases in which the surgeon is reasonably assured that nonunion is inevitable bone grafting should not be delayed except as is necessary to fulfill the usual prerequisites for bone graft surgery. Unless the surgeon is reasonably assured that so called delayed union will soon progress to solid bone union it is believed that bone grafting should be performed without delay. Carpenter



Fig. 5.

Fig. 6.

Fig. 5. Case 3. Nonunion 5 months following severe compound fracture.

Fig. 6. Case 3. 11 months following onlay graft.

Rosenfeld and Meek have described the treatment of limited union by reinforcement bone grafts as a procedure planned to shorten the time needed to obtain a bony union of sufficient size and strength to permit early and unprotected function of the extremity. This treatment of limited union decreases the disability and thereby reduces the morbidity of the fracture.

A patient with nonunion requires a careful consideration of the individual problem at hand and a method of procedure is planned which will assure the maximum of function in the minimum of time. Needless to state, the



Fig. 7.

Fig. 8.

Fig. 7. Case 4. Nonunion of radius 6 months following severe compound fracture. Healing complete for 3 months.

Fig. 8. Case 4. Roentgenograms showing union 7 weeks after onlay graft.



Fig. 9.

Fig. 10.

Fig. 9. Case 5. Nonunion of radius 4 months after injury.

Fig. 10. Case 5. Roentgenograms 6 weeks after onlay graft.

procedure of choice must be a safe one for the patient, and this will necessitate sound surgical judgment and respectful understanding of morbidity. Cancellous bone such as that obtained from the wing of the ilium offers exceptional qualifications as the graft of choice. It is ideal for a spinal or sacroiliac fusion and in nearly all joint fusions which necessitate the use of autogenous bone. Unfortunately the usual bone graft operation for nonunion is performed with the patient on his back, and since the posterior wing of the ilium presents the better donor site, certain technical difficulties most often make the ilium an impractical site from which to obtain the grafts. Adequate internal fixation of the fracture site is very advantageous and can be better obtained by the application of an onlay graft with screw fixation. Cancellous bone in lesser quantities can, of course, be obtained from the tibia. The tibia serves as the best donor site in the majority of cases. Multiple chip grafts as can be obtained from the tibia, also serve to stimulate osteogenesis.

The long bones may be better grafted by the application of long tibial grafts with cancellous bone and chips packed about the fracture site and along the graft. Two to four screws will as a rule adequately maintain in



Fig. 11.

Fig. 12.

Fig. 11. Case 6. Nonunion of humerus 4 months after severe compound fracture. Wound healing complete for 3 months.

Fig. 12. Case 6. Roentgenograms 8 weeks after onlay graft.

ternal fixation of the fracture and graft. Frequently in nonunion of the femur the fracture is fixed by the application of a six screw metallic plate to facilitate postoperative treatment in a Thomas splint and a Pearson attachment traction apparatus. Nonunion of the femur thus treated by the application of a metallic plate in addition to a tibial graft and cancellous bone eliminates the use of plaster and permits early knee motion. Although it is believed that positive fixation of the fracture and of the graft very materially hastens the union, such treatment is not always employed.



Fig. 13.

Fig. 14.

Fig. 13. Case 7. Seven and a half months after fracture of femur.

Fig. 14. Case 7. Seven months after application of onlay graft and plates.



Fig. 15.

Fig. 16.

Fig. 15. Case 8. Two and a half months after fracture of femur.

Fig. 16 and 17. Case 8. Five months after onlay graft and plate.

As a general rule plates and screws are used sparingly if at all in treating a case of nonunion which previously showed infection even though wound healing had been complete for at least 3 months. Bones well covered with muscles, such as the shaft of the humerus and femur will tolerate plates and screws much better than such locations as the lower third of the tibia. The site of the nonunion should be cleared of scar tissue and sclerotic bone, but when extensive infection has been present, it may be unwise to treat the fracture site. An onlay graft may be reasonably expected to take without performing an extensive resection of scar tissue and sclerotic bone. A sliding inlay graft is an excellent procedure for treatment of nonunion of the tibia following a simple fracture but when nonunion follows a compound fracture of the lower third of the shaft of the tibia an onlay graft, without screw fixation is applied to the lateral aspect of the tibia. Intermedullary grafts are rarely if ever used. With loss of substance multiple grafts with much cancellous bone and chips are employed in an effort to restore the bone to its normal size. It is imperative that plenty of bone be used in every case. The surgeon must be ingenious and resourceful and an exponent of sound surgical principles.

#### SUMMARY

The advances in bone graft surgery emanating from the experiences of World War II which are equally applicable to civilian practice are briefly as follows

1 A full appreciation of the value of rendering the patient in optimum condition for surgery and maintaining his blood and nutritional requirements throughout the convalescence, as so well described by Lyons.

2 Like the patient as a whole, the extremity itself is likewise put in optimum condition for surgery.

3 Chemotherapy will permit the infected compound fracture with nonunion to be grafted earlier but never until the elapse of an adequate time interval following complete wound healing.

4 An early recognition of nonunion will permit grafting as soon as the usual prerequisites for bone graft surgery are satisfied.

5 Adequate internal fixation of the fracture and of the graft preferably by using screws and a tibial graft seems to stimulate the osteogenetic activities of the graft and is desirable except when the site of fracture was previously the seat of an extensive infection.

#### REFERENCES

- BROWN, J. B. J. Bone Surg., 944 36 443-454.
2. CARPENTER, G. K. In Lectures on Reconstruction Surgery American Academy of Orthopedic Surgeons. pp. 37-4. 496-50. Ann Arbor Mich. Edwards Bros. Inc., 944.
3. CARPENTER, G. K., and MEECH, K. F. N. York State J. M. 944, 44. 886-890.
4. CARPENTER, G. K., and ROSENFIELD, R. T. Surg. Clin. N. America, 1944, 24 430-434.
5. CARPENTER, G. K., ROSENFIELD, R. T. and MEECH, K. F. J. Bone Surg. 946, 28 692-698.
6. LYONS, CHAMP. J. Am. M. Ass. 943, 3 007-8.
7. MEECH, K. F. J. Bone Surg., 944 3 442-447.
8. SHAW, DARRAL T. Surg. Clin. N. America, 1944 24 303-308.

# FRACTURE OF THE CARPAL SCAPHOID

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THE navicular of the hand is invariably called the scaphoid by those who write of its pathologic state. Obletz and Halbstein (1) described the nutrient foramina on which the blood supply of this bone depends. The largest and most numerous of these foramina are distal to the constricted portion called the waist by clinicians. These writers concluded that a complete fracture at the waist would seriously interfere with the blood supply of the proximal fragment in about a third of the cases. *This is the important factor in the healing of these fractures.*

**Mechanism** These fractures are due to indirect violence transmitted from the outstretched hand along the radial axis of the hand and forearm. These radial axis injuries are in order of sequence but not frequency as follows (1) fracture of the first metacarpal bone, (2) fracture of the greater multangular bone, (3) fracture of the carpal scaphoid, (4) perilunate posterior dislocation of the carpus, (5) Colles fracture, (6) fracture of the head of the radius. These lesions occur separately and in combination (Fig 1 and Fig 2). In the younger age group such as we had to deal with in the armed forces whose strong muscles resist the indirect violence fracture of the carpal scaphoid occurs 4 to 5 times as frequently as Colles fracture. In the more elderly with flabby muscles the wrist immediately extends and Colles fractures predominate.

**Clinical recognition of the fracture** If after a fall on the outstretched hand or similar trauma, the patient complains of pain at the radial side of the carpus, inability to grasp firmly, and shows no obvious deformity but constant, definite tenderness in the interval between the long and short extensor tendons of the thumb a fracture of the carpal scaphoid should be assumed to exist until its absence is proved by roentgenogram.

Presented in the symposium on Fractures before the Clinical Congress of the American College of Surgeons, Cleveland Ohio December 16-20, 1946.

**Roentgenography** The use of the roentgenogram as an aid to diagnosis in a very high percentage of wrist injuries led to the discovery of an enormous number of these carpal scaphoid fractures in the armed forces. A complete or widely displaced fracture may be immediately revealed by the first roentgenogram in conventional positions. At times the first roentgenogram will fail to reveal the fracture which will be readily seen 2 weeks later due to absorption at the fracture line. Those views which show this fracture to best advantage are (1) an anteroposterior with the hand in marked ulnar deviation and (2) a postero-anterior in 45 degree angle oblique projection.

**The fracture** A few of these fractures occur at the tuberosity where the transverse carpal ligament is attached. These avulsion fractures heal uneventfully in short order.

The fracture under consideration occurs at the waist and heals according to the blood supply which remains to the proximal fragment. Fractures with an adequate blood supply to the proximal fragment should heal with 8 to 10 weeks of immobilization while those with an

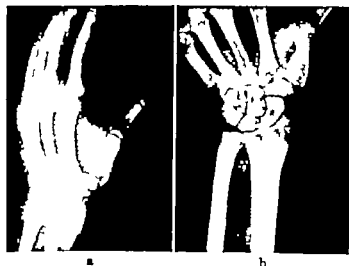


Fig 1. Cpl. S.F. Jeep accident December 16, 1945, Korea. Plaster splint was applied immediately. a, Earliest roentgenogram available March 15, 1946, shows healed fracture of left first metacarpal bone, fracture of left carpal scaphoid unhealed. b, Roentgenogram 3 months later June 13, 1946, carpal scaphoid healed. This case illustrates a combination of two radial axis injuries.

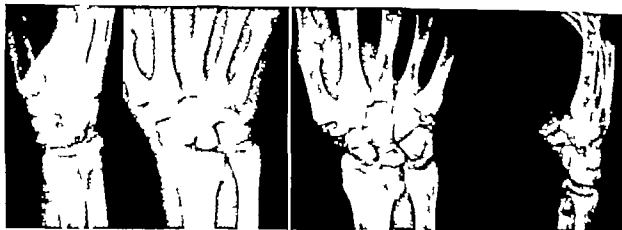


Fig. 2a.



Fig. 2b.

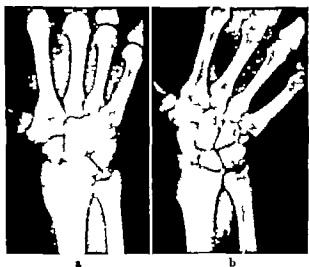


Fig. 3. Cpl. E.M. June 2, 1945 France. Fall on outstretched right hand. Treated 3 months as *strain of wrist*. a, Roentgenogram November 3, 1945, 3 months after injury showing fracture of right carpal scaphoid with marked absorption at fracture line. b, Roentgenogram, July 3, 1946, 3 months after injury shows carpal scaphoid fracture healed. This soldier was disabled 3 months, at least 8 mo. the longer than necessary because his injury was unrecognized.

Fig. 2. Pvt. H.L.B. Jeep accident November 6, 1945, France. Injuries recognized and treated immediately. a, at left, Roentgenogram of right wrist showing *perilunate dislocation*—this a complete badly separated fracture of the scaphoid. a, at right, Roentgenogram of left wrist on day of injury showing fractures of greater multangular, carpal scaphoid and Colles. b, at left, Roentgenogram of right wrist July 30, 1946, 8 months after injury. Dislocation reduced, scaphoid fracture ununited. a, at right, Roentgenogram of left wrist July 30, 1946, 8 months after injury. Fracture of greater multangular and Colles are united. Carpal scaphoid ununited. This case is shown as *bilateral carpal scaphoid fracture with three other associated radial axis injuries in the two wrists*. This soldier refused further treatment, stated that his symptoms were minimal. He could do his civilian job and requested discharge from the service.

inadequate blood supply will require up to 20 weeks or longer before healing ensues. Unfortunately there is no means of determining in advance into which group any given fracture of the scaphoid falls.

#### TREATMENT

Treatment of the fracture is by prompt immobilization of the wrist in a glove type circular plaster splint extending from just below the elbow to the distal palmar flexion crease, allowing full motion in the fingers. The wrist is in slight dorsal flexion. The thumb is usually immobilized in anatomic position beyond the distal joint. Various positions of the thumb have been advocated with equally good results reported. This does not appear to be a vital factor.

Since no complete fracture of the carpal scaphoid through the waist heals in much less than 8 weeks, plaster immobilization should be continuous for this period. The plaster splint is then bivalved, a roentgenogram is

taken, and the splint immediately reapplied. If the fracture is united the splint is discarded. If union of the fracture is doubtful a new circular plaster splint is promptly applied. If this roentgenogram reveals the proximal fragment with its original density while the distal fragment shows atrophy, there is definite evidence of interference with blood supply to the proximal fragment, and prolonged immobilization of the wrist up to 20 weeks or longer may be indicated.

#### RESULTS OF TREATMENT

Shands reported that 195 of 198 carpal scaphoid fractures treated by trained orthopedic surgeons in 6 Army Air Force hospitals resulted in union an incidence of 98.5 per cent. Oblatz (2) reported in greater detail a series of 28 carpal scaphoid fractures from an Army Ground Force Hospital. He personally

followed these cases until plaster splints could be discarded. Union occurred in every case without aseptic necrosis in a single instance.

These 2 instances are, of course, optimum results obtained by experts. Experience gained by the medical officers of the armed forces offers to civilian surgery two salient facts about this fracture: (1) it is a common injury; (2) with complete knowledge of the problem and proper treatment based on that knowledge, a high percentage of those fractures will heal.

Beware of a diagnosis of sprain of the wrist joint! (Fig. 3)

#### REFERENCES

1. OBLETZ, B. E. and HALBSTEIN, B. M. *J. Bone Surg.* 1938, 20, 424.
2. OBLETZ, B. E. *Surg. Gyn. Obst.* 1944, 78, 83.
3. SHANDS, ALFRED R. An Analysis of the More Important Orthopaedic Information. *Recent Advances in Surgery* 1944, 16, No. 4, October.



## MANAGEMENT OF COMPOUND FRACTURES IN THEIR EARLY PHASES

OSCAR P HAMPTON Jr MD F.A.C.S St Louis, Missouri

THE advances during World War II in the management of compound fractures in their early phases came not only in improved techniques of excisional surgery in forward hospitals and in the broad application of specific procedures such as delayed closure of the compounding wounds and surgical incisions or delayed internal fixation of malaligned compound fractures several days later in base hospitals, but of greater importance in a change of concept for the management of these wounds. Moreover the basic principles of the science of surgery itself were irrevocably reaffirmed.

Battle received compound fractures were all compounded from without in and were potentially septic because of the usually present extensive soft part and bone damage, the mud clothing and other foreign material often burned deep in the wound and the prolonged time lag from wounding to surgery. The wounds and incisions of initial surgery of necessity remained unsutured and reduction of the fractures was usually delayed 5 to 10 days until the wounded men had been transferred to base hospitals. The comparable lesions in civilian life, then are injuries many hours or days old

with unreduced fractures and open and possibly grossly septic wounds.

In the early experience, The Orr Trueta regimen of closed plaster subsequent to débridement had in general left much to be desired. Slow wound healing by granulation with heavy scar formation was accepted prolonged wound suppuration with necrosis of living tissue was not infrequent inadequate reduction of fractures anticipating malunion or nonunion was often accepted and the prolonged plaster fixation predisposed to extreme muscle atrophy and fixation of joints. Fear of stirring up and establishing limb or life endangering sepsis including gas gangrene had prevented efforts at delayed wound closure, at delayed open reduction and internal fixation of unreduced fractures, and even at radical secondary débridement to combat sepsis, the therapy of which had included only prolonged drainage through the open wound local and systemic sulfonamide in an effort to control the bacterial flora of the wound and immobilization.

Based upon previous experiences and observations, during the Cassino and Anzio impasse in early 1944 and the later offensive attendant to the Fall of Rome, the closed plaster—open wound—fear of surgery in a septic field concept was discarded in favor of that of repair

From Department of Surgery Washington University.  
Presented in the symposium on Fractures and Other Traumas before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-10, 1946.

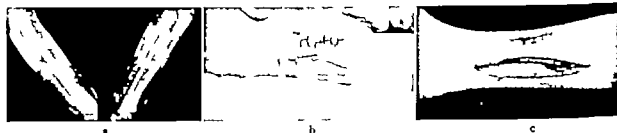


Fig. a. Anteroposterior and lateral views of compound fracture of the tibia at the junction of the middle and lower third, which had been produced by high explosive shell fragments with resulting gaping wound about 3 inches long. b. Eleven days after wounding and débridement, by means of relaxing incision about 6 inches long and

shifting of the flap, the compounding wound was sutured without tension. The defect created by the relaxing incision was at once covered by split graft. c. Twelve days later the compounding wound and the grafted defect were healed. Patient returned to duty status about 4 weeks after he had been wounded. (Courtesy J. B. Lippincott Co.)



Fig. 2 a. Drawing of a huge wound compounding a fracture of the femur as it was observed ten days after wound ing and initial surgery and another drawing showing the sutured wound, with dry fine mesh gauze as a drain to residual dead space. b. Seventeen days later wound healing was complete and a dressing was no longer necessary c.

Anteroposterior and lateral views of the fracture of the femur held in adequate although not anatomical reduction in double skeletal traction. Traction is being made on a wire through the tibial tubercle while vertical lift is being made on the distal femoral fragment by means of a second wire through this fragment.

tive surgery of compound fractures. The new regimen included aggressive secondary surgery in the several days old and possibly septic wound with delayed excision of dead tissue if necessary internal fixation of fractures on precise indications and partial or complete closure of clinically clean compounding wounds with obliteration or dependent drainage of residual dead space. Penicillin therapy systematically was employed as a safe guard against invasive infection of living tissue by the bacterial flora of the open wound. It was used as a means to a better surgical result and not in an attempt to sterilize an open wound. Whole blood replacement therapy was used extensively to permit prolonged anesthesia and surgery as an aid in the prevention of chronic sepsis and presumably as an aid to wound healing.

The concept for the newer regimen may be stated as follows:

'Wound sepsis results from the septic decomposition of dead tissue including blood clot in dead space. If a wound is free of dead tissue and if dead space is obliterated or dependently drained and if living tissue is protected from invasive infection by an effective

antibacterial agent the bacterial flora of an open wound may be disregarded and any reparative procedure may be performed within the range of recognized surgical limitations without fear of sepsis and with the anticipation of good wound healing.'

The experiences and successes achieved in the application of this concept in the management of unreduced compound fractures with open wounds several days after the initial surgery permit the following conclusions. The supporting data, mostly have been published.

1. In the prevention or eradication of wound sepsis, regardless of the time lag since injury or duration of sepsis, the surgical excision of dead and devitalized tissue and the obliteration or dependent drainage of dead space are prime considerations. Devitalized tissue is the forerunner of sepsis and when sepsis intervenes, reparative measures are doomed to failure, delayed or nonunion of the fracture may follow and wound healing will be postponed or prevented. Hence the importance of thorough initial surgery in preparation for reparative surgery several days later.

2. Delayed closure of clinically clean wounds that is wounds free of dead tissue and debris

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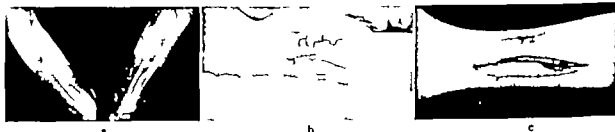


Fig. 1 a, Anteroposterior and lateral views of comminuted fracture of the tibia at the junction of the middle and lower third, which had been produced by high explosive shell fragments with resulting gaping wound about 3 inches long. b Eleven days after wounding and débridement, by means of relaxing incision about 6 inches long and

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judicious application of these principles that is, the excision of dead tissue when and wherever it is found obliteration or dependent drainage of dead space staged closure of wounds, atraumatic technique with fine hemostats and fine ligatures pressure dressings adequate reduction and immobilization of fractures, and precise splinting and with the

adjuvant use of penicillin and whole blood the objectives of the regimen were achieved Surely the same regimen under the same principles is applicable to many compound fractures of civilian life which are seen many hours days or weeks after injury has occurred and particularly to those with established sepsis

## OSTEOMYELITIS FOLLOWING COMPOUND FRACTURES

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THE changes which have been brought about in civilian practice with respect to osteomyelitis complicating compound fractures have resulted from the application of sound surgical principles and careful attention to detail Many believe that the advances made in the treatment of these cases are the result of sulfonamides and penicillin This is not wholly true for while the antibiotics have played an important part good surgical care has been of paramount importance Antibiotics are best applied systematically and there can be no doubt that a patient in poor general condition does not respond as well to these agents in combating infection as one in a good state of health In patients who have had acute blood loss or with hemoglobin values low because of long continued infection, it is necessary to give adequate blood transfusions if antibiotics are to be of value

A debilitated patient is a good host for bacteria A healthy one resists invasion by organisms Compound fractures are severe open wounds The fundamental principles underlying open wounds apply whether the bone is involved or not The realization and adoption of these principles have resulted from experiences in World War II Wounds seen early carefully cleansed of as many contaminating organisms and foreign bodies as is possible and

the devitalized tissue carefully debrided are best closed primarily If this seems not feasible secondary closure (1) of the wound after several days is advisable If large defects in the skin or soft tissue result immediate skin grafts assist the wound to heal kindly even though they may need replacing later with a full thickness sliding or pedicle graft Obviously good principles of fracture and wound care must include immobilization This can and should when possible, be accomplished without the use of screws or plates Large dead spaces must be obliterated (3) and when this is not possible dependent drainage must be afforded to minimize the complication of osteomyelitis

Chronic osteomyelitis resulting from compound fracture actually is less frequent today than it was before the war because these principles mentioned above have been more widely recognized as a result of the experiences of World War II The best treatment for this condition is prevention and careful attention to principles of care of wounds This is the best prophylaxis we have

Chronic osteomyelitis should not be confused with hematogenous osteomyelitis which presents an entirely different problem The two conditions are separate entities and have different clinical pathological radiological and surgical considerations Unlike hematogenous osteomyelitis this type practically never metastasizes but remains an infection within the bone locally The treatment of es



Fig. 3 a, Anteroposterior and lateral view of a comminuted fracture of the femur which is the site of gas abscess. The patient had been wounded by a high explosive shell fragment 10 days previously and had received inadequate excisional surgery. Local and systemic sepsis had followed. Although the gas abscess is visible on the roentgenogram, there were no clinical signs of gas gangrene. b, The gas abscess was drained and devitalized tissue was excised through a long posterolateral incision. The dead space about the fracture site was obliterated by fixing the fragments in apposition by means of a six hole bone plate. This illustration shows the fracture partially united 3

months after drainage of the abscess and concurrent plating of the fracture. The wound had been healed since about 3 weeks after the internal fixation of the fracture. c, The wound remained healed and the fracture firmly united in anatomical alignment. Because of some absorption about screw as visualized on roentgenograms, the plate and screws were prophylactically removed with immediate closure of the wound and primary healing. d This illustration reveals the completely healed wound of the thigh (with some excessive scar formation which required later excision and subsequent repair. This end result is a triumph for the principles of reparative surgery.

and of signs of invasive infection is surgically sound provided dead space is obliterated or dependently drained and excessive tension is avoided. The sliding or advancement of flaps to permit closure without tension is often worthwhile. Therefore given a clinically clean compounding wound several days after excisional surgery wound healing by granulation should be scorned and if surgical limitations do not preclude, wound closure by suture or skin graft should be performed. Wound healing while affected by several factors, is a natural cellular growth provided the wound does not contain dead tissue dead space strangulating ligatures, etc. Wound closure may be practiced to the extent to which these qualifying factors can be surgically obviated.

3 The best evidence of adequate excisional surgery is a clinically clean wound 5 days later the optimum time for delayed wound closure. Within this period excellent drainage of wound exudate and residual debris is provided, and closure of wounds before the formation of heavy granulation tissue and reduction of fractures before the fixation of fragment ends are permitted.

4 Despite an unhealed wound inadequate reduction of fractures need not be accepted if it is preventable by open reduction with or without internal fixation. Reduction of the fracture eliminates the dead space about malaligned fragment ends, avoids subsequent manipulations which may produce additional devitalized tissue and anticipates minimum deformity. Internal fixation is detrimental to wound healing only as devitalized tissue is created in its application or as it interferes with soft part coverage of denuded bone.

5 The regimen as a whole may be expected to achieve minimum sepsis rapid healing of wounds with minimum scar maximum reduction of fractures, and maximum functional restoration of the extremity. In this experience no loss of limb or life attributable to the aggressive surgery was reported.

In summary reparative surgery of compound fractures represented a major advance in World War II. Under its principles, the spotlight was moved from the bacterial flora to the pathology of the open wound and a surgical approach was established for the management of septic compound fractures. By

# APPLIED ANATOMY IN EYE SURGERY

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**A**PPLIED anatomy serves a twofold purpose. It gives a precise basis to those occurrences and procedures that especially involve anatomical knowledge, and, in addition, it converts an otherwise unusually dull subject into one of interest by associating it with something manifestly useful and practical.

The student of anatomy has a somewhat hazy fanciful notion that his study of anatomical structure will, in some way and at some future time prove useful to him. By incorporating with it its surgical application he is made aware of its value in very much the same way as a series of experiments in laboratory physics relates to sheer theoretical, scientific data.

While it is assumed that eye surgeons, in general, are acquainted with most of the premises which I am presenting it is with the hope that the memory of the dissecting days which have been growing a bit gray with some of us will wish to recall some of the anatomical matters which have the most direct bearing on surgical practice.

In surgery of the lids we must constantly bear in mind the delicate nature of the skin as well as the changes which come with advancing years which have a direct connection with surgical performance. The skin of the eyelid is the most delicate in the body pale and loosely attached. The foreskin approaches it most nearly in texture. However, it is not wise to use foreskin for lid replacement because, for some unknown reason, it nearly always becomes deeply pigmented. If not much is needed, the skin of the opposite lid is ideal if available. Probably next in order is that just back of the ear or that from the inside of the arm.

In old age the skin atrophies and loses its elasticity due to atrophy of the elastic fibers. This sometimes induces spastic entropion since the overaction of the orbicularis has no

resilient skin to overcome it. The Ziegler cautery is effective by causing the skin corresponding to the lower margin of the tarsus to adhere to this border so that it will not curl up and roll over the lid margin. In like manner, cauterization of the conjunctival side in hypertrophic ectropion probably causes the conjunctiva to attach itself to the inner border of the tarsal plate. Sometimes in advanced age there will be considerable tearing with a patent drainage canal, often due to lax skin plus a hypertrophy of the conjunctiva. Making only a few punctures immediately inside the canaliculus will bring in the lid margin just enough so that the lower punctum will contact the globe and again siphon off the tears.

It is well to contemplate the width of the tarsal plate in selecting the type of operation for correction of contractile entropion. The tarsus of the lower lid is much narrower than that of the upper the width of the normal upper being about 10 millimeters and that of the lower about 5 millimeters. Hence in surgical correction of the upper lid, where the tarsus is still wide we may attach the cut edge of the skin near the lid margin to the top of the cleaned tarsus and have a right to expect a satisfactory result. This may be further improved by removing the thickened orbicularis attached to the tarsal plate, producing a wider palpebral fissure. The lower tarsal plate is seldom wide enough to justify utilizing this method so the modified Green Ewing method is recommended, as this does not require a wide tarsus.

The eyebrow is thick and curved so as to protect the eye from sweat and blows. It also helps shade the eye from excessive light by bending over. It should not be plucked and if destroyed by injury should be restored for this and cosmetic reasons. The lashes serve the same purpose and need not be trimmed before surgery. It is often a great advantage to grasp the lashes after operation to pull the lid away from the eye in closing it. The lashes can be replaced by a narrow graft from the

established osteomyelitis following a compound fracture is a problem in the care of the local area supported by systemic treatment to aid in combating the infection and supporting the patient constitutionally. Open drainage with removal of infected areas by saucerization permits drainage after the infection has become localized. This is a principle similar to the treatment of localized infection of other parts. A lesson which has been learned from World War II is that large open defects must not be allowed to remain to depress the vitality of the patient. Skin grafts should be applied as soon as clean granulations have covered the drained area to minimize loss of fluid and discomfort to the patient. These should be applied early even though they are not sufficient in themselves to give good permanent coverage to the area. When such wounds have been properly covered the patient is more comfortable and early reconstructive surgery can be accomplished with the aid of antibiotics.

Prior to World War II it was considered poor surgical judgment to attempt reconstructive surgery in the area where infection had taken place because of the possibility of reactivating the infection. On one of the large orthopedic services (2) of a general hospital in the Zone of the Interior 90 per cent of the procedures were done through the original incisions with approximately 5 per cent flare up of infections. Bone grafting to fill defects was also performed 6 to 8 weeks after wound healing. This has been made possible by general supportive measures and the use of sulfonamides and penicillin systemically. The value of appropriate chemotherapy before and after operation in the care of osteomyelitis cannot be stressed too strongly and prolonged administration is of definite value (5).

Reconstructive surgery of the skeletal system should not be done in the presence of draining sinuses, open draining wounds, or any clinical evidence of wound infection. This concept is no different than it was before the

war. Penicillin or sulfonamides cannot be expected to be of value in the presence of undrained abscesses, the presence of sequestra, detached fragments of bone with aseptic necrosis or any other foreign body.

Frequently large open wounds with considerable loss of skin, muscles, tendons, nerves, or blood vessels with bone trauma may be diagnosed as osteomyelitis incorrectly because of the constant drainage or "weeping" from granulation tissue (4). In such cases the drainage will usually stop when the wound is closed by a skin graft if osteomyelitis is not present.

The differences in the care of compound fractures in World War II as compared with World War I are striking. In compound gunshot wounds during the first year of World War I the total mortality was reported to be about 60 per cent (6). With emergency splinting on the battlefield the mortality was reported to be about 12 per cent at the end of the third year. During and following World War I compound fracture wounds were debrided and packed open with vaseline gauze with immobilization by plaster. This continued as the accepted form of treatment even during the late Spanish Civil War (7).

The present concept in the treatment of compound fractures which has resulted from World War II has decreased the morbidity and the incidence of chronic osteomyelitis. The application of the principles usually accepted for other infected wounds, as well as the use of chemotherapy has improved the results in cases of chronic osteomyelitis.

#### REFERENCES

- CHURCHILL, E. D. *Ann. Surg.*, 944, 20, 268.
- DAY, A. JACKSON. Personal communication.
- HAMPTON, OSCAR, P. JR. *Ann. Surg.* 945, 1, 359-332.
- HART, V. L. Personal communication.
- MILGRAM, J. E., Personal communication.
- ORR, H. WIDNETT. *Osteomyelitis and Compound Fractures*. St. Louis: The C. V. Mosby Co., 1929.
- TRUETA, J. *Brit. M. J.* 942, 6, 6.

# APPLIED ANATOMY IN EYE SURGERY

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**A**PPLIED anatomy serves a twofold purpose. It gives a precise basis to those occurrences and procedures that especially involve anatomical knowledge, and, in addition, it converts an otherwise unusually dull subject into one of interest by associating it with something manifestly useful and practical.

The student of anatomy has a somewhat hazy fanciful notion that his study of anatomical structure will, in some way and at some future time prove useful to him. By incorporating with it its surgical application he is made aware of its value in very much the same way as a series of experiments in laboratory physics relates to sheer theoretical, scientific data.

While it is assumed that eye surgeons, in general are acquainted with most of the premises which I am presenting it is with the hope that the memory of the dissecting days which have been growing a bit gray with some of us will wish to recall some of the anatomical matters which have the most direct bearing on surgical practice.

In surgery of the lids we must constantly bear in mind the delicate nature of the skin as well as the changes which come with advancing years which have a direct connection with surgical performance. The skin of the eyelid is the most delicate in the body pale and loosely attached. The foreskin approaches it most nearly in texture. However, it is not wise to use foreskin for lid replacement because, for some unknown reason, it nearly always becomes deeply pigmented. If not much is needed, the skin of the opposite lid is ideal if available. Probably next in order is that just back of the ear, or that from the inside of the arm.

In old age the skin atrophies and loses its elasticity due to atrophy of the elastic fibers. This sometimes induces spastic entropion since the overaction of the orbicularis has no

resilient skin to overcome it. The Ziegler cautery is effective by causing the skin corresponding to the lower margin of the tarsus to adhere to this border so that it will not curl up and roll over the lid margin. In like manner, cauterization of the conjunctival side in hypertrophic ectropion probably causes the conjunctiva to attach itself to the inner border of the tarsal plate. Sometimes in advanced age there will be considerable tearing with a patent drainage canal, often due to lax skin plus a hypertrophy of the conjunctiva. Making only a few punctures immediately inside the canaliculus will bring in the lid margin just enough so that the lower punctum will contact the globe and again siphon off the tears.

It is well to contemplate the width of the tarsal plate in selecting the type of operation for correction of contractile entropion. The tarsus of the lower lid is much narrower than that of the upper, the width of the normal upper being about 10 millimeters and that of the lower about 5 millimeters. Hence in surgical correction of the upper lid, where the tarsus is still wide, we may attach the cut edge of the skin near the lid margin to the top of the cleaned tarsus and have a right to expect a satisfactory result. This may be further improved by removing the thickened orbicularis attached to the tarsal plate, producing a wider palpebral fissure. The lower tarsal plate is seldom wide enough to justify utilizing this method so the modified Green Ewing method is recommended, as this does not require a wide tarsus.

The eyebrow is thick and curved so as to protect the eye from sweat and blows. It also helps shade the eye from excessive light by bending over. It should not be plucked and if destroyed by injury should be restored for thus and cosmetic reasons. The lashes serve the same purpose and need not be trimmed before surgery. It is often a great advantage to grasp the lashes after operation to pull the lid away from the eye in closing it. The lashes can be replaced by a narrow graft from the



brow or from the hair line back of the ear. Recently Goldzieher reported some preliminary experiments he made on the skin of three elderly women after some previous experiments on dogs. He applied two estrogenic substances, estradiol and stilbestrol daily to the inner areas of the arms and thighs for a period of 6 weeks. Small sections of the skin taken from these areas showed restoration of the width of the epidermis, the number of cell layers increased, the individual cells larger and the elastic fibers more numerous.

I have seen the skin of the upper lid so lax that it drooped down and cut off some of the temporal field. For this reason as well as for appearance sake, a strip of it was removed.

The levator palpebrae is inserted in the skin of the upper lid the lower third of the tarsus and along with Mueller's muscle to the upper edge of the tarsus. It is mainly these latter fibers with the attached aponeurosis that we use in Cannas' operation, where the paralyzed levator is attached to the tendon of the superior rectus.

The lymph channels from the upper lid pass through the preauricular node; those of the lower lid, the submaxillary node (Treves). This is important in differentiating the lead of drainage in infections and sometimes helps in locating orbital infections where the septum orbitale has been penetrated.

Paralysis of the sixth nerve is particularly associated with fractures of the base of the skull, owing to its long course beneath the dura and its close confinement beneath the petrosphenoidal ligament. In fact, it was Pannas who first recognized that a fracture of the base of the skull might be manifested by a paralysis of the sixth nerve alone. Crepitus of the lids usually denotes fracture of the nasal bone, although fracture of any of the bones forming the nasal sinus cavities connected with the orbit may give rise to air in the orbit or lids.

The orbital cavity is about half an inch wider in the horizontal than in the vertical direction. Therefore it will be seen that there would be more space between the eye and the orbital wall on the sides than above or below and the greatest interval between the globe and the orbital wall is on the temporal side.

For this reason, growths which start on or at the apex of the orbit, or even on the opposite side may soon find their way to the temporal side of the orbit. Dermoid cysts of the orbit are almost invariably found on the outer side, and although they may appear small, on operation will be found to extend to and be attached very close to the apex of the orbit. It is possible that the orbital septum keeps them within bounds and from protruding forward to any extent.

An intraorbital growth which is not within the intramuscular cone and presents on the temporal side can be reached better through a conjunctival incision than by one through the skin. Sometimes, even with the assistance of x rays, it is not possible to tell whether the growth is beneath or above the periorbita and exploration only will determine that fact. If the bone of the periorbita is involved then access through a skin incision is best. To reach growths in the intramuscular cone a Kroenlein approach seems best. In performing this operation, guard against severing the external rectus too far back or a paralysis may result. If the tendon is cut instead of the muscle belly it can be sewed together without fear of this happening. In performing evisceration of the orbital contents, it is done easily and quickly by separating the periorbita from its attachment to the wall of the orbit and then continuing to loosen it with a periosteal elevator back to the apex then cutting off the entire mass from its apical attachment. A clean orbital wall is thus secured and with a minimal amount of bleeding. The cavity must be kept packed sufficiently tight to keep the lids on a stretch, which will otherwise shrivel and atrophy. Of course, if one does not expect to preserve the lids and eventually fill up the orbital cavity then the lid margins may be freshened, sewed together and utilized to serve as a covering for the denuded orbital wall.

The conjunctiva is very loosely attached to the globe in man. The reverse of this is noted in operating on animals' eyes even in monkeys. Man having a smaller cornea in proportion to the size of the globe than any other animal, necessarily has more of his sclera covered with conjunctiva, exposed than any other creature. The negro, having a larger eye than

the caucasian, makes this still more noticeable. This makes it easier to perform surgery on man than on animals, as anyone who has experimented on animals' eyes will have observed. There are other reasons also. This looseness of the conjunctiva is of value in eye surgery in several ways, such as making conjunctival flaps to cover the cornea correcting mild cases of symblepharon and in other plastic procedures. The distance of the conjunctival fornix from the upper lid margin is from 20 millimeters to 25 millimeters. The tarsal plate is from 10 millimeters to 12 millimeters wide. The distance of the fornix to the corneal margin is 8 millimeters to 10 millimeters. Hence, we have a loose surface of conjunctiva 18 millimeters to 22 millimeters wide from which we may easily take half or three quarters for use of a conjunctival transplant on the other eye socket, or for use in restoring the lining of the canaliculus in a plastic operation for restoring its lumen.

Pterygium is described as a conjunctival growth extending over the cornea. At any rate, the underlying cornea is always involved with destruction of Bowman's membrane not only immediately beneath the pterygium but according to Fuchs, to a point about 3 millimeters beyond the apparent apex. In my experience recurrences can be almost invariably prevented if one includes this involved corneal area in his dissection and resects a few layers of the cornea proper beneath the destroyed Bowman's in dissecting off the pterygium.

The most common tumor of the conjunctiva is the naevus. Many are not pigmented and few of them are malignant. About 10 per cent of the tumors are dermoids and in their removal one must bear in mind that the underlying sclera may be very thin.

While ballooning out the retrotarsal fold with 2 per cent procaine to which a drop or two of epinephrine has been added will completely anesthetize both surfaces of the lids for practically all operations on the lids proper so that no pain will be experienced when the tear drainage apparatus is involved, more than that is required. For the lids all of the terminal nerve endings are thus caught supplying the entire thickness of the lids. In order to anesthetize the canaliculus and sac so

that no pain will be felt by the patient to catch all of the nerves supplying the canaliculus one must first instill a drop of pontocaine then insert a small wad of cotton soaked with pontocaine and epinephrine in the inner canthus and after waiting about a minute insert a fine hypodermic needle into the conjunctiva just behind the punctum and slightly temporarily to it, inject a drop or two of the solution of 2 per cent procaine the needle is then advanced in the loose tissue along the course of the canaliculus and drop by drop injected additionally as it is pushed toward the sac. When it reaches the periosteum covering the sac wall a sharp momentary pain is felt until a drop is injected here. Here, the periosteum is very sensitive as the main branches of the supratrochlear and infratrochlear nerves are encountered. One may now pass the dilator and probe into the canaliculus and down through the sac without the patient experiencing any pain. This, together with the anesthetization of the nasal mucosa by the otolaryngologist is sufficient for the intranasal dacryocystorhinostomy.

In doing an extranasal operation or in removal of the sac, one must block the supratrochlear and infratrochlear and the infraorbital. In passing a probe down the nasal duct one is much more apt to make a false passage with a small probe than with a large one. The lumen of the sac is not just a smooth tube, but is often sacculated in such a manner that the small probe will pass into one of these pockets and penetrate the lining whereas a larger one might spread the lumen so as to obliterate the defect temporarily and go right on through. Pictures of these anatomical variations illustrated in both Whitnall and Schaeffer should impress this fact on our minds with impelling force.

One of the most frequent sources of failure in performing any type of intranasal tear sac operation is the failure of the surgeon to make his opening through the bone and sac inside the nose low enough so that the fluid will drain into the nose and not leave a pocket below the opening holding pus. Another of course, is failure to keep the opening patent. It is essential that the puncta be in contact with the globe and that the canalicula not be slit, in

order to have complete drainage. The canaliculi are also shortened by blinking making them wider and thus helping to carry off the tears. In old age when laxity of the skin sometimes causes the puncta to drop away from the globe, relief can be had by a limited Ziegler cauterization.

In operations on the cornea it is well to recall that normally it is thinnest at the center where it averages about 0.8 millimeter widening at the periphery to about 1.2 millimeters. It gets thinner with advancing years and may be less than 0.5 millimeter at the center in the aged. This, plus the loss of resiliency accounts for the sinking in or collapse of the cornea in very old people after cataract incision. A bubble of air injected into the chamber will maintain the normal curvature of the cornea until it has healed.

While Bowman's membrane, if destroyed never regenerates, it is not an essential part of the cornea for either visual or protective purposes. One may resect a corneal scar and obtain clear vision in its absence with apparently no more hazard to infection in its absence than if it were present. In resecting the cornea for corneal scar or peeling it off it is well to bear in mind several things. First, the formation of connective tissue producing the scar creates a much thicker protective shell than the normal cornea. This means that the cut, in preparation for peeling, must be deeper than one would make in a normal cornea, in order to get below the scar formation. Most eye surgeons fall in their corneal resections by not keeping this fact in mind. It also requires more pressure with the knife. It is also less flexible than the normal cornea and cannot be pulled back too much without endangering perforation of the thin underlying transparent cornea. Second in making the crucial incision with the scalpel don't forget that you are not cutting on a flat surface, but over a convexity with a radius of about 80 millimeters. Hence, the handle of the knife must be raised in starting the incision at the limbus and gradually lowered as the cut proceeds toward the opposite margin so as to keep the cutting edge, and not the point of the knife, in contact with and conforming with the corneal curve. This enables one to make his primary

cut much deeper without the danger of perforation. Third, and no less important an anatomical point to bear in mind is that the lamellae, normally about 60 in number and from 1.3 microns to 2.5 microns thick, run the entire width of the cornea, crisscrossing with each other at right angles and with very little interlacing so that they run almost parallel to the curved surface. When one picks up a single section to be peeled off it is essential that he stay in the same layer as that in which he started otherwise whenever he cuts across the intervening layers, connective tissue will form with resulting scar. By following proper technique, closely watching the line of cleavage, this is not difficult to do.

In an article by Edward Jackson on "The Function and Structure of the Eye," he stressed the fact that transparency depends on permeability to some substances of the transparent membranes, which included Bowman's and Decemet's in the cornea, capsule of the lens, Bruch's membrane of the choroid, and their impermeability to others. Rupture brings about loss of transparency. The cornea may lose its transparency from transudate or edema, as in glaucoma exudate, as in keratitis blood staining from blood in anterior chamber becoming hemolyzed scar tissue formation and dissolving of the cement substances between the lamellae in the stroma so that the refraction index is interfered with. This latter is probably due to infiltration of aqueous, such as that due to rupture of Decemet's from birth injury. Edema due to entrance of fluid through the epithelium can be differentiated and temporarily cleared by the glycerine test suggested by Cogan. Jackson lays continuous stress on the resilience of the cornea and refers to Salzmann's description of the arrangement of the layers, because it is more important and easier to understand when considered as a provision for resilience. Hence, no compression bandage after a corneal cut or cataract operation and keeping the wound elevated. He quotes Ellett, speaking of sutures in cataract operation "I think it does give a relative assurance against prolapse, but then there is still enough trouble from this source to lead me, after a rather extensive trial of the simple operation to give up

in favor of the combined operation, except in such cases where the cosmetic effect was a thing to be considered.' Jackson used no corneal stitch relying upon the resiliency of the cornea.

The elasticity of the cornea is greater in the vertical than in the horizontal direction which may account for the astigmatism in glaucoma according to Schreuder who found it to be anisotropic that is exhibits different properties when tested in different directions.

The cornea is about 12 millimeters in diameter, but the sclera extends 1 millimeter over the edge in the horizontal and 2 millimeters in the vertical meridian. In some cases it extends 3 millimeters or even 4 millimeters over the edge in the vertical meridian especially so in glaucoma cases. This is a fortunate arrangement in shelving the cornea. This broad limbus is marked in *hydropthalmus* too.

The epithelium around the limbus is potentially a pigment bearing tissue this can especially be noted in animals one may therefore get a pigmented papilloma at the limbus with out its being a melanoma.

The sclerocorneal junction is the weakest part of the eyeball. Rupture of the globe at this point may find the lens under the conjunctiva. If the lamina papyracea, which forms the inner wall of the orbit, should rupture then the eyeball will not rupture. One or the other may rupture, but never both. Decemet's membrane may rupture in birth injuries or in keratoconus and lead to permanent clouding of the cornea, probably through absorption of the interlining cement substance of the layers. Decemet's membrane is easily detached, as happens in doing a trephine or cyclodialysis. It curls under certain conditions and is very elastic. Unlike Bowman's it rapidly regenerates. It is really a crust formation laid down by the endothelium lining the inside of the cornea. This is contrary to the opinion of Elliott, who stated that it and the endothelial lining never regenerated and recommended denuding the endothelium just beyond the limits of the trephine opening so that the opening would not fill up.

At the periphery of Decemet's membrane in most people lies the anterior marginal ring as a circular band. It may go only part way

around and be rudimentary and can be seen with the gonioscope. Decemet's membrane is more resistant, both to the trephine and to infection than is the stroma. One may find 'warts (cornea guttata) around the periphery of Decemet's, which can be seen with the slit lamp and sometimes with the gonioscope. So long as they remain in the periphery they are of no special significance but if located in the center of the cornea the vision may be reduced as much as down to 20/40 or 20/70, and this must be kept in mind in cases of otherwise unexplainable reduced vision. They sometimes permit the aqueous to leak into the cornea.

There are a number of things which make knowledge of the scleral structure a matter for serious consideration in eye surgery. The sclera is about 0.6 millimeter thick at the limbus. Just back of the insertion of the muscles it is thinnest—0.3 millimeter or less. This is where the stitches for recession are placed, and fortunately need not, and should not be deep. Going back to the equator it thickens to 0.6 millimeter and increases to 1.0 millimeter in the back. At the point of entrance of the optic nerve it is very thin owing to the perforations of the lamina cribrosa. On account of this inequality of the thickness one can easily see the futility of using pins in operating for retinal detachment for, if the pins are set for the proper depth in the thin area, they will not be deep enough where the sclera is thickest. The reverse is also true. The zone overlying the ciliary body is a circular area concentric to the limbus 5 to 6 millimeters back. The equator is 13 to 14 millimeters back of the limbus. The area of the venae vorticosae is represented by a concentric band 3 millimeters wide and 18 to 21 millimeters back of the limbus, or 5 to 8 millimeters back of the equator. The superior temporal vena vorticosae lies 7 millimeters back of the equator, the superior nasal 7 to 8 millimeters the inferior temporal 5 millimeters and the inferior nasal 6 millimeters. These exits can be seen and in operations for detached retina and posterior sclerotomy these positions must be kept in mind. In posterior sclerotomy it is best to keep near the equator to avoid these and the long ciliary vessels.

Calcification of the sclera is very common in old age and follows absorption of the elastic

fibers in the sclera. This tends to give one the impression of increased intraocular tension by the finger test which is not borne out with the tonometric measurements. Again the point of the cataract knife may encounter one of these hard particles and interfere with making a satisfactory section. They are usually found on the nasal side as grayish depressions, about 4 millimeters back but exceptionally may appear further forward near the margin. If this process is far advanced the eye loses its power to adjust itself to lessened volume, as when the chamber is opened and the lens removed this can be made up by injecting air into the chamber. This factor may account for choroidal detachment, according to Fuchs.

The emissary perforations in the sclera lie 4 to 6 millimeters back of the limbus and are of great importance. Sometimes the long ciliary nerves loop up and look like small, gray tumors in this region. These have been excised under this delusion which is followed by anesthesia of the corresponding width of the cornea. They can be easily differentiated after having first anesthetized the eye by grasping the mass which induces severe pain. Old glaucoma can often be suspected by the enlargement of the ciliary arteries emerging suddenly from these openings, giving the impression of being more greatly enlarged than they really are. New growths of the ciliary body often emerge from the emissaries and give the impression that they are autonomous, localized ones. Transillumination and other means will determine such.

The sclera is loosely attached to the choroid except where the vessels and nerves penetrate it. In making an incision for cyclodialysis, a sharp corneal hook picks up the sclera, making it very easy to cut through the sclera without touching the choroid, since traction with the hook pulls the sclera away from the choroid. Be sure to make the cut in a place free from vessels which is not hard.

In performing posterior sclerotomy for glaucoma, it is essential to use a knife just as sharp as one would wish for in making a cataract incision and thrust it quickly through into the vitreous with the blade parallel to the anteroposterior fibers so as not to separate the retina from the choroid. As the blade is withdrawn

the incision is enlarged toward the posterior pole. There is a definite place for this little used operation one of which is in cases in which after a drainage operation the iris or ciliary body has come forward into the wound following an apparently successful operation causing the tension to rise again. The release of the pressure behind the lens will often cause the ciliary hernia to recede and remain back. There need be little or no bleeding if the technique is carried out properly. This admonition must also be heeded in making the incision for the removal of foreign bodies by the posterior route. In this case the incision must be fully 50 per cent larger than the largest diameter of the foreign body for one never knows which end is coming first and it may even come broadside. A long incision heals just as quickly as a small one and does not invite danger of retinal detachment, in my experience, even though one fails to perform electrocoagulation as a preventative measure.

The capsule of Tenon is both membranous and elastic. It is more or less adherent at the attachment of the muscle tendons and in some places to the fat of the orbit. Semeraro found that in tests carried out on the cadaver Tenon's capsule is nonexistent in some cases. This fact may account for the slipping out of the capsule of the implant in many cases of enucleation where the operation seemed to have been well carried out. We have never encountered this condition in the living eye in the many operations involving the muscles, although it does seem to be much less developed in some cases than in others. There is no actual space between the ocular surface of the capsule and the orbital surface opposing it, but the two are connected by a felting of very fine strands of connective tissue. These are loose enough to permit the eyeball to move freely in a limited way but in extreme excursions both globe and capsule move together as a whole in a bed of orbital fat, which is loosely connected to the capsule behind. There is a difference of opinion as to how far forward the capsule extends. Sobotta states that it terminates at the upper retrotarsal fold and at the insertion of the muscles. Most authorities agree that it blends with the conjunctiva as far forward as the corneal margin.

Where the vessel sheaths blend with the capsule, they give offshoots to the orbital walls known as the check ligaments. We shall speak of these in a moment. The septum orbitale is a thin membrane of connective tissue which extends from the entire orbital margin toward the palpebral opening and tends to hold infections to either the orbit or to the anterior part of the globe. The capsule of Tenon as well as the periorbita and the sheath of the optic nerve, are continuous with the dura. For this reason it is dangerous to perform enucleation in panophthalmitis with marked cellulitis of the orbit, as it may lead to meningitis and subsequent death of the patient. I saw this happen once while I was a medical student. Evisceration is here indicated. In removing the contents of the globe it is imperative that no remnant of the uveal tract remain. The choroid is firmly attached in two places posteriorly, where the posterior ciliary vessels and nerves enter and in front where the anterior vessels and nerves pass through the emissaries. These points must be most carefully inspected on conclusion of the operation. When all of the pigmented material has been removed, the sclera will be seen as a white smooth surface and there will be no bleeding. If the usual enucleation is done and a glass ball is inserted it is well to figure out just how large the cavity is so that too large a one will not be introduced and be expelled. If we could count on preserving every bit of capsule as far forward as the attachment of the muscle tendons and not allow any for the depth of the sutures, then we might easily put in a 14 millimeter or even a 15 millimeter implant in the capsule. However, anteriorly the capsule is so intimately connected with the sclera that it isn't detached for several millimeters back of the insertion. Therefore, if one inserts a small ball, not over 12 millimeters in diameter there will be less stretching of the capsule in sewing it in and more likelihood of it not being expelled. This rule holds good, also for implanting after evisceration for the reason that taking off all of the cornea and part of the sclera lessens the diameter of what remains. It would seem that Burch's recommendation of leaving the cornea intact and implanting a larger sphere should give a far better result.

In a clean enucleation it is not necessary to sew the tendons together for they are closely attached to the capsule and fall naturally together whether the capsule be sewed or not. In enucleating a globe for absolute glaucoma where we have a very deep cup, if the nerve is cut too closely one is apt to lose vitreous for there is no vitreous hyaloid membrane either over the nerve head or the ora serrata. Women's eyes are larger than men's and the negro eye is larger than that of the white man hence, a slightly larger implant can be used.

In man, the conjunctiva is very loosely attached to the globe except at the limbus. It stretches readily. The capsule of Tenon is supposed to run forward beyond the attachment of the muscle tendons to blend with the conjunctiva. For all practical purposes one can almost forget it is there, unless it constitutes the deep layer under the loose, conjunctival connective tissue which hugs the sclera. In making a flap for sclerocorneal trephine, one must hug the scleral surface closely with the blunt scissors in order to obtain a thick, protective flap. At the point where the sclera and cornea join, the knife is substituted and the cornea split. One can easily determine when the cornea has been reached by its bluish appearance. The same technique for splitting the cornea in a sclerocorneal trephine is recommended as in the resection for corneal scar. If properly done it requires less than a minute's time.

In exposing the muscle tendons for advancement recession or enucleation the capsule of Tenon should be disturbed as little as possible and none of it lost. Make the incision in the conjunctiva large enough for freedom of operation for a large incision heals just as easily and quickly as a small one. When the area to be explored is sufficiently exposed remember that immediately under the conjunctiva and over the capsule is some loose connective tissue which will be grasped by the forceps instead of the capsule if it is not pushed aside. To accomplish this place the flat fixation forceps so that the blades will be closed and parallel to the length of the tendon press it down on the globe and at the same time, separating the blades while still maintaining the pressure. It is necessary that the forceps have

a strong spring in order to do this properly. Then, without releasing the pressure, separate the blades about 2 or 3 millimeters and then make increased pressure against the sclera so as to indent it while closing the blades. The forceps will now have a good hold on Tenon's. Keep the grasp firmly make a snip with the scissors close to the end of the forceps while pulling it slightly away from the sclera keep the original grasp on the capsule until the hook has been slid under the tendon. The reason the blades must be kept parallel to the length of the tendon is that when the eye is rotated to expose the area, the capsule, as well as the tendon is put on a stretch which makes it easy to be grasped thus and very difficult if it is attempted against the stretched tissue.

The average distance for the attachment of the recti muscle tendons back of the limbus is, medial 5.5 millimeters inferior 6.5 millimeters lateral 6.9 millimeters superior 7.7 millimeters. Hence, the forceps must be placed far enough back to catch the free side of the tendon. Of course, these measurements vary considerably and, according to Motais they may be as far back as 7 millimeters for the medial and 11 millimeters for the superior. It is better to allow for the maximum than to get too far forward. It is also well to bear in mind the width of these tendons so that in first placing our forceps in position we will not include any of the tendon fibers. The average breadth of the tendon varies from 9.2 millimeters for the lateral to 10.75 millimeters for the superior. Thus one sees that in placing the forceps it is well to be about 6 to 7 millimeters beyond the estimated center of the tendon to be exposed. While the medial rectus is thickest and strongest, its tendon is also the shortest, averaging less than 4 millimeters in length while the lateral, which is the weakest, is nearly 9 millimeters long. It also must be noted that the lines of insertion of the tendons are not straight, but are curved, or even wavy and do not lie parallel to the corneal margin. For example, it is easier to approach the tendon of the superior rectus from the medial side than from the temporal since it is several millimeters closer to the limbus nasally.

The superior oblique attachment to the globe lies just behind that of the superior rec-

tus. Therefore, all one has to do to expose the superior oblique tendon is to engage the attachment of the superior rectus tendon with the hook, reverse the pull by turning the hook and draw the hook backward, thus engaging the tendon of the superior oblique and pulling it forward into the conjunctival wound.

Since the inferior oblique arises from a small depression on the orbital floor just within the inferior orbital margin lateral and close to the nasolachrymal canal, it can be easily exposed by a deep incision into the lower conjunctival sulcus deep enough to strike the perosteum on the floor of the orbit, introduce the hook into the opening until it strikes the floor and then sweeping it nasally until the resistance of the attachment is felt whereupon it is drawn into the wound.

Stitches for a recession are placed where the sclera is thinnest. Fortunately the stitches in this case need not be and should not be as deep as for advancement, for there is less pull on the muscle operated upon after than before the operation for two reasons. First, because the tendon is set farther back, and because the muscle is partly paralyzed from handling. If all of these rules are followed out, bearing in mind the anatomical features mentioned, the tendon of any of the muscles, either straight or oblique can be caught with the first sweep of the hook. Failure to do so means faulty technique.

The attachments of the capsule of Tenon to the margins of the orbit prevent the muscles from entirely retracting and, even when the globe has been removed give them bases to act upon, thus preserving some motility in the stump. Rough handling of these attachments so as to mutilate these parts of the capsule can result in an ugly proptosis after a strabismus operation or sinking of the globe after enucleation. When a part of the capsule known as the suspensory ligament of Lockwood is mangled the eyeball drops or there may be excessive lateral rotation of the globe or upward movement. Instruments should always be sharp so that clean cuts can be made with the scissors instead of tears. Clean cuts heal easier and are less prone to infection.

O'Connor suggested a novel method of increasing the effect of the Himmelsheimer oper-

ation by utilizing the nasal third of the rectus muscles, turning them under the rectus tendons before sewing them laterally. The objection to this, however, is that it puts even a greater stretch on these transposed portions. A more secure method is suggested for this valuable conception utilizing the paralyzed, split rectus to attach to the vertical recti and then severing the nasal third of their attachment to the globe. This involves the same principle as the O Connor method is easier to execute and eliminates the danger of tearing loose of the vertical strips.

In operating on the muscles in order to obtain complete anesthesia, it is necessary not only to instill an anesthetic in the conjunctival sac and inject the intramuscular cone but also to use a very fine needle and inject a drop or two into the muscle belly itself. While most of the sensory nerve endings terminate near the tendinous attachment, the tendon tissue is too dense for it to spread and complete absence of pain will be accomplished only by injecting into the muscle itself.

In a recent article on "Guides to Choice of Operation for Squint" Sugar stressed Biel schowsky's guide to choice of operation based on anatomical and physiological principles. They are important enough to repeat here.

1 When a difference in the two eyes under cover can be determined, the eye showing the smaller deviation is the paralyzed one.

2 When the vertical deviation of the paralyzed eye is greater in adduction an oblique muscle is involved (because the obliques help in adduction) and for the same reason when it is greater in abduction a vertical muscle is involved.

3 The image of the paralyzed eye is always seen in the direction in which the affected muscle should move the eye.

4 When tilting of images is marked and tipping of the head greatly increases diplopia, an oblique muscle is nearly always involved.

5 The principal action of a muscle should always be considered.

Klein in investigations concerning the lens capsule and its importance in the technique of intracapsular cataract extraction emphasizes the fact that the zonular lamella is a very thin membrane that covers the peripheral parts of

the anterior lens capsule and is easily separated from it. The posterior capsule is thinner than the anterior lens capsule, the central area of each is thinnest, the maximum thickness being between the equator and the center. In old age the zonular fibers become fragile and the capsule thicker (there is an exception, that of the Morgagnian where both become thin). By a special method, he found that the capsule can resist a pressure of 150 to 200 millimeters of mercury. He recommended traction on the lens capsule and simultaneous pressure at the limbus with a hook to rupture the zonule then, repetition of the maneuver in a different direction. In intumescent and hypermature lenses, as well as in those cases where there has been a previous uveitis, the zonule is so weakened that it is ruptured with a minimum amount of pressure so that the lens can be extracted by the Smith method without touching the capsule. These are the only cases where the Smith method is recommended.

Since the lens capsule is thickest between the center and the periphery this is where it should be grasped with the Arruga or similar forceps in breaking the zonule. There is a tendency of many surgeons in order to make sure of securing a firm hold on the capsule, to take too wide a bite. When this is done it stretches the capsule to such an extent that it is more liable to break before the zonule ruptures. The zonular lamellae may extend back as far as the ora serrata and if pulled upon too much can detach the retina or pull a hole in it. This may occur in doing an intracapsular, or even in doing a needling if not done properly. The lamellae may not attach and there may actually be a thickened capsule around the edge of the lens which may desquamate into the anterior chamber and cause glaucoma.

The anterior hyaloid has tremendous stretching qualities and may come forward after the cataract incision and be mistaken for vitreous. If the speculum be immediately removed and traction made by pulling down on the upper lid, it usually retracts and one may proceed with the operation. Here is another advantage of having lashes with which to grasp the upper lid in order to pull it away from the globe. There may be an anomalous



union of the anterior hyaloid with the lens capsule which proves a detriment to extraction in the lens capsule for in this case the hyaloid is torn and vitreous exudes. This anomalous condition cannot be determined beforehand.

In the embryo there is a sinus running around the pupillary area and in adult eyes cysts sometimes form in this sinus area separating the pigment layer. They may manifest themselves by floating down in the pupillary area as a black mass when we may assume that it is a cyst. If however the black mass is seen at the base of the iris melanoma must be suspected.

Tags near the base of the iris show a relation to the pectinate ligament in lower animals. Normally in the human there are only a few trabeculae in the angle. These may extend from a peripheral iris knob which at times is present in the human. If present in a glaucomatous eye the synechiae will run from it to the angle.

The vessels of the iris run parallel with the radiations. Hence cutting the iris in the direction of the fibers in an iridectomy causes less bleeding and, at the same time, enables one to make a deeper iridectomy. For this reason I fail to see how a peripheral iridectomy in acute glaucoma can be as effective as a complete one, as claimed by some.

Sugar stresses the importance of knowing the depth of the anterior chamber in glaucoma and describes a method for measuring it by means of the McNair Bettman portable slit lamp. The important thing is the angle. Of special significance is the condition of the angle, which can be determined by gonioscopy. Through this means Barkan has developed the operation of goniotomy for congenital glaucoma, which consists of removing or cluding fetal meshwork from the angle promising much for this hitherto almost intractable disease. Anderson's analysis of 84 specimens,

finding the canal open in 75 per cent of the early specimens and no trace of it in children over 2½ years of age, none of which had been operated on strengthens Barkan's warning for early operation in these cases, since the distention of the eyeball tends to obliterate the canal. Barkan makes the distinction between goniotomy in the infant, which consists of removal of fetal remnants from the angle versus trabeculotomy in the adult, whose object is to incise the angle wall that is, the trabeculum itself. In the May issue of the *Archives of Ophthalmology* an article appeared by Hughes and Gartner in which they recommended the removal of the aqueous, substituting air thereby deepening the anterior chamber so that it is possible to perform goniotomy in cases with a shallow chamber as well as in those cases with a wide angle.

#### REFERENCES

1. BARKAN, OTTO: Goniotomy for Congenital Glaucoma. Read before section ophthalmology, American Medical Association, San Francisco, June, 1946.
2. BIELSCHOWSKY, A. Motor Anomalies. Dartmouth College Publications, 1944.
3. BURCH, FRANK E. *Am. J. Ophth.*, 1940, 23: 47-51.
4. COOKE, D. G. *Am. J. Ophth.*, 1943, 26: 251.
5. GOLDBERGER, S. J. *Geriatrics*, 1946, Aug.
6. HUGHES, W. L., and COLLE, J. G. *Arch. Ophth.*, 1946, 35: 5-542.
7. JACKSON, EDWARD. *Am. J. Ophth.*, 1944, 24: 277-281.
8. O'CONNOR, R. *Am. J. Ophth.*, 1935, 18: 813.
9. PARSONS, H. *Pathology of the Eye*. New York. Petruson Sons, 1908.
10. REESE, A. S. Lecture before Research Study Club, Los Angeles, Jan. 1942.
11. SCHAEFFER, J. P. *The Nose and Olfactory Organ*. New York. Blakiston Sons & Co. 1920.
12. SONNTEG-McMURRICH. *Human Anatomy* vol. 1. Philadelphia W. B. Saunders Co. 1907.
13. SUGAR, H. S. *Am. J. Ophth.*, 1942, 25: 250-255.
14. TODD, T. W. *BLANCHER, WILLIAMS, and TODD. Human Biol.* 1940, 12.
15. TRIVETT, F. *Surgical Applied Anatomy*. Philadelphia. Lea Bros., 1893.
16. WETTERALL, S. E. *Anatomy of the Human Orbit*. London and Philadelphia. Oxford Medical Publications, 1921.
17. WILKINSON, M. and ALVIZ, B. Y. *Surgery of the Eye*. Philadelphia W. B. Saunders Co., 1930.



described by Krimsky. A prism is held in front of the fixing eye with the apex toward the nose in a convergent squint. This causes the eye to shift toward the nose to resume fixation and the squinting eye will make a corresponding shift away from the nose. Thus using the fixing eye as a handle, and varying the size of the prism the squinting eye can be moved back and forth until the corneal reflex is accurately centered. This is exactly what is done with a Priestly Smith tape but the prism reflex test is considerably simpler to use. It can be used only for monocular squints. The perimeter is still the best method for obtaining distance measurements on a patient with poor fixation in one eye.

As soon as the child is old enough to cooperate (3 to 5 years of age) and if both eyes are capable of fixation the cover test of Duane is the method of choice for measuring squint. This method has been admirably set forth in the writing of the late James W. White. It will do all that he has claimed for it and we should all learn to rely on it very largely in the measurement of squint.

#### TREATMENT

Regarding the actual treatment of strabismus, it hardly seems necessary to urge that these children be seen as early as possible after 6 months of age. Unfortunately some pediatricians still advise waiting to see if a deviation will be outgrown but I believe that their number is diminishing. Possibly not much will be done in the way of treatment until the child is a year old but it is worth while to see him earlier to watch developments. Occasionally operation will be indicated as will be discussed later. Whatever therapeutic measures may be required it is undeniable that the earlier they are employed the more complications, such as amblyopia, abnormal retinal correspondence and muscle changes will be avoided or minimized and the chances will be better for binocular vision and fusion.

I believe that there is general agreement as to the value of giving glasses that fully correct any significant hyperopia or astigmatism. The accommodative squints do not often appear before 2 years, but the glasses should be worn as early as possible.

*Amblyopia.* In this air minded age good visual acuity in both eyes has become even more essential. This means that the correction of amblyopia ex anopsia is the responsibility of the ophthalmologist. Such correction can be accomplished in the majority of patients under 8 if time is taken to impress parents with its importance. Again the earlier occlusion is begun the more quickly will the result be obtained. As mentioned above, it is not necessary to wait until the vision can be measured to know that you are dealing with amblyopia. If the squint is solidly monocular you can assume that the squinting eye is amblyopic and proceed with occlusion. By watching the behavior of the eyes when the occluding bandage is changed, one can proceed with confidence and safety. As long as the originally fixing eye resumes fixation whenever the bandage is removed, the objective has not been achieved. In young children, it is easy to cause fixation to shift to the previously squinting eye, an event that distresses the mother but pleases the doctor because it proves that both eyes are sound. There is no way to differentiate amblyopia ex anopsia from a true amblyopia in little children so all patients should have a trial course of total occlusion for at least 2 months. At the beginning of occlusion anything short of total occlusion 24 hours a day is apt to be a waste of time. It is easier for the child to have it on all the time it will bring the result most rapidly. A firm adhesive bandage over cotton, is the occluder of choice. Later and this will vary from 2 to 8 weeks or more, various occluders can be used on the glasses, but I rely largely on atropine in the better eye with paper on that spectacle lens. It should be apparent that atropine alone will be successful only in cases of slight amblyopia or extreme hyperopia when combined with an occluder on the spectacles, the drug will only succeed after the squinting eye has acquired the ability to fix.

#### ORTHOPTIC EXERCISES

It is extremely difficult if not impossible to get an idea of the true value of orthoptic exercises from the literature. There is no way to reconcile the highly optimistic report of results obtained by Berens and his associates

with the completely negative report of Fowler, both are competent reporters but they cannot possibly both be right. Unfortunately in the majority of articles reporting indications for orthoptic exercises and the results of orthoptic treatment, definitions and classifications of cases are either absent or so indefinite that few conclusions can be drawn. There is yet no unanimity about the value of orthoptics. In the opinions of many ophthalmologists, it has failed to achieve an established position in the treatment of squint. Yet it is being used by far too many reliable clinicians to be ignored.

It has not been my practice to use orthoptic exercises routinely in healing strabismus. This decision was reached after experience gained while in charge of an orthoptic Clinic at Vanderbilt Clinic, in New York, from 1935 to 1938 while serving on the American Orthoptic Council for several years and from reading the orthoptic literature closely. There are two principal reasons for my decision. First, it was not possible for me to predict the outcome of orthoptic training with sufficient accuracy to feel justified in prescribing it for my patients. No doubt there are orthoptic technicians who can make fair prognostications of their own management of these cases. However if an ophthalmologist is going to use this method of treatment, he too must be able to tell his patient approximately what he has a right to expect in a given time. At the present time I am unable to do this.

My second reason is that I do not have the facilities for carrying out the treatment. Most of us do not have a sufficient number of muscle cases to employ a full time technician. The obvious solution is for several ophthalmologists to pool their cases and resources and set up a technician in a separate office. This has been done in a few cities with notable success but, at present, I know of only one technician in New York to whom private patients can be sent. As you may surmise, she is far too busy to do more than see an occasional case for any one doctor.

In spite of other practical obstacles there is no doubt that there is value in orthoptic exercises, that some patients with accommodative squint would get rid of their glasses more quickly and more certainly with training that

some patients with small deviations could avoid operation and more patients could achieve binocular single vision with fusion after operation. We need to learn a great deal more so that we will know which cases offer reasonable prospects of success and so that accurate prognoses can be given to our patients. In this direction, I hope to see many new orthoptic clinics established.

*Age and indications for operation.* In recent years the trend in this country has been toward earlier operation until it is now not uncommon to do the operation while the child is in the neighborhood of 1 year of age. These early cases are of course those born with the squint, which means a true muscle anomaly. These are nearly all marked deviations with frequently a vertical complication. While refractive errors can hardly play a part at this age it is probably wise to do retinoscopic and fundus examinations, under ether if necessary. It is usually apparent that nothing but surgery will correct the deviation. The parents are distressed and embarrassed over the appearance of their baby. The avoidance of secondary muscle changes and the chances of re-establishing binocular vision, all greatly outweigh the disadvantage of operating without a complete analysis of the case. This analysis could be gained only after long delay.

In the larger group of cases that come on gradually after the second year and have more or less relation to accommodation operation should be delayed until other measures have been tried. Glasses should be worn for several months amblyopia corrected and possibly there should be orthoptic training. When these measures have been carried out, abandoned or considered unsuitable, operation is indicated regardless of the age. However, for psychological reasons great effort should be made to complete the essential preliminaries and to perform the operation before the child enters school. For the same reasons it may be desirable to shortcut the preliminaries in some cases and operate earlier. A serious objection to orthoptic training is that valuable time may have to be lost in waiting for the child to attain an age when exercises can be given.

Only in those cases with high hyperopic errors (usually +4 or more) where the deviation

is largely eliminated by glasses, should the operation be postponed indefinitely. The majority of these children will not require operation and at around 15 years they will be able to remove their glasses when not doing close work. When the occasional operation becomes necessary only that portion of the deviation remaining when glasses are worn should be corrected. Care must be taken not to weaken convergence unduly.

*Choice of operation.* It is almost impossible to tell someone else what procedure to do for a given deviation. Each surgeon must decide which of the many modern techniques makes the most sense to him and which he can do best. Exactly similar results can probably be obtained in several ways. Mention of a few general principles may be helpful. For the usual concomitant esotropia which measures a little greater for *near* than *distance*, a resection of the externus and a recession of the internus of the same eye are my choice. I operate on the squinting eye because it makes sense to the parents and the muscle changes will be in this eye. If there is a conspicuous overaction of the inferior oblique of that eye, a recession of this muscle at its insertion is done at the same time. Even if the overaction is bilateral, the inferior oblique of the fixing eye need not be touched as its overaction rarely becomes manifest. When the deviation is greater for *distance* emphasis is placed on the resection of the externus when much greater for *near* the recession of the internus is stressed, or possibly divided between the two eyes. In alternating esotropia, it seems logical to operate on both eyes and while this would probably give the best result, it is not practical to operate on 4 muscles when not absolutely necessary so I would handle them like the monocular squints. An exception to this is the very young alternator who uses the right eye to look to the left and the left to look to the right, and never abducts either eye. Here, bilateral recessions of the interni are indicated. In alternators there will frequently be bilateral overaction of both inferior obliques. If these are approximately of equal amounts and not extreme, they can usually be ignored.

The question of how much to do to correct a given deviation is constantly asked by the

Residents. The best suggestion that I can offer is the figure that Dunnington and I reached several years ago when we analyzed a fairly large series of our operations. We found that when we did a 10 millimeter resection of the externus and a 4 millimeter recession of the internus, on the same eye, we averaged 40 diopters of correction. This is only a rough guide but it provides a starting point.

While I do not want to stress technique because I believe that the many minute variations that have been described are unimportant, I do want to make an appeal to each surgeon to perfect his own technique. It is important that he be able to reproduce an operation with precision as that is the only way that he will be able to find out just what his operation will do. Eventually he will be able to translate accurate measurements into definite, predictable surgical results. I have been using the resection described by Lancaster for several years. Being able to tie the 2 mattress sutures while the tendon is still held firmly in the muscle clamp appeals to me as safer and more definite than other methods. For the recession of the internal rectus, I use two single arm sutures one in the upper third of the tendon secured by passing the needle through the tendon a second time, and the other in the lower third of the tendon both placed as close to the insertion as possible. Great care is used at this point to waste as little of the tendon as possible. The sutures are then passed through the superficial fibers of the sclera, a measured distance from the stump and at least 8 millimeters apart so as to spread the tendon flat. The conjunctiva is closed with care 3 to 5 interrupted sutures being used. The recession of the inferior oblique is done by the method described by White (9). It seems to offer the best possibility for a graded weakening of this muscle. Avertin and ether anesthesia is routine. No cocaine plain catgut sutures on atraumatic needles are used throughout. I bandage only the eye operated upon and do not use atropine. The bandage is changed on the second operative day and removed entirely on the 4th or 5th. These details are mentioned only because they may be of interest, not because I believe that they are necessarily the best.

## SUMMARY

Early examination by means of the symbol E to test vision, and measurement of the deviation by means of the corneal reflexes and the prism reflex test are emphatically recommended

Treatment should start as early as possible and should include occlusion in all cases of monocular squint.

The reasons for not using orthoptic exercises routinely are stated

Operation can be done safely at 1 year and in certain cases gives definite advantages when done early

The indications for operation have been discussed and my choice of operations has been given briefly

## REFERENCES

1. ADLER, F. H. *Tr. Am. Ophth. Soc.* 1945 43 255
2. BERENS, C., ELLIOTT, A. J. and SOBACKI, L. *Am. J. Ophth.* 1941 24 1418.
3. DUNNINGTON J. H. and WHEELER M. C. *Arch. Ophth.* 1942 28 1
4. FOWLER, M. J. *Arch. Ophth.*, 1942 28 507
5. HIRSCHBERG J. *Centralbl. prakt. Augenh.* 1885 9 325.
6. KIMBLEY E. *Arch. Ophth.* 1943 30 505
7. LANCASTER, W. B. *Am. J. Ophth.*, 1931 14 483
8. WHITE, J. W. *Am. J. Ophth.* 1941 24 156 also 1944, 27 977
9. *Ibid.* 1943 26 586

## A NEW TYPE OF BASKET IMPLANT FOR USE AFTER ENUCLEATION

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CONSIDERABLE thought has been given recently to the possibility of improving the cosmetic result in enucleation or evisceration procedures. It is probable that out of this interest will come improvements that will stand the test of time and use.

The ideal cosmetic result should achieve the following

1. Wide range of co-ordinate movement with the remaining eye.
2. Instantaneous movement over a short range.
3. Normal lid contour i.e. (a) no sagging of lower lid (b) no sinking in of upper lid.
4. Permanence of the implant. This implies that it shall not migrate or be extruded.

No procedure, whether enucleation or evisceration, with or without an implant has achieved all of these results up to this time. Different procedures have been devised as recently revealed by Dimitry that have resulted in a good movement of the stump but the problem has always remained of transmitting this movement to the prosthesis. The basket type implant to be described is a step toward improving the transmission of this movement from the stump to the prosthesis on what might be called conventional lines, i.e. the prosthesis is completely enclosed in tissue.

The purpose of a basket implant, with a resulting depressed area in the socket, is to give the prosthesis, which has a stud projecting posteriorly (Fig 1) a grip on the stump. This necessitates, of course, a custom-designed prosthesis and, in addition, imposes new problems of design on the artificial eye maker. This is due to the fact that there is more ability of the cuplike depression to move the artificial eye than there is space in which the eye can move. Thus, it is necessary to adjust carefully the

size and shape of the prosthesis in order to use the minimum amount of space and still maintain a normal fissure. This is facilitated if no attempt is made to fill out a depressed upper lid with the prosthesis, but that is left to the surgeon.

The standard basket now used is shown in Figure 2A and B. It is made of lucite (methyl methacrylate) and measures 11 by 15 millimeters. This size seems to be the best whether the eye to be enucleated is large or small. The anterior edge is slightly thickened the sides of the basket are fenestrated to allow for invasion of tissue. In addition, there are 3 holes in the bottom, measuring 1 millimeter in diameter 2 of which are for sutures. Larger and smaller baskets have been tried but a tendency to reduce movement has resulted in either case. Other materials are being tried, but lucite has been found satisfactory up to the present time. A lucite button, measuring 5 by 8 millimeters, with four 0.8 millimeter holes (Fig 2C) is used to tie the sutures through and maintain the depression during healing. Three double-armed sutures are used black No 0 nylon, blue No 00 dermal and purple coarse dermal. These are used because of their greater strength and smoothness, allowing sutures to be pulled up without breaking. They are of different colors to permit ready identification. One inch (2.5 cm.) straight intestinal needles are used to allow their passage through the plastic button.

At the end of the operation a special plastic retainer (Fig 2D) is placed inside the lids after the method of Gifford. This greatly reduces postoperative edema, keeps the basket centered, and completely prevents any prolapse of the conjunctiva. The average operating time for this procedure is the same as for any implantation procedure, namely 22 to 25 minutes.

Two baskets slightly smaller than the standard have been placed inside the sclera after

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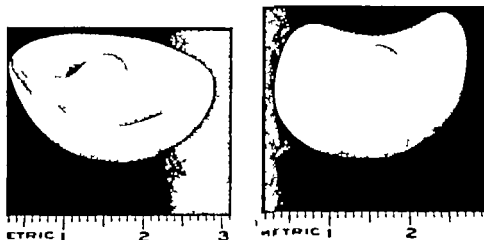


Fig. 1 Plastic prosthesis showing projecting stud on posterior surface.

evisceration. No advantage accrued as far as movement of the stump was concerned and the depression into which the stud of the prosthesis fits was considerably smaller. In addition, there was extreme postoperative edema involving the entire side of the face which lasted 7 to 10 days. I have seen 2 cases in which a ball implant was placed in the sclera with extremely good movement practically as good as that of the normal eye but because of the smooth contour only a small amount could be transmitted to the prosthesis.

The muscles are not sutured in this procedure. Figure 3 shows the posterior view of a basket implant removed at autopsy 8½ months after operation from a patient who was killed in an automobile accident. It will

be seen that all the muscles including the obliques are attached near the rim of the basket.

#### OPERATIVE PROCEDURE

Anesthesia is induced by intravenous injection of sodium pentothal and retrobulbar injection of 2 cubic centimeters of 2 per cent procaine hydrochloride.

The eye is prepared in the usual manner. A speculum (Weeks) is inserted, the conjunctiva dissected from the limbus, and the dissection carried to the fornices in all directions. The rectus muscles are then isolated and cut free from their insertions. The conjunctival opening usually is enlarged nasally and temporally about 2 millimeters to permit passage of the globe. The globe is grasped with fixation

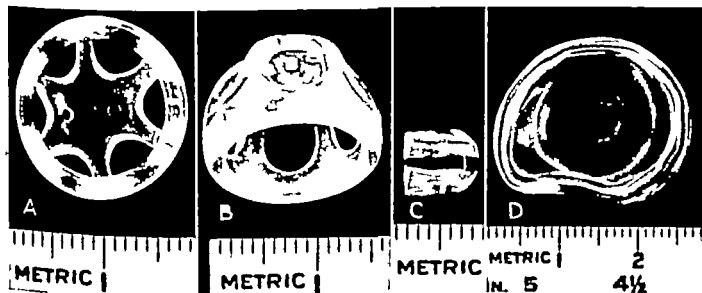


Fig. 2. A, Top view of lucite basket; B, side view; C, lucite stud; D, posterior view of lucite with central depression for stud.





Fig. 3. Posterior view of basket, implant removed at autopsy 8 months following implantation showing muscles attached to anterior edge.

forceps at the tendon of the internal rectus muscle and the nerve cut with enucleation scissors. The prolapsed globe is then freed from the oblique muscles and removed.

A dry gauze sponge and a little pressure usually reduce the bleeding quickly to enable one to inspect Tenon's capsule (Fig. 4).

The basket with one black nylon suture, size No. 0 fitted with two straight 1 inch

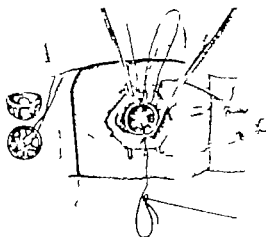


Fig. 5. Basket with No. 0 black nylon suture inserted. Suture carried through Tenon's capsule and conjunctiva at 12 and 6 o'clock.

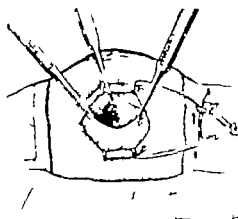


Fig. 4. Tenon's space exposed, ready for insertion of basket implant.

intestinal needles, is then placed in Tenon's capsule (Fig. 5). The upper suture is brought through a firm bite of Tenon's capsule at 12 o'clock and out through the margin of the conjunctiva. The lower suture is brought out similarly at 6 o'clock.

A blue No. 00 dermal double-armed suture with 1 inch intestinal needles is then carried through Tenon's capsule and the conjunctiva about 2 millimeters on either side of the black suture which was placed at 6 o'clock (Fig. 6A). Each suture is then carried through in a simi-

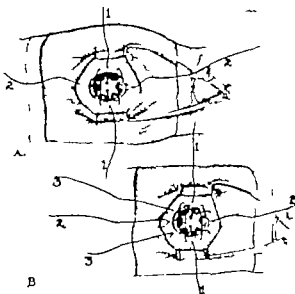


Fig. 6. A, Blue dermal mattress suture, carried through Tenon's capsule and conjunctiva on either side of black suture from within outward and finally through Tenon's capsule and conjunctiva at 3 and 6 o'clock.

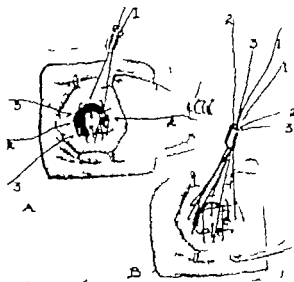


Fig. 7. Black nylon suture, 1, carried through holes in lucite stud. B. purple dermal suture, 3, carried through the same holes in stud as suture, 1. Blue dermal suture, 2, carried through the other two holes in lucite button.

lar manner at 12 o'clock. The suture on the right side is now carried through Tenon's capsule and the conjunctiva at 3 o'clock on the same side and the suture on the left at 9 o'clock.

A purple dermal (coarse) double armed suture, similar to the blue dermal suture is now placed about 2 millimeters on either side

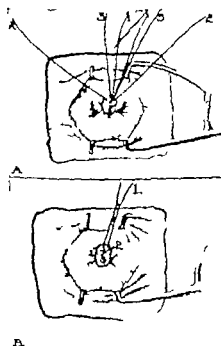


Fig. 9. A. Suture, 2, pulled up, imbricating Tenon's capsule and conjunctiva vertically. B. Suture 2, tied and cut. Suture 3 pulled up tight and cut through, imbricating Tenon's capsule and conjunctiva horizontally and closing the basket opening.

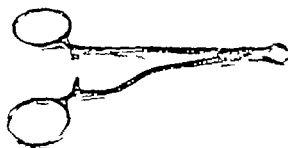


Fig. 8. Button holder

of the blue suture at 3 o'clock, the needle taking similar bites of Tenon's capsule and coming out through the conjunctiva. These two sutures are now carried across above all other sutures and brought out 2 millimeters on either side of the blue suture at 9 o'clock (Fig. 6B).

These two mattress sutures (blue and purple) are placed as outlined in the preceding paragraphs so that when they are pulled up they cause a double imbrication or folding of Tenon's capsule and the conjunctiva and the black sutures still come out through the upper layer after this has been done. All sutures are carried through the lucite stud, as shown in Figure 7A and B. Sutures 1 and 3 pass through the same two holes and suture 2 through the other two holes.

While the assistant holds the button with the lower end at the level of the rim of the basket with the button holder (Fig. 8) the blue suture is pulled up, tied and cut (Fig. 9A) and then the purple suture is similarly



Fig. 10. Suture 1 pulled up, tied and cut forcing button with Tenon's capsule and conjunctiva down into the basket.



Fig. 1. Plastic retainer

handled. This pulls Tenon's capsule and the conjunctiva into place and closes the opening.

A single tie is now placed in the black suture and as this tie is gradually pulled up the index fingers make traction and a little pressure. The assistant then releases the button from the forceps. As this tie is pulled tight, it forces the button with Tenon's capsule and the conjunctiva down into the cup. Three knots are placed and the suture is cut (Fig. 10). No conjunctival sutures are necessary.

A lucite retainer is placed inside the lids. An adhesive dressing with firm pressure but with no roller bandage is applied.

#### POSTOPERATIVE COURSE

The first dressing is done on the third postoperative day, the retainer being removed and

the socket irrigated. The retainer is replaced and if there is still some edema an adhesive dressing is put back on for 2 more days. In most cases the dressing can be omitted. On the fifth postoperative day the sutures and the button are removed. A temporary retainer with button attached (Fig. 11) is placed in the socket at this time. This is removed daily and the socket is irrigated for a week.

In none of the cases in which operation was performed has there been any prolapse of the conjunctiva. This is probably due to the type of operation and to the retainer. In general, there has been little reaction and no discomfort at all after the first postoperative day.

At the end of 2 to 3 weeks, depending on the shrinkage of its tissues, the socket is ready for a custom made prosthesis, similar to the one shown in Figure 1.

#### COMPLICATIONS

It is important not to pull the sutures beyond the snug state, as otherwise pressure necrosis and exposure of the bottom of the basket will result. This complication will also occur if the button is not removed at the end of 5 days. If exposure of the bottom of the basket does occur, a retainer without a button attached is put in, and granulation and epithelization will take place in a few days, without impairment of the result. If after the sutures and the button are removed on the fifth post-

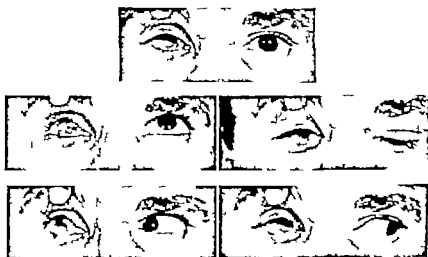


Fig. 12. Appearance of socket in patient one month after operation, showing impression in the basket and the range of motion.

operative day there is a thin appearing lining on the bottom of the basket a plain retainer can be used from 1 to 3 days and then a button retainer employed

A sufficiently firm bite of Tenon's capsule must be obtained in placing the mattress sutures, since there is slight tension on the capsule when it is inverted into the basket. In 2 cases in which a ball implant was removed and a basket put in the sutures did not hold. This was also true in a case in which a considerable amount of scar tissue was present—the sutures cut through the inelastic scar tissue. It was necessary in these 3 cases to remove the baskets.

Postoperative hemorrhage has never been a problem in our cases. In the 3 cases just mentioned in which the sutures did not hold because of scar tissue and the basket was removed approximately 10 days after operation, it had to be dissected out. Certainly the basket cannot be extruded.

#### PROSTHESIS

The socket is ready for the final prosthesis at the end of 2 or 3 weeks. This has been of plastic, made according to the standard Army procedure and under the direction of Captain Stanley F. Erpf and Captain Arthur L. Lund

blad of the Dental Corps of the Army of the United States

The prosthesis is not made from an impression of the socket, since that would result in its occupying too much of the available space. Figure 1 shows some variations in the prostheses that have been fitted. In general, the stud is adjusted to fit into the depression and the base around this stud is cut away to allow the edge of the basket to come forward when the socket is turned. Through support of the stud there is considerable relief of pressure on the tissues in the region of the fornices.

It is not absolutely necessary to use a custom made eye with a stud, good movement can often be obtained with a Snellen form. The reason for this is that the movement of the prosthesis is in part due to the change in the shape of the socket when the basket rotates; one side becomes shallow and the opposite side deep and the eye has to move.

The following tabulations were made on the basis of observations on 60 sockets fitted with artificial eyes. Practically all of them were fitted with custom made plastic eyes. It is realized that this small number may not represent a true cross section. The series was collected from the wards without regard to the preoperative condition. It consisted of 20

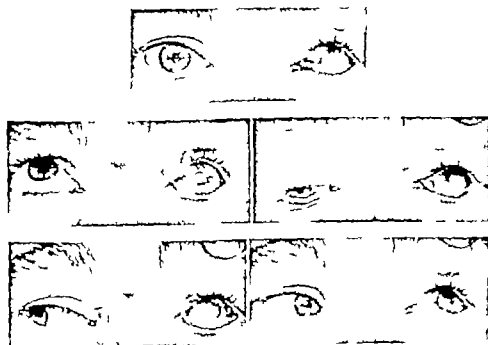


Fig. 13 Patient 5 months after operation showing depression and movement of socket.

sockets without implants 20 with ball implants and the first 20 with basket implants.

Average motion degrees	No Implant	Ball Implant	Basket Implant
Nasally	19	9	25*
Temporally	3	5	12
Superiorly	25	20	20
Inferiorly	12	20*	30
Total	69	74	109

The sockets without implants showed the greatest variation in movement from patient to patient and those with basket implants the least variation. This is illustrated by the following tabulation.

Prosthesis having	No Implant	Ball Implant	Basket Implant
45° total horizontal movement	1 of 20	3 of 20	8 of 20
5° total vertical movement	6 of 20	8 of 20	19 of 20

These tabulations do not indicate the action of the oblique muscles which is a prominent feature of the basket sockets. Neither do they indicate the most important characteristic of all that is, the much more rapid response to movement of the muscle cone, with a notable decrease in the time lag as compared with that for the normal eye.

#### SUMMARY

On the basis of 100 operative procedures, a new type of basket implant for use after enucleation is presented which with a new type of prosthesis, gives more instantaneous movement and a wider range of action. This procedure, combined with use of a plastic retainer eliminates prolapse of implant and shortens the postoperative convalescence period.

## RECONSTRUCTION OF ORBITAL FLOOR DEFECTS

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THE floor of the orbit is triangular in shape and is made up largely of the orbital plate of the maxilla. The orbital portion of the zygomatic bone makes up the anterolateral portion and a small portion of the posterior part of the floor is formed by the orbital process of the palatine bone. The anterior margin is thicker and stronger than the remainder of the floor. The inferior orbital fissure is the lateral boundary of the floor and the infraorbital sulcus runs forward along the central portion of the floor from the inferior orbital fissure to the infraorbital foramen which lies about 1 centimeter below the lower orbital margin. The sulcus and foramen transmit the infraorbital artery and the main portion of the second division of the trigeminal nerve that is the maxillary nerve which is known as the infraorbital nerve as it passes into the infraorbital sulcus.

Trauma to the lower orbital margin with resulting fracture of the margin and floor of the orbit not infrequently produces more severe displacement of the thin floor of the orbit than of the thicker and stronger margin itself. The displacement of the floor is usually downward due to the concave orbital surface of the floor anteriorly and because an air space the maxillary antrum lies below the floor. It is Pfeiffer's opinion that fracture of the wall of the orbit is the entire cause for traumatic enophthalmos. Of 53 cases reported by him 24 had a depressed fracture of the floor with out any fracture of the orbital margin. More than half of these were caused by a blow with a fist. Pfeiffer states that in the cases of less severe enophthalmos the posterior portion is fractured and in the cases of more severe displacement the entire floor is broken through. It is surprising how infrequent there is permanent visual damage in these cases. At times severe trauma to and fracture of the supraorbital area may produce an accompanying

depressed fracture of the floor of the orbit due to transmission of the force through the orbital contents. Depressed fracture of the floor may also occur from the explosive force of shell fragments entering the orbit and from actual perforation of the floor by shell fragments or other foreign elements. It is quite unusual to have an elevation of the floor of the orbit unless there has been a severe crushing trauma to the region of the antrum.

A diagnosis of depressed fracture of the floor of the orbit is made on the history of trauma and the presence of depression of the eyeball with some enophthalmos. Diplopia may be present and also anesthesia or hypesthesia over the distribution of the infraorbital nerve. Immediately following the trauma these signs may be masked by edema and orbital hemorrhage. There may even be an initial exophthalmos. Crepitation from air in the soft tissues and palpable displacement of the orbital margin may be evident. Careful stereoscopic x-rays will usually confirm the diagnosis. There may be marked loss of vision due to internal ocular damage or due to compression of the optic nerve by fracture into the optic foramen or by hemorrhage into the optic nerve sheath in the foramen.

When there has been little or no depression of the floor of the orbit no treatment is indicated. When very definite depression is present it should be corrected as soon as the initial reaction has subsided. This is best done by the otolaryngologist by means of a Caldwell-Luc approach with elevation of the depressed orbital floor and moderate packing of the antrum for a day or two. When this is not done a permanent depression of the orbital floor and orbital contents results. Fracture and displacement of the lower orbital margin should also be corrected as early as possible with internal wiring of the fragments or some method of external fixation if necessary.

When there has been a severe compound comminuted fracture of the lower orbital margin it may be necessary to debride some of the

From the Surgical Service at O'Reilly General Hospital. Presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.



Case  
 Fig. 1 Appearance on admission. Fig. 2 Final result. Fig. 3 Wedge acrylic implant.

loose bone fragments. This results in more or less subsequent external deformity.

The purpose of any procedure to reconstruct the orbital floor is primarily to elevate the orbital contents. If sufficient correction of this depression is obtained it will also eliminate the sinking or retraction of the upper portion of the upper eyelid and lessen the enophthalmos. In late cases of depressed floor it is not possible to elevate the floor to its normal position because of the firm adhesions which have formed. In the past this has usually been accomplished by the use of autogenous or preserved cartilage grafts to the floor of the orbit under the periorbital. This is the method used by most of the general plastic surgeons during the past few years in the army general hospitals that were ophthalmic and plastic centers. The taking of an autogenous rib cartilage graft makes an additional procedure and at times the pleura has been accidentally perforated. The use of preserved cartilage has been quite satisfactory although it has been demonstrated that preserved cartilage buried subcutaneously produces a typical low-grade foreign body reaction over a period of months and is gradually absorbed and replaced by fibroblastic tissue. Osteoperiosteal grafts from the tibia have also been used. These are used to bridge the defect and usually require temporary additional support by packing in the antrum. This, together with taking of the graft, makes a needlessly complicated procedure.

It was our experience at O'Reilly General Hospital and also the experience of ophthalmologists at some of the other army eye centers, that the use of various inorganic materials has been very satisfactory for orbital floor reconstruction with resulting simplification of the surgical procedure.

In June of 1945 at the suggestion of Dr Reudemann of Cleveland, Lieutenant Colonel Struble at Crile General Hospital used tantalum wool and later tantalum mesh to fill in defects of the orbital floor in battle casualties in whom the Reudemann implant eye was being used. Struble stressed the importance of careful preoperative x ray determination of the size of the defect and received excellent cooperation from his roentgenologist, Lieutenant Colonel Shifflet.

During the latter months of 1945 Captain Souders of Dibble General Hospital used rhomboid shaped plates of the plastic acrylic (methyl methacrylate) to cover the defect of the floor of the orbit in old fracture cases who had some depression of the eyeball. Souders used various sizes and thicknesses of these acrylic plates depending on the amount of depression of the eyeball and size of the defect in the orbital floor. The dissection was made through a skin incision along the lower orbital margin but he placed the acrylic plate on the periorbital and not under it. The plate was held in position by sutures through small holes near the anterior edge of the plate and through the periorbital.

About this same time Major DeVoe of Halloran General Hospital used a packing of glass wool under the periorbital in several cases of depressed floor to fill in the defect and elevate the eye and orbital contents. He reported very satisfactory results and no complications.

In the spring of 1945 at O'Reilly General Hospital we began to use a wedged shaped acrylic implant to the floor of the orbit to elevate the orbital tissues in cases of anophthalmos who had had an enucleation with small implant in Tenon's capsule, or who had had a



Case 2

Fig. 4. Appearance on admission



Case 3

Fig. 5. Final result.

simple evisceration of the eyeball. This procedure proved a quite satisfactory method to eliminate or lessen the retraction or sinking of the upper portion of the upper eyelid. We soon applied this procedure to cases of old fracture of the floor of the orbit with depression of the eyeball and enophthalmos. The acrylic wedges were made in 3 sizes: the average or middle size being about  $2\frac{1}{2}$  centimeters by  $1\frac{1}{2}$  centimeters and about 8 millimeters thick at one end and tapering down to about 4 millimeters at the other end. The operation is similar to that used by Gilles and others except that the wedgeshaped acrylic implant is used instead of a cartilage graft. After incision through the skin and subcutaneous tissue down to the lower orbital margin, the periorbital skin is incised and the periorbital thoroughly elevated with a submucous elevator. A wedge-shaped acrylic implant is then placed on the depressed floor with the thick end of the wedge posterior. A large enough implant is used to satisfactorily elevate the orbital contents and two or more implants can be used in cases of severe depression of the floor. Traction sutures in the tendons of the lateral and medial rectus muscle are a great aid in drawing the eyeball upward and forward at the time the wedge is being inserted. The periorbital is firmly closed with No. 000 gut mattress sutures. Subcutaneous sutures should also be used to avoid a depressed postoperative scar. A good pressure dressing is important to prevent or lessen hematoma.

Gilles was one of the first writers to recommend the use of cartilage grafts for replacing loss of bone of the orbital rim. This has been used extensively since that time. Landmann in 1916 first described the use of an iliac bone graft to the mandible and this was later ap-

plied to the malar and infraorbital area by a number of plastic surgeons.

During the past few years tantalum plates, tantalum mesh, and acrylic plates have been used to replace loss of orbital margin. Too frequently the preformed tantalum or acrylic plate does not give the proper contour to the overlying tissues. It is difficult to alter these plates satisfactorily at operation. Also it is not a simple procedure to fashion the plate. Tantalum mesh is easily shaped at the operating table but it does not become firmly attached to the surrounding bone. Rib cartilage grafts do not become attached to the bone and also may change after operation. It was the experience of the eye and the plastic service at O'Reilly General Hospital that these inorganic materials and also cartilage grafts did not give as satisfactory results in reconstruction of the lower or lateral orbital margin or malar area, as did the use of grafts of iliac bone. After removal of most of the cortex the cancellous bone can be easily shaped to fill in the defect properly and give a very satisfactory contour to the overlying tissues. If the ends of the graft rest on exposed bone it soon becomes firmly attached to this bone. A blood supply is rapidly formed into the grafted bone and a cortex or pseudocortex forms on the surface of the graft. Postoperative hematoma will seldom cause trouble if a narrow rubber



Fig. 8.

Case 4.

Fig. 9.







Fig. 15. Appearance on admission

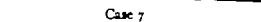


Fig. 16. Before bone graft.

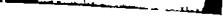


Fig. 17. Result.

CASE 5 (Figs. 10, 11 and 12) Patient was struck in the right orbital area with a large stone and incurred severe compound depressed fracture of supraorbital area and of the floor of the orbit. Débridement of frontal sinus area and repair of lower eyelid performed at another general hospital. Admitted to O'Reilly General Hospital 3 months later. Severe enophthalmos and depression of right eye as well as marked depressed deformity of supraorbital area were present. He had loss of central vision due to traumatic damage to macular area. One month after admission the eye was quite well elevated and the enophthalmos fairly well reduced by means of five acrylic wedge implants to the depressed floor of the orbit. Recovery was uneventful. Two months later an iliac bone graft to the supraorbital area was performed by Lieutenant Colonel Karlson.

CASE 6 (Figs. 13 and 14) Patient incurred a compound comminuted fracture of right zygoma and severe laceration of right eye from shell fragment wound. The right eye was enucleated 3 weeks later and 1 month following that a large cheek flap rotated to fill defect over zygoma region. He was admitted to O'Reilly General Hospital 6 weeks later. There was a long broad depressed scar from lateral lower orbital margin down to angle of jaw with loss of malar eminence and of lateral lower orbital margin. The lateral canthal area was drawn down about 1/2 centimeter. Three months later an iliac bone graft was used to reconstruct the lateral lower orbital margin and malar area, with excision of much of the scar. Two months later the lateral canthus was elevated by means of a Z-plasty or interposition of flaps.

CASE 7 (Figs. 15, 16, and 17) Patient incurred severe compound comminuted fracture of right zygoma and maxilla with avulsion of lower eyelid and anterior segment of eyeball from shell fragment. The wound was débrided the same day. The eye was eviscerated 3 days later. He was admitted to O'Reilly General Hospital 1 1/2 months later. There was a loss of entire right lower eyelid with conjunctiva and skin adherent to the remains of lower orbital margin. Due to fracture of the floor of the orbit there was marked depression of the orbital contents. Several operations were used to reconstruct the lower eyelid and the area of the lower orbital margin was reconstructed with an iliac bone graft. After the eyelid fissure was reopened the orbital con-

tents were elevated by means of an acrylic wedge implant on the floor of the orbit. A fascia lata graft was used to correct the retraction below the brow.

### SUMMARY

Fractures of the floor of the orbit should be reduced soon after injury if feasible.

When late reconstruction is indicated the orbital contents can be very satisfactorily elevated by means of an acrylic implant on the depressed floor. Other materials such as tantalum mesh and glass wool have been satisfactory in the hands of some surgeons.

Small losses of the lower orbital margin can be satisfactorily filled by a fascia lata graft. Larger losses are best reconstructed by a graft of cancellous iliac bone with more consistently good results than cartilage grafts or preformed tantalum or acrylic plates.

### REFERENCES

1. DeVoe, A. G. Repair of Orbital Defects with Glass Wool. Motion Picture presented at annual meeting of Acad. of Ophth. & Otolaryn., Chicago, Oct. 1946.
2. GILLIES, H. D. Plastic Surgery of the Face. New York: Oxford University Press, 1920.
3. IVEY, R. H., and CURTIS, L. Fractures of the Jaw. Philadelphia: Lea & Febiger, 1931.
4. LINDENBAUM. Referred to in Ivey, R. H. and Curtis, L.
5. PREIFFER, R. L. Arch. Ophth., 1945, pp. 718-726.
6. STIFFLET, E. L. The Use of Orbital Tissue as an Aid in Reconstructive Surgery of the Orbit. Paper presented before the Military Ophthalmological Meeting, Crile General Hospital, 1945 Nov.
7. SMITH FARRIS. Manual of Standard Practice of Plastic and Maxillofacial Surgery pp. 71 to 75 and pp. 220 to 222. Philadelphia: W. B. Saunders Co. 1943.
8. SOUTHERS, B. F. Elevation of Orbital Contents with Plastic Plates. Military Ophthalmological Meeting, Crile General Hospital, Cleveland, Ohio, 1945 Nov.
9. STROBLE, G. C. The Use of Tantalum Mesh in Ruedemann Eye Implant in Orbital. The Military Ophthalmological Meeting and the Hospital Cleveland, Ohio 1945 Nov. 2 General.
10. WHEELER, J. M. The Collected Papers of Wheeler, M. D. p. 340 and p. 437. Vol. 2. Columbia University Press, 1939.

# THE RECONSTRUCTION OF THE UPPER LID

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WHEN considering this subject, 'The Reconstruction of the Upper Lid' almost every person who has had experience with ophthalmic plastic surgery will immediately think of some more or less complicated case in the correction of which he had a part. The difficulties and complexities of such individual cases are most stimulating—of this there is no doubt. Nevertheless such cases as all others are corrected through certain basic principles peculiar to the subject, and common to all these conditions.

Regardless of any one technique these principles can be divided into two major subdivisions—when reconstructing an upper lid is a good functioning eyeball present, and is the socket surgically anophthalmic? These two possibilities modify the surgery necessary to a tremendous degree.

A second group of three probable conditions which influence the necessary surgery and contingent upon the first subdivision are the eyelid defects themselves. First, is the deformity under treatment the result of the loss of the external layers of the lid only with normal conjunctiva present; second in the case considered are all the structures of the lid both anterior and posterior surfaces, wanting even partly; and third are only the posterior lid surfaces and structures predominately deficient?

The presence of an intact functioning eyeball in lid reconstructions compels, without permissible modification, the use of conjunctiva or of mucous membrane for the reconstruction of the posterior surface of either lid. The absence of an eyeball, that is surgical anophthalmos, permits the use of epithelium either as a free skin graft or as some type of pedicle flap for replacing the lost posterior surface of the reconstructed lid. The reconstruction of a lid in cases in which no eyeball

is present is a simpler procedure because demands are less exacting. Even the question of later lid motility is relatively insignificant, because corneal exposure and difficulties from that are not a problem. As a matter of fact in many of these cases the ideal result hoped for is that of good looking fixed lids which will retain a prosthesis satisfactorily even though they may be quite immobile.

A third consideration of importance in the reconstruction of a lid especially the upper lid is a thorough knowledge of the rather complex anatomy of this lid. Surgical principles which are harmonious with the anatomy of the upper lid are certain to give much better results than any technique which disregards this anatomy. One must remember that the lid has two major parts—a posterior conjunctival and tarsal plate surface or layer and an anterior muscle and skin layer. The muscle pull of the levator palpebrae superioris is at a right angle to the muscle action of the orbicularis fibers. The two muscles lie in entirely different planes. These two muscles are not only antagonistic, one to the other but both are very active muscles. Last the two canthal angles are themselves quite immobile but here the two muscles have common attachments.

Reconstructive surgery for the correction of defects in the posterior surface of the lids is essentially the reconstruction of a cul-de-sac by means of mucous membrane. Cicatrices may be present simultaneously in the external surface of the lid, which needs reconstruction and resuture but this is a minor part of the surgical procedure. A free graft of mucous membrane sutured into a correcting position is the basic essential (Fig. 1).

This same situation, when present with surgical anophthalmos means a necessary correction either with the same type of graft or by means of a free skin razor cut graft. This must be cut as thin as is humanly possible. In these instances the external surface

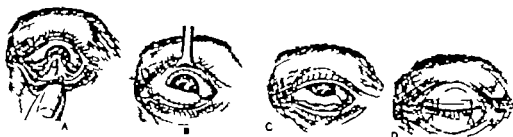


Fig 1. Mucous membrane correction of the posterior surface of a defect of the lid.



Fig 2. Simultaneous correction of posterior and anterior surfaces of the upper lid. Prosthesis in position.



Fig 3. The major portion of the upper lid is lost with much cicatrix present. The entire superior cul-de-sac is absent. A pedicle flap from the forehead and a free skin graft to the posterior surface of the lid.

of the lid which is deficient may be corrected simultaneously with either a pedicle flap or a free skin graft. Figure 2 is such a case. The superior cul-de-sac of the deficient socket was corrected by mobilizing the remains of the upper lid still present, swinging these inward upon themselves as a hinged flap to form the new posterior surface of a new lid. At the same time, the anterior surface of this lid was corrected with a free skin graft. It is in this type of case that the use of supraclavicular skin has such impressive successes. Figure 3 is a similar case in which the correction of the external surface was achieved by means of a pedicle flap from the contiguous regions. A free razor cut epithelial graft was placed on the posterior surface of the lid flap. A pedicle flap had to be used here because of the extensive scar in the tissues remaining. To remove all of that meant the removal of almost the entire lid. In general pedicle flaps are to be

used only when necessary, never as an operation of election. When that is so as in this indication there need be no hesitancy about their use. If properly executed the additional scarring which they cause can be held to a minimum often to an amount quite inconsequential. The value of a pedicle flap lies in the ability to transplant larger portions of epithelium under difficult circumstances (anatomic, naturally) with a greater chance for continued viability in the graft than if that same amount of skin had been transplanted freely and without this added means for nutrition i.e. the pedicle.

The ideal reconstruction of an upper lid in the presence of a normally functioning eyeball assuming that both the anterior and the posterior surfaces of the lid have been lost in part depends upon a technique originally advanced by Landolt in 1901 and subsequently carried to even greater general ex-



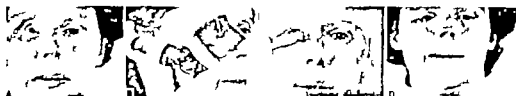


Fig 7 The complete correction of the upper and lower lids by an epithelial lined flap

form a smooth lid margin. That tarsus which formerly lay in the lower lid will now lie in part, if not wholly, in the upper lid. The conjunctival surface of the two lids is usually quite adequate for good function. Figure 5 is an illustration of this technique. The entire upper lid was not lost but the major part was missing. The illustration in center shows the intermarginal attachments. The curve of that points out rather clearly the total amount of new tissue now lying into this position. The illustration at right shows the new palpebral fissure following its formation—also the degree of closure possible.

In this case the lashes were suggested by a line of tattoo marks at the new lid margin. A hair bearing graft for the eyelashes of the upper lid can be placed into position rather readily prior to the formation of the new palpebral fissure. Such a graft should be taken from the lower edge of the opposite eyebrow cut with beveled edges and sutured into position.

A second technique to be considered under similar circumstances i.e. eyelid defect in the presence of a good functioning eyeball necessitates the implantation of a mucous membrane graft into either the forehead or the upper lid immediately beneath the skin surface, to prepare the necessary graft with a posterior mucous membrane layer which will function as conjunctiva. This graft either as a free graft or as a pedicle flap is then transplanted to its correcting position for the simultaneous reconstruction of both the conjunctival and skin surfaces. Figure 6 shows the utilization of this basic principle by means of a pedicle flap. Mucous membrane covers the posterior surface and epithelium the anterior surface. Some of the principles of Wheeler's halving operation will apply in the utilization of this technique. This is so because those principles of Wheeler's are basic with ophthalmic plastic surgery whenever accurate car-

penetry is necessary in lid surgery. They are not characteristic of any individual procedure.

The mucous membrane to be used is taken from the buccal mucosa trimmed to maximum thinness wrapped over a mold, and then buried into a pocket prepared for it. After this has taken surgically any portion of the mucous membrane may be transplanted with any amount of epithelium needed. In the instance shown a certain portion of the lid remains were rearranged and utilized by scar resection and by suture. The case was one of postmalignancy reconstruction. Somewhat less than one-half of the lid was still wanting following that. The mucous membrane epithelium pedicle flap was quite sufficient for a good correction. That portion of the rather conspicuous mucous membrane still present upon the skin of the lower lid had to be removed and the area covered with a skin graft. Skin from the supraclavicular region or from the opposite upper lid are equally satisfactory for this.

Hughes carried out this principle of combined mucous membrane epithelium graft by implanting the mucous membrane into a pocket of the opposite lid. Skin and mucous membrane were then transplanted as a free graft. Even though this technique was successful for the lower lid and perhaps should be



Fig 8. An epithelial lined pocket on the face prior to transplantation for a new upper lid.



Fig. 9. A, left, Deformity of upper lid corrected by scar resection and resuture, also with a necessary enucleation. B 3 months following surgery

recommended for that, the use of a flap is better for an upper lid repair

The complete correction perhaps better expressed as correction for the more or less complete loss of an upper a lower or of both lids, in the absence of an eyeball is similarly done but with epithelium rather than with mucous membrane. A pocket of epithelium is formed on the forehead or beneath the skin of the upper face. Following that one may transplant a flap having two epithelial surfaces, an anterior and a posterior surface thus making possible correction for the complete loss of one or more lids. The principle is quite like that described in detail for the use of mucous membrane but the absence of an eyeball permits the use of epithelium for the posterior surface of the new lids. Figure 7 illustrates such a case before and after its correction. Figure 8 shows a pocket upon the face before transplantation to an upper lid

In this presentation the only cases considered for the explanation of the rules for lid reconstruction were those in which there had been a loss of soft tissue to such an extent that the replacement of these tissues was necessary for the correction of the case. Many cases could be presented wherein the correction was obtained by simple (meaning uncomplicated and not ease of performance) scar resection resuture and the reposition of those tissues still present to correct the plastic defect present. Figure 9 is such a case. The necessary enucleation of the phthisical eye had little effect upon the condition of the lid. Scar removal and suture were responsible for the satisfactory result obtained. This possibility as a surgical principle must be remembered in the

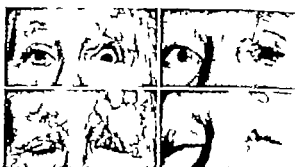


Fig. 10. A, left, Extensive ectropion following herpes, the lids opened and closed. B Correction with a raised free skin graft.

consideration of cases for correction. It is properly included herein considering the title of the paper and the scope of its subject matter

#### RECAPITULATION AND CONCLUSION

In this presentation such defects as ectropion entropion symblepharon etc., have not been the basic conditions under consideration. The extent of pathology possible in some of these conditions, however as illustrated in Figure 10 might permit one to consider this degree of deformity worthy of the term—lid reconstruction. It is, nevertheless only a case of extensive ectropion and as such is to be corrected by procedures rather well established for this type of condition

The real purpose of the paper has been to outline the principles underlying lid reconstructions, and especially when applied to the upper lid. The different anatomic possibilities which present themselves for correction differ so decidedly in their demands and hence in the permissible surgical techniques available for correction that it was thought necessary to emphasize again that basic fact.

These surgical principles as they have just been discussed are the result of clinical experience and as such they should be seriously considered as these cases appear for correction.

# THE MANAGEMENT OF NONMAGNETIC INTRAOCULAR FOREIGN BODIES

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THE character of intraocular foreign bodies coming to the ophthalmic surgeon's attention has changed materially in recent years. Formerly 95 to 98 per cent were magnetic, leaving a bare 2 to 5 per cent of cases to which the magnet was not applicable. Now some series of cases are reported in which the nonmagnetic percentage runs as high as 10 and even 40 per cent.

The ratio of nonmagnetic to magnetic intraocular foreign bodies was always higher in battle casualties than in civilian life. This ratio took a sharp rise with the nefarious introduction by the Axis forces of nondetectable nonmagnetic land mines in the North African Desert campaigns as reported by Stallard (16). The World War II experience of the United States Army Medical Corps is well described in Wilder's report, that out of 150 enucleated eyes received at the Army Institute of Pathology 89 harbored nonmagnetic particles.

The increased use of alloys containing copper, aluminum, brass, lead, zinc, manganese, nickel, etc., in industry as well as war thus presents new and difficult problems. In addition to these one runs across eyes harboring glass, plastics, coal, stone, sand, lashes, grit, wood, and other substances.

Our miracle tool the magnet is worthless in application to nonmagnetic substances. Nor does it attract steel alloys containing considerable manganese. Often the ophthalmologist was thus made to despair on seeing a patient with a nonmagnetic intraocular foreign body. New simplified and improved x-ray and other localization methods with improved surgical techniques have made it possible to save some of these eyes from blindness. Several problems present themselves when one is called to attend a traumatized eye.

1. How shall one proceed in the average case of ocular injury?

2. When should an intraocular foreign body be suspected?

3. How much damage has been done to vital structure?

4. Is a foreign body present within the eye and how can we readily localize it accurately?

5. How does one differentiate the nonmagnetic from the magnetic foreign body?

6. To what extent does infection complicate the picture and how shall we control it?

## HISTORY

The ophthalmologist should investigate the possible presence of an intraocular body in every case of possible injury and especially in uveitis. The history is most important. The examiner must question the patient in detail about the likelihood of exposure to injury while hammering, chiseling, or working with rotating or moving machinery. One should note whether the patient was near flying particles or near an explosion or in proximity to shattering solids. An investigation of the tools and substances in use at the time of accident gives a clue as to the likelihood of the intraocular particle being magnetic or otherwise. It also may tell us whether the fragments are glass or stone, or copper, or steel, etc.

Stallard (16) writing of his North African war experiences found a clue to the nature of the intraocular fragments by examining small particles lodged in the skin of the lids and face. U.S. Army ophthalmologists have examined injured eyes which contained more than one particle, some magnetic and others nonmagnetic. Close questioning of the patient may further reveal the size of the fragment and its course of flight toward the eye. The lapse of time since injury is necessary to ascertain fragments that have been in contact with soil may harbor tetanus bacilli. These and a host of other details may be elicited by a careful history. Previous negative examinations or the story of removal of a superficial corneal

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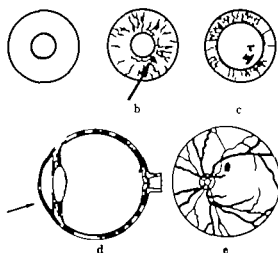


Fig. Course of foreign body through the globe and trauma caused to a, cornea (perforation) b, Iris (arrow points to hole) c, lens (tract through t) d, Section of globe showing tract of particle, location of foreign body and vitreous opacities due to hemorrhage e, Foreign body lodged in retina, as viewed through ophthalmoscope.

particle should not lead us astray. There are many cases on record dismissed with a pat on the shoulder which later turn up with siderosis or chalcosis or a cyclitis due to an intraocular foreign body.

#### THE EXAMINATION

Both eyes must be examined subjectively and objectively. One may find evidence of disease, of injury or even of sympathetic ophthalmia. Visual acuity and field examination of each eye where possible should be followed by complete examination with all the instruments and methods at our command. The anterior segment must be studied with loupe and oblique illumination, with ophthalmoscope, with the transilluminator and particularly with the slit lamp microscope. The cornea, the conjunctiva, the sclera, the anterior chamber, the iris, the lens, the vitreous, the entire visible retina and the optic nerve must be painstakingly scrutinized. If photophobia or pain interfere a drop of local anesthesia such as tetracain 0.5 per cent may facilitate the examination. A perforating wound in the cornea as evidenced by a hole in Bowman's and especially in Descemet's membrane leaves permanent telltale evidence. A hole in Descemet's membrane or in the iris leaves permanent evidence. Discovery of such, however minute is proof of a penetrat-

ing wound and charges the examiner with an exhaustive study to establish the presence of an intraocular foreign body and to localize that foreign body.

The value of exhaustive routine examination is evident from the next 2 cases cited.

**CASE 1.** A.T., mechanic, aged 30 years, complained of occasional discomfort and redness of the left eye. Routine examination revealed a minute perforation of Descemet's membrane. A history of injury 6 months previous while chiseling was finally elicited. The patient remembered that a foreign body was removed from the conjunctiva by a fellow workman. Since then his eye watered in bright light, etc. The first x-ray examination was negative. A second x-ray examination by Vogt's soft tissue technique revealed a minute fragment near the iris root. With the aid of gonioscopy it was possible to visualize the foreign body covered by exudate in the lower anterior chamber angle. The particle was subsequently removed and the eye quieted down.

**CASE 2.** J.B. Auto repairman, aged 34 years, referred with 24 hour old perforation of his left eye by a piece of wire. Examination revealed a left corneal perforation in the pupil zone with swollen traumatic cataract bulging into the anterior chamber.

Vision of the right eye was 20/25. Slit-lamp examination of that eye revealed early siderosis and a healed limbus perforation. X-ray examination of both eyes located a small irregular metal splinter in the right ciliary body. The left eye was negative roentgenologically.

Further questioning revealed a history of injury 9 months previous while working on another job. The first aid attendant and the plant surgeon found no foreign body at that time and since there was no pain and very little redness the eye was dismissed as negative at that time.

The examination gave evidence of a distinct injury involving both eyes, the fresh perforation of the left eye without foreign body, a forgotten injury of the right eye (proved to harbor a small steel splinter). A magnet extraction was performed by the anterior route on the right eye. The left eye was atropinized and watched for several days after which a linear cataract extraction was performed.

#### ROENTGENOGRAPHY AND LOCALIZATION

With the clinical examination completed one proceeds to x-ray examination and localization. Accurate localization is the *sine qua non* for the proper management of intraocular foreign bodies. It is best to look up a roentgenologist who takes special interest in foreign body localization. It is good policy for the ophthalmologist to be thoroughly familiar with x-ray foreign body localization. He should be

able to supervise the localization and he should be able to suggest variations in the technique so as to determine whether a fragment is in or just outside, the eyeball. Glass (unless containing lead) wood and many other substances are not opaque to x rays. Metallic and stone splinters are x ray opaque. But a minute foreign body can be overlooked. Sometimes artefact shadows are produced by imperfect screens. Because of this it has been our practice to advise first qualitative study by (a) stereo-x ray in posteroanterior view with patient's chin and nose resting on the x ray cassette (b) lateral stereo of the affected eye, (c) skeleton free (soft tissue) technique of Vogt (28-29) for minute fragments in the anterior segment (see Figs. 1-2). The latter is performed by pressing the corner edge of a dental film into the inner canthus and shooting across from the temporal side with the central x ray beam (soft ray). This can be done with the eye looking successively in various directions namely up straight ahead down abducted and adducted as necessary. This exposes all portions of the anterior segment. The eyelids may be pulled out of the way by adhesive strips. A small metal marker attached to the upper and lower limbus at 12 and 6 o'clock helps orientation. Proptosis produced by injecting retrobulbarly 2 to 4 cubic centimeters of 2 per cent procaine aids in exposing more of the globe to this skeleton free soft tissue technique. Thus, some substances such as glass or minute metal splinters, which would be obscured by bone shadows and would not show up by the usual technique, become visible by Vogt's method.

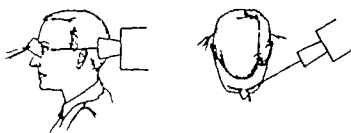


Fig. 2. Vogt's skeleton free x ray technique for localization of foreign bodies in the anterior segment of the globe. Plate tube distance 30 inches equals 75 centimeters.

Localization is readily performed by Comberg's method (2-12). This method is simple and accurate when properly applied. It is foolproof for it indicates automatically voluntary or involuntary rotation of the eyeball away from the desired position.

A drop of 0.5 per cent pontocaine is instilled in the conjunctival sac.

A contact lens with 4 lead markers on the limbal sclera is inserted beneath the eyelids so that the raised portion fits over the cornea. The lens is rotated so that the lead markers are at, or nearly at the 3, 6, 9 and 12 o'clock meridians.

First a posteroanterior exposure is made with the patient in prone position (chin and nose resting on cassette to throw the petrous pyramid shadow below the orbit) (Figs. 4-6). The patient looks straight ahead so as to see a reflection of his uninjured eye in the cassette or in a small pocket mirror lying on the cassette before the uninjured eye (Fig. 4a). The central ray (perpendicular to the plate) is aligned with the anteroposterior (visual) axis of the globe. In the presence of strabismus a thin

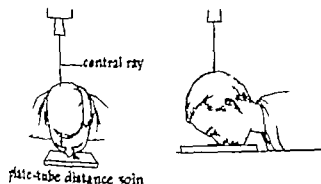


Fig. 3

Fig. 4

Figs. 3, 4, 4a, 5. Modified Comberg localization technique with contact lens. Central ray is over the injured eye.

Figs. 3, 4, and 4a show method of taking posteroanterior

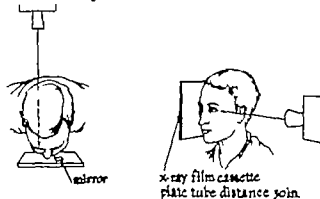


Fig. 4a

Fig. 5

exposure in chin nose position. Uninjured eye looks into fixation mirror. Figure 5 shows method of lateral exposure. Injured eye is next to plate. Central ray passes through limbus. Plate tube distance 30

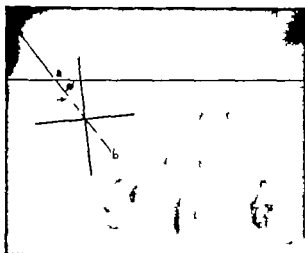


Fig 6



Fig 7

Fig 6 X-ray localization posteroanterior view (chinrose position petrous pyramid projected below orbit). Contact lens with lead markers in position. Foreign body is shown by arrow.  $c$  is corneal center located by drawing diagonals between markers. Line  $ab$  drawn through foreign body and corneal center makes angle  $\phi$  with horizontal orbit line.

Fig 7 X-ray localization lateral exposure. Glass localizing contact lens with lead markers resting on globe. Arrow marks foreign body. Measurements along line  $cd$  gives distance of particle behind limbus. Correction factor due to x-ray distortion in Figures 6 and 7 is per cent.

cover glass mounted on a black cardboard triangular wedge is used as an angle mirror to reflect a pocket flash light into the noninjured left fixating eye (Fig 3). The light is held so that the visual axis of the injured right eye is perpendicular to the x-ray plate. The central ray must pass coaxially with the visual line of the injured eye. If one-eyed the patient is instructed to look at the reflection of his eye in the polished cassette surface. If this is not possible due to low visual acuity the angled cardboard mirror and flash light are employed before the only eye. Then a lateral exposure is made with the patient lying on the affected side and looking straight ahead at a mark on the opposite wall. The central ray should pass through the limbal plane bisecting the cornea (Figs. 5-7).

The measurements taken from the posteroanterior and lateral views are corrected for distortion by reducing them by 10 per cent. They are then plotted on Comberg's localization chart (Fig 8). In the posteroanterior view (Fig 6) the lead dot shadows are connected diagonally by lines scratched on the x-ray plate to give the center of the cornea. A line,  $ab$  drawn through the foreign body and the corneal center  $c$  makes angle  $\phi$  with a line

drawn parallel with the roofs of both orbits. The angle is measured with a protractor and transferred to the localization chart (Fig 8)—and is shown to correspond with the 120 degree meridian. The distance from foreign body to visual axis on x-ray plate (Fig 6) corrected for x-ray distortion by 10 per cent is plotted on this circular front view.

From the lateral exposure (Fig 7) one determines the distance of the foreign body from the limbal plane along the line,  $cd$ . The anterior and posterior limits, 13.8 millimeters and 16.6 millimeters respectively are plotted on the meridional section of the eye through the 120 degree meridian. The radial distance—foreign body to posteroanterior axis—is taken from (Fig 6) as plotted on (Fig 8a) and is again plotted on (Fig 8b). This corresponds with its position in the upper temporal quadrant of the posterior vitreous. One can readily realize that a movement of the globe would be shown by a corresponding change in position of the localizing shell. (Figs. 6 and 7 show exposures with a glass contact lens.)

There are several objections to the Comberg contact lens. It does not always lie centered on the cornea and being made of glass can break on falling.



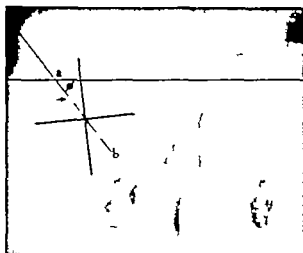


Fig. 6.



Fig. 7.

Fig. 6. X-ray localization posteroanterior view (chinrose position petrous pyramid projected below orbit). Contact lens with lead markers in position. Foreign body is shown by arrow.  $c$  is corneal center located by drawing diagonals between markers. Line  $ab$  drawn through foreign body and corneal center makes angle  $\phi$  with horizontal orbit line.

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be done by such methods. Nor are such tests conclusive. The magnet should be applied only in the operating room and then only after x ray localization. The sideroscope was in use in the latter part of the 19th century to determine the magnetic character of foreign bodies. It was unreliable and fell into disuse.

Since 1943 I found the Berman locator especially valuable in determining whether an intraocular foreign body is magnetic or nonmagnetic. It has been useful in locating and pinpointing the spot on the sclera closest to the magnetic fragment. It has served as a check on x ray localization (which is usually correct and occasionally faulty). It has made possible the determination as to whether the fragment has actually moved after magnet application. It has helped me to decide whether the giant magnet or the hand magnet was necessary for extraction of a foreign body. It has served as a psychological comfort throughout the operative procedure. It was first used by Moorhead at Pearl Harbor in 1941. Minsky published the first recorded application of the locator for the transscleral removal of an intraocular foreign body. So far it has not aided in localizing small nonmagnetic fragments.

#### JUDGMENT AS TO PROCEDURE

Having determined the character and having localized the foreign body, having determined the absence or presence and extent of infection, having arrived at some conclusions as to the amount of ocular trauma and having come to the conclusion that some measure of vision can be saved, one asks himself which foreign bodies should be removed and which might best be left undisturbed?

Chemically inert substances such as glass and stainless steel do not cause ocular irritation as a rule. Aluminum is also well tolerated. On the other hand, brass, copper, zinc and their alloys, iron and steel produce ocular inflammation and deterioration. One must use careful considerate judgment in deciding on operative interference.

Prompt removal of an intraocular foreign body before it sets up too much irritation or infection and before it becomes surrounded by exudate is essential. It is wise to attempt the removal of all irritating nonmagnetic foreign

bodies, if one can avoid excessive mutilation of the globe in doing so. Prompt and early surgery followed by a well considered plan of procedure should be the rule. The surgeon with all facts at hand decides whether operative interference or conservative treatment is to be followed. Should surgery seriously threaten the integrity of the eyeball and prove to be mutilating or destructive, then one must realize that nothing is to be gained by performing an operation.

#### COMBATING INFECTION—PROPHYLAXIS

Every early foreign body case, when first seen, must be considered as potentially infected. To combat such infection and before any organism can be isolated, the surgeon must rely on prophylactic measures. Since the days of Wagner Jauregg's malaria treatment of syphilis, ophthalmologists have found that foreign protein therapy in the form of 15 to 30 million typhoid bacilli antigen intravenously or 10 cubic centimeters of boiled milk intraglutely are helpful in controlling intraocular inflammation. On admission 1500 units of antitetanic serum is given. Penicillin—100,000 units—is given intramuscularly as an initial dose and is repeated in 50,000 unit doses every 3 hours for 4 to 6 days. We have also found subconjunctival injection of 500 units of penicillin dissolved in 0.5 cubic centimeter normal saline to be helpful.

*Sulfadiazine has been especially valuable in our experience in combating infection.* Six grams are given during the first 24 hours beginning with a 2 gram dose. Four grams are then given daily in divided doses for another 48 hours. Thereafter 2 grams are given every 24 hours for 5 days. A blood level of 8 to 10 milligrams is desirable. The urine must be watched for sulfa crystals. The blood must be watched for leukopenia and anemia.

#### PREOPERATIVE CARE

As preparation for local anesthesia, pentobarbital 0.1 gram is given 1 hour before operation. The skin is scrubbed with soap, irrigated and painted with 3½ per cent tincture of iodine or merthiolate.

Local anesthesia is performed in the following manner:

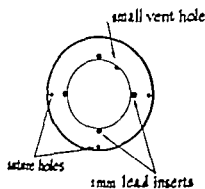


Fig. 9.

Fig. 9. Modified Comberg localizing shell made of plastic or glass. It may be anchored to episclera at 3 suture holes.

Fig. 10. Author's corneal splinter forceps. a, General view of entire forceps; b, enlarged view showing sharp

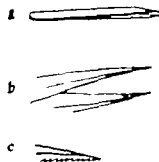


Fig. 10.

points and serrations on blade, c, lateral view illustrating backward pointing serrations. They afford a strong grasp.

Fig. 11. Kuhnt's method of removing penetrating corneal splinter: pupil zone, aided by use of forceps.

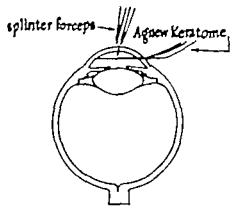


Fig. 11.

1. Pontocaine hydrochloride 0.5 per cent is instilled topically 3 drops at 1 minute intervals.

2. Procaine 2 per cent with 1:30,000 epinephrine is injected into the lateral canthus subconjunctivally and into the superior rectus tendon.

3. Akinesia is performed by injecting 5 cubic centimeters of 2 per cent procaine, containing 1 mm of 1:1000 epinephrine 10 to 15 millimeters anterior to the incisura intertragica (ear notch).

4. Retrobulbar injection consists of 0.5 cubic centimeter solution, containing cocaine hydrochloride 1 per cent, procaine 2 per cent, epinephrine 1:30,000.<sup>1</sup>

#### CORNEAL FOREIGN BODIES

Superficial foreign bodies may be wiped off with a moistened cotton applicator after topical anesthesia. Imbedded particles are dislodged with a sharp spud used to pry up the edge of the fragment. Multiple imbedded foreign bodies are readily removed with the 1 millimeter curet.

The narrow beam of the slit lamp microscope is invaluable in ascertaining the depth of a corneal foreign body. It readily affords information as to whether a particle is wholly intracorneal or projects into the anterior chamber. Metallic shivers or wooden splinters between the corneal lamellae are removed by dissecting down on them and then prying them

<sup>1</sup>To prepare procaine 2% with 1:30,000 epinephrine, add 1 ml. of 1:1000 epinephrine solution to 1 cc. of 2% procaine solution.

up with a cataract knife. When somewhat dislodged the splinter is grasped with the author's corneal splinter forceps (22) (Fig. 10). This forceps has fine rasped teeth which point backward and provide an excellent hold. Thorns and wood splinters are likely to cause keratitis if removed incompletely. On the other hand small glass spicules or coal particles or powder particles if wholly intracorneal may be left undisturbed since they rarely irritate.

The more troublesome corneal foreign bodies are the ones penetrating to or into the anterior chamber. There is always danger of pushing them into the chamber; also the hazard of producing traumatic cataract if the projecting fragment strikes the lens capsule.

Penetrating corneal foreign bodies in the pupillary zone are best removed by the method suggested by Kuhnt many years ago (Fig. 11). Pilocarpine is used to contract the pupil. A narrow keratome (4 mm. wide) such as that of Agnew or of Castroviejo is introduced through the cornea and the point anchored on the other side. The keratome blade thus lies beneath the foreign body. One now dissects the corneal layers down to the foreign body and removes the fragment with the splinter forceps. The keratome is now withdrawn and the pupil is dilated with atropine. The anterior chamber is restored with normal saline to avoid anterior iris synechia.

A penetrating splinter in the periphery is removed after making a corneal flap inserting 1 or 2 interrupted sutures (Fig. 12). The flap is lifted and the foreign body is removed with





Fig. 12.

Fig. 12. Limbal incision and preplaced sutures for removing peripheral placed penetrating corneal splinter.

Fig. 13. Second step in removal of splinter from everted cornea with forceps.

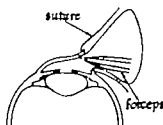


Fig. 13.

forceps from within (Fig. 13). It may be necessary to pry the splinter loose with a knife needle.

Another method for removing deep corneal foreign bodies is to make pressure from inside with a small Reverdin needle (inserted through a keratome incision) against the posterior surface of the cornea while cutting down onto the foreign body (Fig. 15).

#### FOREIGN BODIES IN THE ANTERIOR CHAMBER

Magnetic particles in the anterior chamber rarely require the insertion of an instrument into the globe, except for toilet of the wound. On the other hand the nonmagnetic fragment must depend on special forceps, a blunt iris hook, and an Elschnig spatula for its removal. Small particles of glass, coal, inert solids, and rootless lashes do not as a rule require surgery. Copper and brass must be removed.

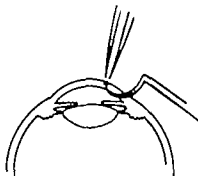


Fig. 15. Use of Reverdin needle through keratome incision to press foreign body backward through cornea while extraction is attempted from without.

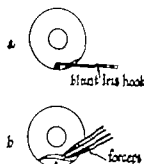


Fig. 14.

Fig. 14. a, Use of blunt iris hook to dislodge fragment wedged in chamber angle. Final removal with forceps. b, Forward incision in cornea permitting access into chamber angle.

It has been our practice to use the Berman locator in every case, and on occasion we found an intraocular foreign body to be magnetic, when the history suggested otherwise. The penetrating corneal foreign body is at times pushed into the anterior chamber and then it is obviously handled as such.

For the operation one should have at hand the usual iridectomy instruments, plus serrated curved anterior chamber clot forceps, Arruga's capsule forceps, the author's corneal splinter forceps, Tyrrel's blunt iris hook, Elschnig's cyclodialysis spatula, and an anterior chamber irrigator. It should be a rule to fill the anterior chamber with normal saline at the end of the operation. Hyphema should be allowed to absorb or must be irrigated away before removal can be attempted.

Nonmagnetic foreign bodies not enmeshed in iris tissue are readily grasped and removed with one of the above special forceps through a properly placed keratotomy. It is best to avoid the wound of entry unless it is large. The corneal incision should be posterior to the foreign body so that the rear wound lip will not interfere with instrumentation. The particle should be grasped so that it will not dart away. The lens capsule must be avoided. After removal of the fragment, any iris prolapse that may be present is replaced; the chamber is then restored with saline and in most cases it is advisable to close the incision with atraumatic silk sutures. This prevents postoperative iris prolapse. No atropine is instilled at this time. A binocular occlusive dressing is applied. After 3 or 4 days, 2 per

cent atropine is instilled. Both eyes are kept closed for 1 week if the incision is longer than 6 millimeters.

Anterior chamber foreign bodies of long standing either adherent or enmeshed in iris tissue may at times be teased loose. They usually require an iridectomy. Only the smallest amount of iris tissue should be sacrificed.

#### ANTERIOR CHAMBER ANGLE

Nonmagnetic particles lodged in the chamber angle present a special problem. Most of them are found in the lower angle recess due to gravity. They are usually wedged between iris and cornea and are often covered by exudate. They may be readily seen by gonioscopy. Removal may be accomplished by a method long in use. A limbal incision is made several millimeters to the side of the particle (Fig. 14a). The fragment is pried loose with a blunt iris hook and is then removed with forceps. The incision is then closed with silk sutures and the anterior chamber is reestablished with normal saline.

Desmarres in 1874, Goulden in 1920 and Lancaster later described another good approach to particles lodged in the anterior chamber angle. An incision is made from within forward across the cornea from 5 to 7 o'clock with a narrow Graefe cataract knife (Fig. 14b). This permits one to pry the foreign body loose with the blunt hook and then to reach in with forceps and remove it. The chamber is restored and the corneal wound is closed with one or two interrupted sutures. Both of the above methods have been tried several times and found satisfactory by the writer.

It may at times be necessary to incise the angle from without (*ab externo*—according to the method of Gayet). Or one can use Meller's method of making a hinged trephine button over the site of the foreign body. Here one must be certain not to have a corneal shelf overlying the fragment in the chamber angle.

#### IRIS

Nonmagnetic particles lodged in iris tissue at times be freed with forceps inserted through a keratotomy. However when it is only enmeshed or when the iris is excessively traumatized in removing the splinter I have

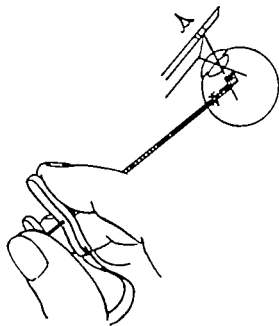


Fig. 16. Method of using author's self-closing vitreous foreign body forceps under ophthalmoscopic control.

found it best to excise a small portion of iris with the foreign body.

#### POSTERIOR AQUEOUS CHAMBER

To remove foreign bodies from behind the iris just to the side of the lens equator one must have extremely accurate x ray localization with contact lens or limbus marker. A Gayet incision is made subconjunctivally (beneath a previously dissected flap) with Lunds gaard's knife. A McLean corneoscleral suture is then placed and the incision is completed *ab externo* into the chamber angle. A drop of adrenalin 1:100 and a drop of thrombin solution are placed on the iris root to prevent and arrest hemorrhage. Iridodialysis at the root is accomplished by holding the iris up and cutting it at its attachment with pointed scissors under Beebe loupe magnification. The iris is now held aside while the corneal flap is lifted by the assistant. The surgeon reaches in with forceps, grasps the foreign body and removes it. The fragment if present for any length of time may be enmeshed in exudate. One must be extremely careful to avoid lens injury. The incision is closed with the above mentioned suture. A thin strand of iris stroma may be incarcerated in the wound just before closure if the iridodialysis is longer than 3 millimeters. The conjunctival flap may be replaced and held with 2 interrupted silk sutures.

## FOREIGN BODIES IN THE LENS

Nonmagnetic foreign bodies are sometimes tolerated by the lens for long periods of time because of its slow metabolism. They may thus be carried along until the lens becomes completely cataractous. For removal of lenticular foreign bodies the pupil must be dilated maximally. Magnetic splinters are readily dislodged with Haab's giant magnet from either partly or wholly cataractous lenses.

To remove visible nonmagnetic splinters from the lens Donovan in 1925 suggested a unique method. A small keratotomy is made and a short beveled 19 gauge hypodermic needle mounted on a Luer syringe is inserted into the lens up to the foreign body. The plunger is pulled on to grasp and hold the foreign particle by suction. Donovan has reported successful extraction of several lenticular foreign bodies by this method.

If the fragment lies just beneath the anterior capsule it may be grasped with a toothed capsule forceps.

The customary practice with foreign bodies in the lens (without irritation of the eye) is to await complete maturity of the cataract. Combined intracapsular extraction is then attempted. In adults under 40 the Pagenstecher technique (of holding a Weber loop or broad spatula just behind the superior lens equator while counter pressure is made at the lower limbus) is employed. Vitreous loss is kept at a minimum by tying previously inserted corneoscleral sutures. In patients past 40 years of age one tries to remove the lens in capsule using Arruga's forceps or the enclavator. Rupture of the capsule with escape of the foreign body can present a serious complication. If it is visible one can grasp it with forceps. If it is not seen readily then one applies the scleral transilluminator gently to the globe in an attempt to see the foreign body shadow. The cataractous nucleus is expressed. Irrigation under Beebe loupe control is resorted to to float the foreign body into view.

## NONMAGNETIC FOREIGN BODY IN CORPUS CILIARIS OR CHORIOID

Accurate localization is essential. A ring marker sown to the episclera is helpful. The conjunctiva is incised several millimeters be-

hind the localized spot and the sclera is bared over this area. The exact spot of localization is marked with gentian violet. A meridional incision is made through the sclera by gradual dissection attempting to come down to the foreign body. The lips of the sclera are held aside by silk sutures (according to Mendoza's method). The foreign particle may appear in the uvea herniating into the incision if localization and dissection is accurate. Transillumination (with Lancaster's or Lange's instrument) applied to the opposite side of the globe is helpful. To avoid hemorrhage epinephrine 1:100 is dropped onto the scleral incision with thrombin solution to aid clotting. If the foreign particle lies a little deeper than the ciliary body is incised radially. The particle is seized with forceps when it comes into view. If one waits a minute or two it will at times present itself in the wound and can be removed. Protrusion of ciliary body is excised and the aforementioned Mendoza suture is tied closing the incision. The conjunctiva is closed with running suture. The same technique is followed for particles in the choroid except that the site of incision in the sclera is surrounded with 6 surface coagulations. If the particle is magnetic and near the pars plana of the ciliary body one can use the technique suggested by Verhoeff in 1932 and by Barbour and Fraclik in 1941.

## FOREIGN BODIES IN THE VITREOUS CHAMBER

For many years, eyes harboring copper or its alloys in the vitreous were given up to enucleation. Now newer techniques and instruments can save some of these cases. Several methods can be used. The choice of method depends on the location of the particle, on its visibility with the ophthalmoscope and on the cloudiness or bloodiness of the vitreous.

*Method 1 for vitreous.* Direct vision or ophthalmoscope. In a case with clear lens in vitreous and foreign body visible with ophthalmoscope without undue rotation of the eyeball. The sclera near the foreign body is bared. The site of incision is marked with gentian violet and surrounded by 6 to 8 surface coagulations. A 4 to 8 millimeter long incision is made in the sclera in the shape of capital I or T (with the

long arm of the letter meridional) The length of the incision is governed by the size and shape of the fragment The uvea is exposed while the sclera is held aside with one or two Mendoza sutures The uvea is incised with the cutting current of the diathermy The particle may be seen glistening in the incision and is extracted with forceps and the sclera immediately closed with the above mentioned sutures If the particle is not readily seen in the incision one views it with the ophthalmoscope and extracts it with the author's self closing vitreous chamber (23-24) forceps introduced into the incision The wound is closed as above. It may be touched with trichloroacetic acid or 95 per cent phenol (18) The conjunctival incision is then sutured

*Vitreous Method 2 Ophthalmic endoscope*  
The ophthalmic endoscope was devised in 1934 (25) and demonstrated that Spring in non luminous form at the Section of Ophthalmology of the American Medical Association In the Fall of 1934 (26) the self luminous model was demonstrated at the Academy of Ophthalmology and Otolaryngology I have used it successfully in 5 cases It has been used with success by Spaeth and others.

The endoscope consists of (1) a light carrier with a miniature lamp (2) a special inverted Galilean telescope 2.5 millimeters in diameter and (3) a small tubular forceps. These are held together in one plane by a metal sheath There is an adjustable sleeve which can be preset for depth of entry of the forceps into the vitreous. The operative end of the instrument has a stop to prevent its being thrust into the vitreous chamber bodily There is an electric connection which supplies current for the miniature lamp from a battery. The cross section of the operating end is 2.5 by 6.5 millimeters. The telescope affords a field of view 60 degrees in diameter Thus at 10 millimeters distance the field is 10 millimeters in diameter at 15 millimeters distance it is 15 millimeters in diameter Thus, two thirds or more of the interior can be covered by moderate tilting of the instrument shaft. Particles at 15 millimeters distance from the telescope end are magnified two diameters and become larger as they near the telescope The inverted Galilean system permits everything to be in

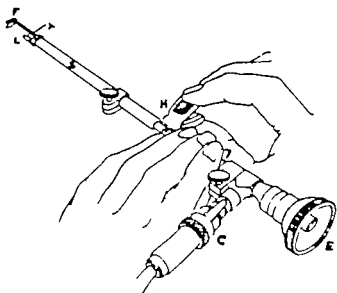


Fig 17 Method of holding ophthalmic endoscope during operation. Surgeon's left hand holds and steadies the instrument body The right thumb and index finger actuate the grasping forceps, *H* whose blades, *F* are seen just beyond the telescope, *T*, and miniature lamp, *L*, *S* Adjustable sheath *C* electric battery connection, *E* eyepiece

focus except that the objects appear smaller as the distance from the telescope lens increases This instrument should be used only in clear vitreous The forceps used are shaped so that some may grasp a shot while another is used for an irregular shaped splinter They are either self-closing or manual closing

It is of extreme importance for the surgeon who proposes to use this instrument to become thoroughly familiar with its application by working in a small light proof pill box (1 inch in diameter—about the size of the globe) The surgeon must learn to overcome the handicap of working with a monocular instrument. He must learn to hold it and handle it properly He must learn to orient himself with the instrument at all times. After mastering removal of small objects from the pill box one advances to practice with pig's eyes.

#### STERILIZATION OF OPHTHALMIC ENDSCOPE

The instrument is washed with green soap rinsed in distilled water and sterilized by immersion for 20 minutes in 0.1 per cent mercury cyanide solution or 0.03 per cent mercuric phenyl nitrate It is rinsed in sterile water and wiped dry Alcohol or heat sterilization or various chemicals except the ones advised will damage the lens cement and the fine electric insulation and will ruin the instrument

When proposing to use the endoscope one begins with an accurate x ray localization and a definite plan of operation. The approach may be between any of the recti muscles or beneath the superior or inferior rectus after they have been cut at their insertion to the globe. The lateral and medial rectus regions are avoided to prevent injury to the long ciliary arteries. The selected site for scleral incision is plotted with gentian violet and surrounded by surface diathermy coagulations or partly penetrating applications of the Kronfeld diathermy needle. This measure is for the prevention of retinal detachment. The incision is made 7 millimeters long in the meridional direction just down to the choroid. Scleral sutures are inserted in the incisional margins to hold them apart and the ends of the incision are cut at right angles for 1 millimeter on each side and on both ends (so that the incision appears I shaped). Epinephrine 1 per cent solution and thrombin are applied to the choroid surface and after 30 seconds wait the choroid and retina are incised with diathermy or with scissors or with a shallow thrust of a cataract knife. The lips of the wound are held apart with sutures by the assistant and the endoscope is inserted just to the opening with the closed miniature forceps about 5 millimeters in front of the telescope and slightly to one side. The surgeon looks through the eyepiece of the illuminated instrument which is connected to an electric battery with preset rheostat. The assistant watches to see that the body of the instrument is not shoved or pushed into the globe. The surgeon sights the foreign body and grasps it with the forceps. The forceps is closed and pulled up to the telescope slowly and the entire instrument is withdrawn. During the procedure one assistant keeps the wound flaps against the sheath of the endoscope with his sutures so as to avoid loss of vitreous. On removal of the instrument he closes the incision and ties the scleral sutures. The conjunctiva is closed with running suture. Of 5 patients operated upon, one has 20/30 vision, another has 20/100 vision, a third case can count fingers. The fourth patient has a blind soft eye. The fifth case done in October 1946 has 10/100 vision with a partial traumatic cataract. This is a major procedure and

the surgeon who uses this instrument should play with it for several weeks before he inserts it into an eye.

*Vitreous Method 3. Transillumination.* By this method one exposes the sclera as above for transscleral approach. One or two small trans illuminators are placed on the opposite side of the globe to the incision, thus illuminating the vitreous. The foreign body is outlined against the illuminated interior between the lips of the scleral incision. The foreign body is visualized and grasped with small serrated forceps. The incision is closed as in the first two methods. The sclera is also diathermized about the incision to seal off the retinal hole and prevent detachment. I have used this method in 3 instances and am favorably impressed by it. Schutz and Lindner have applied this method.

*Vitreous Method 4. Biplane Fluoroscope.* Cross has found the biplane fluoroscope useful in the removal of shot from the eye. Smaller objects do not cast sufficient shadow to be visible with the fluoroscope. He inserts a cross action wire forceps into the vitreous and is guided in his movements by the fluoroscopist. In the hands of Cross with the aid of his expert fluoroscopist the method has proved successful in several cases. I have had no personal experience with this technique because of lack of a biplane fluoroscope.

*Optic nerve.* Foreign bodies in the head of the optic nerve can probably be removed with the ophthalmic endoscope. The damage to the nerve head with subsequent cicatrization would probably result in a blind eye. Although removal of magnetic fragments from the nerve head is sometimes followed by moderately useful vision.

*Nonmagnetic scleral foreign bodies.* Scleral foreign bodies generally do little damage unless they project from either side of the sclera. They can be readily localized and dissected out and sometimes pried loose. If one is in doubt about the location of the foreign body the sclera can readily be palpated with a probe or the end of a muscle hook. The site of the hard particle can be definitely felt.

Orbital foreign bodies can usually be left alone unless because of location or size they make pressure on vital structures or cause dis-

comfort and pain. They do not come within the scope of this paper.

*Postoperative treatment* The postoperative management consists of

1 *Antibiotics* Sulfadiazine has proved the most successful agent in my experience for controlling infection. In fresh injuries 30 grains is given on admission and is followed by 15 grains every 4 hours for 1 or 2 days. The dosage is then reduced to 15 grains every 6 hours for another 48 hours. Thereafter 15 grains are given 3 times daily for 3 to 4 days. Sodium bicarbonate in the amount of 10 grains is given with each dose and a liter of water is consumed daily. The urine is watched for crystals. The blood level of sulfadiazine is kept between 8 and 10 milligrams. The blood count is also watched for reduction in red and white blood cells and their differentiation.

Penicillin may be given intramuscularly. The first dose is 100,000 units in 5 cubic centimeters of  $\frac{1}{4}$  per cent novocain. Thereafter 25 to 50 thousand units are given intramuscularly every 3 hours for 3 to 4 days.

2 *Foreign protein therapy*—Tetanus anti-toxin is given subcutaneously as a specific for the prevention of lockjaw in fresh injuries. Boiled milk in 10 cubic centimeters amount for men and 8 cubic centimeters dose for women and appropriate smaller dosage for children is given intramuscularly on admission to fresh injuries and every third day for 3 doses if indicated.

Typhoid A antigen is given intravenously instead of the intramuscular milk. The first dose is 15 to 20 million. It is increased by 15 to 20 million every third or fourth day as necessary. A reaction is desirable. Old people do not tolerate this therapy well.

3 *Atropine* is used postoperatively unless contraindicated by a rise in tension. Its application is delayed for 3 days in anterior chamber cases. (It is not used preoperatively in anterior chamber cases.)

4 *Daily dressings* are done for traumatic cataract and postoperative intis for atropine instillation. Other intraocular cases are dressed every other day. Both eyes are usually kept closed for 1 week. Cases of retinal detachment or threatened detachment have both eyes kept closed for 2 to 4 weeks.

5 *Position in bed* Patients with wounds of the cornea are required to lie flat in bed for 48 hours. Scleral wounds or incisions do best when kept flat for one week. Incisions in the lower sclera require several days longer in a flat position.

6 *Diet* Liquid diet is given for 48 hours. Soft diet follows for 4 days. Light general diet is given after 6 days postoperatively.

7 *Bowels* The intestinal tract is kept cleared by mineral oil given for 3 days. Simple enemas are given after 48 hours if necessary.

8 *Sedatives* Codein sulfate in doses of  $\frac{1}{4}$  to 1 grain may be given and repeated. Phenobarbital in  $\frac{1}{4}$  grain doses is at times used as a sedative.

#### GENERAL RULES IN NONMAGNETIC INTRAOCULAR FOREIGN BODY CASES

1 Make a careful examination and take a complete history. Use every modern device for arriving at a complete diagnosis.

2 Get an idea as to the extent of trauma to the various structures and as to the impairment of function.

3 Assay the probability and extent of infection. Consider each case as potentially infected. Take prophylactic and therapeutic measures for its control.

4 Make an x-ray examination in each case with varied types of exposure and position. Stereoscopic x-ray films are valuable. Accuracy in localization is paramount.

5 Avoid removal of chemically inert foreign bodies unless they do harm because of size or mechanical irritation.

6 Avoid mutilating surgery and avoid groping in the vitreous. They lead to destruction of vision and of the globe.

7 Suspect and treat immediately all retinal detachments. Take precautionary preventive measures as outlined above.

8 Remove intraocular foreign bodies promptly to prevent their becoming enmeshed in exudate and organized scar tissue and also to prevent the damage that results from prolonged stay in the eyeball.

9 Multiple intraocular foreign bodies make conservative therapy a consideration of the first importance.

When proposing to use the endoscope one begins with an accurate x ray localization and a definite plan of operation. The approach may be between any of the recti muscles or beneath the superior or inferior rectus after they have been cut at their insertion to the globe. The lateral and medial rectus regions are avoided to prevent injury to the long ciliary arteries. The selected site for scleral incision is plotted with gentian violet and surrounded by surface diathermy coagulations or partly penetrating applications of the Kronfeld diathermy needle. This measure is for the prevention of retinal detachment. The incision is made 7 millimeters long in the meridional direction just down to the choroid. Scleral sutures are inserted in the incisional margins to hold them apart and the ends of the incision are cut at right angles for 1 millimeter on each side and on both ends (so that the incision appears I shaped). Epinephrine 1 per cent solution and thrombin are applied to the choroid surface and after 30 seconds wait the choroid and retina are incised with diathermy or with scissors or with a shallow thrust of a cataract knife. The lips of the wound are held apart with sutures by the assistant and the endoscope is inserted just to the opening with the closed miniature forceps about 5 millimeters in front of the telescope and slightly to one side. The surgeon looks through the eyepiece of the illuminated instrument which is connected to an electric battery with preset rheostat. The assistant watches to see that the body of the instrument is not shoved or pushed into the globe. The surgeon sights the foreign body and grasps it with the forceps. The forceps is closed and pulled up to the telescope slowly and the entire instrument is withdrawn. During the procedure one assistant keeps the wound flaps against the sheath of the endoscope with his sutures so as to avoid loss of vitreous. On removal of the instrument he closes the incision and ties the scleral sutures. The conjunctiva is closed with running suture. Of 5 patients operated upon, one has 20/30 vision another has 20/100 vision, a third case can count fingers. The fourth patient has a blind soft eye. The fifth case done in October 1946 has 10/100 vision with a partial traumatic cataract. This is a major procedure and

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# VISUAL FIELD DEFECTS DUE TO HEAD INJURIES

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THE visual pathways are so extensive that injury to any part of the cranium may result directly or indirectly in defects in the field of vision. These pathways extend from the ganglion cells of the retina by way of the optic nerves, the chiasm, the optic tracts, the lateral geniculate bodies and the optic radiations to the visual cortex in the occipital lobes. The additional cortex and fibers necessary for voluntary and reflex movements, visuopsychic functions and association of one area with various other areas comprise a still more complicated and extensive network which involves every portion of the brain.

This paper will consider only the representation of various parts of the retina in the visuosensory cortex of the occipital lobes of the brain. An attempt will be made to summarize our present knowledge and to point out the difficulties in studying this subject. Proof that a given area of the cortex subserves a certain function is difficult as one seldom sees a clean-cut, isolated lesion to correlate with one's clinical findings.

First let us review the anatomy of the visual pathways. The nerve fibers from the temporal halves of each retina pass backward in the temporal portion of the optic nerve; they do not cross in the optic chiasm. Fibers from the nasal halves of the retina pass backward in the nasal portion of the optic nerve but decussate at the chiasm. Fibers from the fixation area or macula form the papillomacular bundle which enters inferotemporally and then assumes a more central position. In the chiasm these fibers lie posteriorly and undergo semi-decussation.

Behind the chiasm are the optic tracts, each of which is made up of (1) fibers from the temporal portion of the retina of the same side, (2) fibers from the nasal half of the retina of the opposite side, and (3) macular fibers from the temporal half of the same side and from

the nasal half of the opposite side. Thus the macular fibers may be said to form a minor chiasm within the major chiasm. This semi-decussation of the central fibers is most important as we shall note again.

The least possible confusion will be had if we look upon the central area of the field as having the same characteristics as the peripheral field. The optic tracts remain condensed throughout their course and end in the lateral geniculate bodies.

From the geniculate bodies to the occipital cortex we find the optic radiations. The geniculocalcarine fibers lie in the internal capsule behind the sensory fibers and internal to the auditory fibers. Fibers from the upper retinal quadrants (lower portion of the visual fields) lie dorsally, while fibers from the lower retinal quadrants (upper fields) lie ventrally. In the anatomical space between these lie the macular fibers (the central field). Some of the ventral fibers detour into the uncinate region of the temporal lobe around and over the anterior horn of the lateral ventricle before bending backward along the lower aspect of the ventricle to end in the anterior portion of the lower calcarine cortex. These fibers correspond to the temporal crescents of the field. The majority of the fibers in the optic radiations pass directly to the calcarine cortex.

Observers have diverse opinions regarding the representation of the fixation area or macula in the cerebral cortex. A review of their reasons would serve no useful purpose here.

The visual cortex occupies part of the medial surface of each occipital lobe and posteriorly the visual area extends a little onto the lateral surfaces. The visual area extends from the tip of each lobe where the fixation area is represented forward to the splenium of the corpus callosum at the anterior end of the calcarine fissure where the periphery of the retina is represented. The lingual gyrus lies below and the cuneus above the calcarine fissure. The upper portion of each retina is represented in the area above the calcarine fissure.

Presented before the Clinical Congress of the American College of Surgeons, Cleveland, December 16-20, 1946.



10 Do not overlook foci of infection and other systemic conditions that may delay healing and cause complications.

11 Have a definite well considered plan for each operation

12 Know your surgical instruments thoroughly and be sure that they are in first class working order

13 Be sure of the ophthalmic endoscope before attempting its use. This can only be had after continued and repeated practice so that its operation is automatic. When properly used this instrument may be invaluable in salvaging a potentially lost eye due to a retained nonmagnetic foreign body

14. Scleral and corneal incisions and wounds heal faster and better when properly approximated by sutures.

15 The topical application of epinephrine 1:100 and thromboplastin or thrombin will often prevent destructive hemorrhage

16 Enucleation is sanctioned only when the globe is collapsed and extensive vitreous loss has taken place and light perception is lost. Do not rush to enucleate when both eyes are injured.

17 Remember the danger of sympathetic ophthalmia. Three weeks is the safe period at the longest to temporize from the time of injury. A decision should be arrived at within 14 to 16 days as to enucleation of a potentially dangerous eye.

The subject was considered from the standpoint of adequate thorough survey of the injured patient including history and every necessary examination to arrive at an accurate diagnosis. Consideration was given to con-

servative treatment for chemically inert foreign bodies. Techniques were outlined for these measures and for simple accurate methods of x ray localization. Operative techniques were described for the removal of nonmagnetic intraocular foreign bodies, from cornea, anterior chamber iris, lens, ciliary body vitreous, choroid and sclera.

## REFERENCES

- BARBOUR, F. A., and FRALICK, F. H. *Am. J. Ophthalm.* 194 24, 553.
- COMBERG, W. *Arch. Ophthalm., Berl.* 1937 8, 75.
- CROSS, G. H. *Tr. Am. Ophth. Soc.*, 1937, 3, 80.
- DORVAM, J. A. *Tr. Sect. Ophth. Am. M. Ass.* 1924, p. 60.
- DROGOWITZ, W. M. Personal communication.
- FRANKEL, and GRAUER. *Fortsch. Röntgenstrahl.* 1939, 40, 2.
- GUNDLICH, TRYOVE. *Tr. Am. Acad. Ophthalm.*, 1946, 7, 7.
- LANCASTER, W. B. *Am. J. Surg.* 1938, 43, 30.
- LINDNER, KARL. Personal communication 1935.
- MIDGLEY, H. H. *Arch. Ophthalm.*, 1944, 31, 207.
- MOOREHEAD, J. J. *J. Am. M. Ass.*, 1943, 2, 123.
- PELLETER, R. L. Discussion on Speech, loc. cit. p. 55 (15).
- SCHOTT, J. A. *Am. J. Ophthalm.*, 1942, 25, 70.
- SPACKMAN, E. W. *Am. J. Ophthalm.*, 1934, 2, 107.
- SPARTAN, E. B. *Tr. Sect. Ophth. Am. M. Ass.*, 1944, p. 45.
- STALLARD, H. B. *Brit. M. J.* 1942, 3, 639.
- Ibid.*, p. 630.
- STERN, E. *Am. J. Ophthalm.* 1932, 5.
- THORPE, H. E. Discussion on Speech loc. cit. p. 56 (3).
- Idem.* *Arch. Ophthalm.*, 1944, 3, 497.
- Idem.* *Tr. Am. Acad. Ophthalm.*, 1946 (in publication).
- Idem.* *Arch. Ophthalm.*, 1944, 3, 497.
- Idem.* *Tr. Am. Acad. Ophthalm.* 1946 (in press).
- Idem.* *Arch. Ophthalm.*, 1936, 5, 308.
- Idem.* *Tr. Sect. Ophth. Am. M. Ass.*, 1934, p. 290.
- Idem.* *Tr. Am. Acad. Ophthalm.*, 1934, 39, 422.
- VERMORRE, F. H. *Am. J. Ophthalm.* 1933, 5, 689.
- VOGT, A. *Schweiz. med. Wochs.* 1925, 4, 982.
- WIEZER, S. *Klin. Mbl. Augenh.*, 1923, 8, 34.
- WILDER, H. C. *Bull. U. S. Army M. Dep.* 1945, 4, 9.

tion. We would like to have had more complete neurosurgical notes but we also understand why they are not available.

When the ophthalmologist is plotting and interpreting visual fields, it is essential that he bear in mind the fact that injuries other than the one producing the field defect may affect the results obtained. Listing of some of these factors may help to illustrate this point.

1 The patient may not understand what is expected of him during the test

2 Emotional instability and fatigue may affect the result. It is not easy for even a normal person to have his fields checked

3. Hysteria and malingering may be responsible for part of the defect. One usually thinks of hysteria and malingering as pure or isolated phenomena. A patient who has sustained a genuine injury resulting in partial loss of his visual field may exaggerate this loss of his field because of fear or a desire to obtain a greater disability pension

4. Paralysis of extraocular muscles may result in apparently defective visual acuity or defects in the visual field which disappear when the head is placed in the proper position. Paralysis of the sixth nerve or conjugate deviation of the eyes are two examples. Here again there may be a true field defect exaggerated by improper position of the patient

5 Poor response due to involvement of Wernicke's auditory area (areas 41 and 42 of Brodman) may prevent proper responses to vocal instructions.

6 Involvement of the motor speech area of Broca (area 44 of Brodman) may result in poor vocal responses from the patient

7 The patient may have difficulty in fixing or maintaining fixation of the target because of poor visual acuity, central scotoma, or a hemianopic defect with splitting of the fixation area. Conversely patient may seem to maintain fixation better than he actually does.

8 The visuopsychic areas may also be involved and make it difficult or impossible for the patient to give adequate responses when being tested

Area 18 the parastriate area, surrounds the visuosensory area (17) in the occipital cortex. A lesion here prevents a patient from recognizing an object even though he sees it.

Area 19 the peristriate area surrounds area 18. The patient may see (area 17) and recognize (area 18) but be unable to remember or revisualize the characteristics of an object.

Because of the proximity of areas 17, 18, and 19 more than one area may be destroyed by the injury

#### 9 Lesions in the parietal lobe

Area 39 lying anterior to area 19, in the angular gyrus of the parietal lobe has to do with interpretation of symbols combining recognition and revisualization (which are dealt with separately in areas 18 and 19)

Area 40 deals with mathematical figures and calculations. It is located in the supramarginal gyrus of the parietal lobes.

Areas 39 and 40 are said to be more dominant than areas 18 and 19

10 Disturbances of higher psychic and association areas may also interfere with proper testing of the visual fields

Some of the factors listed above are of practical importance and easily demonstrated. Those which deal with psychic and association functions are listed as of theoretical interest as our precise knowledge is too limited for practical clinical application. The opportunity for further study is with us today as never before because of the many service men who have survived a great variety of head injuries. It is to be hoped that Veterans Hospital staffs will follow these patients carefully with repeated neurological, neurosurgical, ophthalmological and finally with postmortem studies. When the injured brain is fixed and studied grossly and microscopically we can find the true extent of the lesions which resulted in visual field changes observed during life. This should settle many disputed points—but will do so only if our clinical notes are accurate and complete.

If this demonstration stimulates others by its inadequacies rather than by its excellence of detail its purpose will have been served

#### CASE REPORTS

These cases were collected in conjunction with Dr. J. N. Greear, Jr. now in Washington, D. C. and formerly Chief of Eye Section, Valley Forge General Hospital.

CASE 1. This patient sustained a fracture of the left parietal and occipital bones with multiple depressed fragments of bone, laceration of the dura and

while the lower portions of the retinas are represented below the calcarine fissure. Sectors adjacent to the vertical meridian of the retina are represented along the lips of this fissure, while sectors to the sides of the horizontal meridians are projected in the depths of the fissure. The temporal crescents of the binocular fields are represented in the oral parts of the calcarine fissure.

The cortical area representing the fixation area is quite extensive as compared with the area representing the peripheral portions of the visual fields. This is analogous to the large motor and sensory areas in the parietal cortex representing finger and thumb as compared with the area representing trunk.

It is unfortunate that our methods of studying cerebral localization are so limited. Obviously we cannot induce lesions in human subjects, nor can we obtain subjective responses from animals. Electrical stimulation of the visual cortex of man results in responses less precise and more difficult to interpret than the responses invoked by test objects used in taking visual fields. Electroencephalography has so far shown little promise as a method of studying the visual apparatus. Complete neurological and ophthalmological examinations are our best methods, and plotting of the visual fields the most satisfactory single test.

Four types of lesions in the brain can be correlated with visual field defects. Each of these has its disadvantages and limitations. Vascular lesions have provided valuable information regarding cerebral localization. However individual variations in blood supply are not infrequent. Occlusion of certain cerebral arteries is common, but occlusion of smaller branches supplying small areas of the cortex is not common.

While some tumors produce clean-cut field defects, much depends upon the time of study of an expanding lesion. Infiltrating tumors have indefinite borders. Local or distantly applied pressure from a tumor may result in atrophy, edema, or vascular occlusion in areas remote from the space-taking lesion.

Excision of tumors or of scar tissue allows the neurosurgeon to note the exact area involved. This is our best method of clinical study.

Injuries provide the next best method. One must keep in mind several factors which may affect the interpretation of traumatic lesions. One of these is the element of time as hemorrhage, edema, and contusion produce varying pictures.

Regardless of the lesion studied, post mortem examination with sections of the entire brain is by all odds the most reliable.

Among the factors that render interpretation of visual field defects due to injuries hazy and difficult are these:

- 1 Depressed skull fractures produce effects which are at least partially reversible by elevation of the fragments.

- 2 Foreign bodies may be found at one site, but have traversed important structures in reaching this site. It is therefore most important to know the location of the entire tract of a foreign body.

- 3 Blood vessels may be torn or thrombosed giving the picture of a vascular lesion alone or a combination of vascular, cortical, and radiation fiber injury. Indeed, vascular injury may play a rôle in a high percentage of field defects due to trauma. We may say that it is unimportant to know whether damage to cortical cells is direct or due to loss of blood supply. However the field defect is likely to be larger in a vascular injury. The prognosis is often much better when the blood vessels are only partially or temporarily occluded. It is important to remember that terminal branches of the calcarine and middle cerebral arteries do have anastomoses in the pia before piercing the cortex.

- 4 Edema from any cause may be responsible for transient effects on the visual fields.

- 5 A brain abscess may be a late, unsuspected complication of injury and add its effects to the visual field defect.

- 6 The neurosurgeon may not be able to tell how much of the lesion is destructive and how much is due to edema, hemorrhage, or contusion. He is handicapped in observing landmarks and often cannot see the entire extent of the injury because of the small opening in the calvarium through which he operates. The brilliant work of the neurosurgeons in the past war has kept alive many men who would otherwise not have returned to us for examination.

tion. We would like to have had more complete neurosurgical notes but we also understand why they are not available.

When the ophthalmologist is plotting and interpreting visual fields, it is essential that he bear in mind the fact that injuries other than the one producing the field defect may affect the results obtained. Listing of some of these factors may help to illustrate this point.

1 The patient may not understand what is expected of him during the test.

2 Emotional instability and fatigue may affect the result. It is not easy for even a normal person to have his fields checked.

3 Hysteria and malingering may be responsible for part of the defect. One usually thinks of hysteria and malingering as pure or isolated phenomena. A patient who has sustained a genuine injury resulting in partial loss of his visual field may exaggerate this loss of his field because of fear or a desire to obtain a greater disability pension.

4 Paralysis of extraocular muscles may result in apparently defective visual acuity or defects in the visual field which disappear when the head is placed in the proper position. Paralysis of the sixth nerve or conjugate deviation of the eyes are two examples. Here again there may be a true field defect exaggerated by improper position of the patient.

5 Poor response due to involvement of Wernicke's auditory area (areas 41 and 42 of Brodman) may prevent proper responses to vocal instructions.

6 Involvement of the motor speech area of Broca (area 44 of Brodman) may result in poor vocal responses from the patient.

7 The patient may have difficulty in fixing or maintaining fixation of the target because of poor visual acuity, central scotoma or a hemianopic defect with splitting of the fixation area. Conversely patient may seem to maintain fixation better than he actually does.

8 The visuospsychic areas may also be involved and make it difficult or impossible for the patient to give adequate responses when being tested.

Area 18 the parastriate area, surrounds the visuosensory area (17) in the occipital cortex. A lesion here prevents a patient from recognizing an object even though he sees it.

Area 19 the peristriate area, surrounds area 18. The patient may see (area 17) and recognize (area 18) but be unable to remember or revisualize the characteristics of an object.

Because of the proximity of areas 17, 18 and 19 more than one area may be destroyed by the injury.

9 Lesions in the parietal lobe.

Area 39 lying anterior to area 19 in the angular gyrus of the parietal lobe has to do with interpretation of symbols combining recognition and revisualization (which are dealt with separately in areas 18 and 19).

Area 40 deals with mathematical figures and calculations. It is located in the supramarginal gyrus of the parietal lobes.

Areas 39 and 40 are said to be more dominant than areas 18 and 19.

10 Disturbances of higher psychic and association areas may also interfere with proper testing of the visual fields.

Some of the factors listed above are of practical importance and easily demonstrated. Those which deal with psychic and association functions are listed as of theoretical interest as our precise knowledge is too limited for practical clinical application. The opportunity for further study is with us today as never before because of the many service men who have survived a great variety of head injuries. It is to be hoped that Veterans Hospital staffs will follow these patients carefully with repeated neurological, neurosurgical, ophthalmological and finally with postmortem studies. When the injured brain is fixed and studied grossly and microscopically we can find the true extent of the lesions which resulted in visual field changes observed during life. This should settle many disputed points—but will do so only if our clinical notes are accurate and complete.

If this demonstration stimulates others by its inadequacies rather than by its excellence of detail its purpose will have been served.

#### CASE REPORTS

These cases were collected in conjunction with Dr J. N. Greear Jr. now in Washington D.C. and formerly Chief of Eye Section Valley Forge General Hospital.

CASE 1: This patient sustained a fracture of the left parietal and occipital bones with multiple depressed fragments of bone laceration of the dura and

while the lower portions of the retinas are represented below the calcarine fissure. Sectors adjacent to the vertical meridian of the retina are represented along the lips of this fissure while sectors to the sides of the horizontal meridians are projected in the depths of the fissure. The temporal crescents of the binocular fields are represented in the oral parts of the calcarine fissure.

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On the eighth day after injury a second craniotomy was done evacuating a subdural hematoma which was compressing the left occipital lobe by 1.5 centimeters. When the necrotic tissue of the brain was removed, a defect 3 centimeters deep remained. Then a clot was removed from the right occipital lobe whose cortex was largely liquefied. The neurosurgeon's operative note states, 'There was considerable damage to both occipital lobes thus accounting for the blindness. The damage however did not appear to me to destroy the calcarine area completely and it may be that after edema subsides vision may return, particularly in the upper fields.'

Three weeks after injury the patient had light perception. Vision gradually improved. Eight months later vision was right eye 20/40 J 6 and left eye 20/20 J 1.

Visual fields showed loss of all but the central one degree. The patient can read only one letter at a time, but he says he sees this clearly.

We have definite evidence of severe damage to both occipital lobes and a note that all of the calcarine area did not appear to be destroyed. There must be damage to the anterior portion of the calcarine areas, and undoubtedly to the optic radiations.

In these patients we must be on the lookout for hysteria or exaggeration of the field defect despite the genuine severe injury. That is they must have a large field defect due to injury but for some reason may show too much loss. A medical officer once told me of suspecting a patient with such a field of getting around too well. Under sodium amytal the patient confessed that he had a wider field but because of a personal problem he elected to show this limited field.

So far as we were able to ascertain 2 of our patients actually had this type of field. Similar cases have been described by Gordon Holmes and by Scarlett and Ingham after World War I. McDonald has described bilateral homonymous hemianopia due to bilateral occlusion of the calcarine arteries. A vertical strip of field was retained below the spared fixation area.

CASE 7 This patient showed field defects which are the antithesis of the last one. That is he has bilateral central scotomas with normal peripheral fields.

He was injured by shrapnel sustaining a depressed fracture of the occipital bone with multiple foreign bodies. The next day débridement of the wound was carried out. Three days later vision began to improve and did so for 2 months. Four months after injury the depressed fracture was elevated, pieces of bone and shrapnel were removed from the right occipital lobe. Both occipital lobes were found contused and degenerated, some of the cortex being replaced by xanthochromic scar tissue.

Vision was 20/200 J 0 eccentric in each eye. The peripheral fields were normal. The central fields showed bilateral central scotomas with most of the scotoma to the right of the midline. Injury to the cortex at the tip of both occipital lobes especially the left accounts for the field defect.

Gordon Holmes has shown a variety of homonymous central field defects, both unilateral and bilateral.

#### SUMMARY

A review of the anatomy of the visual pathways has been given.

The areas of the visual cortex representing all parts of the retina (or of the visual fields) have been pointed out.

An attempt has been made to show the difficulties encountered in studying the visual cortex.

Seven illustrative case reports are given.

It is hoped that Veterans Hospitals will compile extensive data on casualties of this type following through to postmortem examination as this is the only reliable method of determining the many things we do not know about cerebral functions. The opportunity is greater than ever before and we trust shall never be so great again.

#### REFERENCES

1. HOLMES, G. H., and LISTER, W. T. *Brain*, 1916 39 34.
2. HOLMES, G. H. *Brit. J. Ophthalm.*, 1918 2 253.
3. LYLE, D. J. *Neurophthalmology* Springfield Illinois Charles C. Thomas, 1945.
4. SCARLETT, H. W. and INGHAM, S. D. *Arch. Neur. Psychiat.* 1922 8 225.
5. TRAQUAIR, H. M. *An Introduction to Clinical Perimetry* 4th ed. London Henry Kimpton, 1942.
6. McDONALD, P. R. *Arch. Ophthalm.*, 1943, 29.

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The field defect was right homonymous hemianopsia with sparing of the fixation area and a portion of the right field adjacent to the vertical meridian. Visual acuity was 20/15 J<sub>1</sub> in each eye.

The site of injury data obtained at operation, plus the field defect indicate a lesion of the left occipital cortex, probably vascular in type. Sparing of fixation is due to the dual blood supply to the cortex.

**CASE 3** This patient sustained a severe compound comminuted fracture of both leaves of the occipital bone, with stellate fractures of both parietal bones. Multiple foreign bodies were seen at a depth of 5 to 6 centimeters in the left parieto-occipital area.

Craniotomy was performed the next day. Débridement left a 6 by 3 centimeter defect in the occipital bone. A hematoma and damaged tissue of the brain were removed. The foreign bodies were not removed from the left occipital lobe.

The patient was apparently blind for a period of 15 days, during which time both pupils reacted to light. He also showed sensory aphasia and generalized hyperreflexia. Bilateral papilledema was present for a considerable length of time before subsiding spontaneously.

Röntgenogram showed a 4 by 8 centimeter defect in the occipital bone more to the left side. Linear fractures radiated in all directions from this defect. Two large foreign bodies were present in the parietal lobe 9 centimeters above the mastoid bone.

The field defect was right homonymous hemianopsia with division or splitting of the fixation area. Visual acuity was right eye 20/70 plus 2 J<sub>1</sub> and left eye 20/100 plus 1 J<sub>1</sub>. Degenerative changes visible in the nerve heads and maculae, a result of prolonged papilledema account for the decreased acuity.

The information obtained at operation plus the field defect place this lesion in the left occipital cortex and deeper tissues of the brain. The sensory aphasia and hyperreflexia were due to damage to the parietal lobe.

**CASE 3** This patient sustained a penetrating wound of the skull and both occipital lobes by a shell fragment which entered the left occipital and came to rest in the right occipital lobe. The foreign body was removed and débridement carried out.

X-ray examination showed a large surgical defect involving the union and upper portion of the occipital bone—with fracture lines radiating into the left parietal bone and to both petrous pyramids.

Visual acuity was right eye ability to count fingers at 1 foot nasally and left eye at 3 feet temporally. There was conjugate deviation of the eyes to the right; pupils reacted to light; fundi were normal.

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age to the entire left visual cortex and to the tip of the right occipital lobe by the foreign body accounts for the field defect.

**CASE 4** This patient was struck by mortar shell fragments, sustaining a compound, comminuted fracture of the occipital bone with depressed fragments driven into right occipital lobe of brain.

Two days after injury craniotomy was done. The tip of the right occipital pole and the calcarine area were destroyed by the fragment of bone. The dura was torn on both sides of the midline. The longitudinal sinus was thrombosed. The patient was unconscious for 11 days. Examination on about the fourteenth day showed complete blindness lasting several more days. Later the patient showed homonymous hemianopsia by the confrontation method. The fundi were normal. Vision was reduced to ability to count fingers.

X-ray examination showed a 4.5 by 6 centimeter defect in the middle of the occipital bone with a stellate fracture extending into the right parietal bone.

The last field examination showed a left homonymous hemianopsia plus loss of part of the right lower quadrants of the field and involvement of both fixation areas. The field defect is explained by damage to the right calcarine area and tip of the right occipital lobe. The left occipital lobe must have been damaged above the calcarine fissure with injury to the tip of the occipital lobe or the central fibers beneath the cortex.

**CASE 5** This patient was injured in a plane crash sustaining a compound depressed skull fracture in the midoccipital region. Thirty-six hours later the depressed fracture was elevated. Two fragments just to the right of the midline were found 1.5 centimeters below the dura piercing the longitudinal sinus. A larger portion of the right leaf was pried outward into proper position. The dura was intact except at the longitudinal sinus. The field defect 4 weeks later was a left homonymous hemianopsia sparing the fixation area. Vision was 20/30 J<sub>1</sub> in each eye.

Four months later the field defect was a left homonymous lower quadrantanopsia with sparing of the fixation area. Vision had improved to right eye 20/15 J<sub>1</sub> and left eye 20/20 J<sub>1</sub>.

Here we know that the right occipital cortex was damaged. The improved fields are explained by recovery from edema or contusion of the cortex adjacent to the destroyed cortex.

**CASE 6** This is one of two patients with bilateral homonymous hemianopsia with sparing of the fixation area and retention of good central vision in each eye. This patient was injured by artillery shell fragments, sustaining a compound, depressed fracture of the left leaf of the occipital bone and several foreign bodies in the left frontal lobe of the brain.

On the day of injury the wound was débrided and the longitudinal sinus packed with muscle tissue to arrest bleeding. One week later the patient was completely blind had a bilateral papilledema but his pupils reacted to light.

On the eighth day after injury a craniotomy was done evacuating a subdural hematoma which was compressing the left occipital lobe by 3 centimeters. When the necrotic tissue had been removed a defect 3 centimeters in diameter was removed from the right hemisphere. The white matter was largely liquefied. The surgical operative note states: "There was considerable damage to both occipital lobes, the right lobe being the heavier. The damage however appeared to me to destroy the calcarine artery and a fist may be that all the fibers may return particularly in the upper part of the cortex. An area gradually improved but the left vision was right eye 2/40 J.C.N. 10/20 J.C.N."

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## REFERENCES

- HOLMES G. H., and LISTER W. T. Brain, 1916 39 34
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# THE FENESTRATION OPERATION

## An Evaluation of Its Present Status

GEORGE E. SHAMBAUGH, Jr., M.D., Chicago, Illinois

THE consensus of published reports indicates that the fenestration operation has taken its place as an accepted otologic procedure for certain cases of deafness due to otosclerosis. In evaluating the scope of usefulness of the operation at the present time there are 6 important questions that we should try to answer

- 1 Which patients should be operated upon?
- 2 Which technique yields the best results?
- 3 How does the hearing after operation compare with a hearing aid?
- 4 Can the operation arrest or prevent the nerve degeneration of otosclerosis with stapes ankylosis?
- 5 What are the risks?
- 6 How permanent are the hearing improvements?

### WHICH PATIENTS SHOULD BE OPERATED UPON

The first question of which patients should be operated upon has been discussed in the literature by a number of otologists with general agreement except on one point. Otologists who have had experience with the fenestration operation agree that the external and middle ear should be free from any active or recent inflammation that the eustachian tubes should be normally patent and that the drum membrane should be intact. They also agree that the ideal patient for operation has a stapes fixation with normal cochlear function as evidenced by the masked bone conduction audiogram within normal limits for the speech frequencies, with an air conduction audiogram averaging 40 decibels or more loss for the speech frequencies (Fig 1). The point of disagreement lies with those patients who cannot be classed as ideal because one or more of the speech frequencies by bone conduction is be-

low the normal range. Should the operation be refused these patients as some have advised or should the otologist consent to operate if the patient clearly understands that he cannot expect to attain the 30 decibel practical level?

Last spring the American Society for the Hard of Hearing through Dr. Fowler mailed out to its members who had had the fenestration operation the following questionnaire (Fig 2). To aid this evaluation of the operation from the patient's viewpoint two copies of the questionnaire were sent to each of my patients operated upon since I began this work 8½ years ago with the request that one copy be mailed to the American Society for the Hard of Hearing in Washington and the second copy be mailed to the Chicago society. Through the gracious co-operation of the Chicago society I have been able to study these replies.

Before presenting the results of this inquiry let me make it perfectly clear that I am fully aware of the errors inherent in any such attempt to evaluate a medical procedure, for patients are notoriously prone to psychological reactions that may distort their judgment concerning the value and results of any therapy. Nevertheless, it would be a mistake to disregard entirely the patient's subjective evaluation of his operation provided we also insist upon objective audiometric proof of a sustained hearing improvement.

A total of 853 patients operated upon by me were mailed the questionnaire, and 623 replies were received. These were divided into 5 groups.

Group I. Operation successful in all respects; hearing has remained improved; family regards operation warranted in view of the results; the patient does not now wear a hearing aid; the patient would have the operation performed again were he to experience the same results.

From the Northwestern University Medical School.  
Presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-30, 1946.

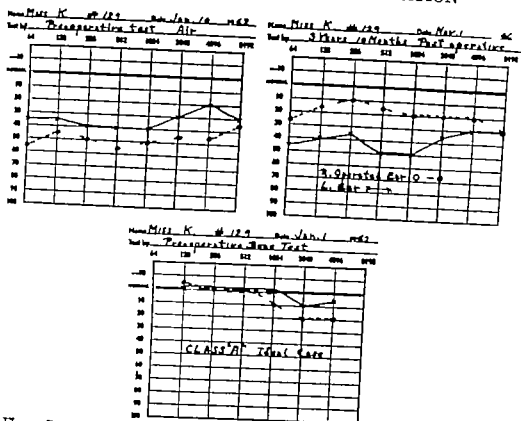


Fig. 1. Preoperative air and bone audiograms on a patient classed as ideal for operation, and postoperative air audiogram.

Group II Operation successful in that family regards it warranted by the results and patient would have it performed again for the same results but a hearing aid is still worn on certain occasions

Group III. Family regards operation as not warranted by the results but patient would

- Name
- Date of fenestration operation
- By whom performed?
- State of hearing immediately before and following the operation audiogram if available
- State of hearing one year following operation audiogram if available
- State of hearing at present time audiogram if available
- Effect on hearing for conversation (Better \_\_\_\_\_ No change \_\_\_\_\_ Worse \_\_\_\_\_)
- What is the opinion of your family in regard to the operation? In view of the results was it warranted? Yes \_\_\_\_\_ No \_\_\_\_\_
- Do you still use a hearing aid? Yes \_\_\_\_\_ No \_\_\_\_\_
- Would you have the operation performed again if you were to experience the same results? Yes \_\_\_\_\_ No \_\_\_\_\_
- Will you please add any other comments you believe might be helpful to others contemplating the operation

Fig. 2. Questionnaire sent to patients who had had the fenestration operation.

have it performed again were he to experience the same results and he does not now wear a hearing aid

Group IV Too soon after operation to be able to answer all of the questions

Group V Failure Patient would not have the operation performed again were he to experience the same results

Of the 623 replies 516 or 82.8 per cent regard the operation as successful in all respects 25 or 4 per cent regard it as successful, but still use a hearing aid at times 7 or 1 per cent regard it as successful but the family is doubtful 8 or 1 per cent wish to wait a while longer before committing themselves 66 or 10.6 per cent regard the results as a failure (Table I)

TABLE I.—REPLIES TO QUESTIONNAIRE RECEIVED FROM PATIENTS WHO HAD HAD FENESTRATION OPERATION

	Replies	Percentage of total
Group I (Successful)	516	82.8%
Group II (Partial Success)	25	4%
Group III (Partial Success)	7	1%
Group IV (Undecided)	8	1%
Group V (Failure)	66	10.6%

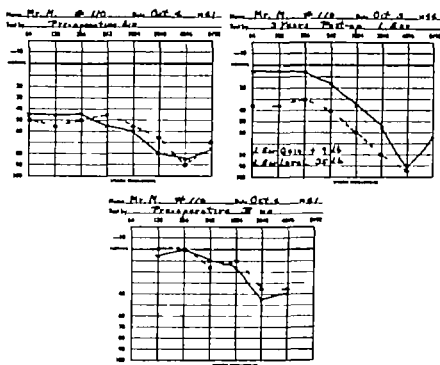


Fig. 3. Preoperative air and bone audiograms and postoperative air audiogram on patient who regards the operation as successful but whose hearing did not reach the 30 decibel practical level.

When we study the individual patients who regard the operation as successful in all respects (Group I) we find that 303 of the 516 reached the 30 decibel practical level as a result of the operation 71 more were within 5 decibels of the practical level while 142 have a loss of more than 35 decibels for the speech frequencies. How can these patients regard the operation as successful? The answer is that many of them gained so much for the lower frequencies that they can compensate in part for their relatively poor hearing for the speech frequencies (Fig. 3). Others were so profoundly deafened before operation that the improvement has been of great practical value even though it failed to bring them to the 30 decibel level of practical hearing. In other words the number of decibels that a patient gains is important to him, as well as the final hearing level that he attains.

The second group is also of interest. These patients regard the operation as successful but they still use a hearing aid at times (Fig. 4). Here again we have patients with a profound preoperative loss, some of whom were unable to wear a hearing aid because of their pro-

found loss, but who now obtain very good results with a hearing aid and therefore regard the operation as worthwhile. Many of these patients state that the hearing results from the operation far exceeded their expectations.

From our experience and observation we believe that the fenestration operation has 2 important fields of usefulness: first in patients with stapes fixation and normal hearing by bone conduction where we have a good chance of restoring practical hearing and second in patients who are profoundly deafened and show beginning nerve degeneration where we cannot expect to bring the hearing to the practical level but where with a definitely guarded prognosis, the patient will usually gain enough hearing to regard the operation as very much worthwhile.

The following classification of cases for operation is suggested:

**Class A.** Ideal Normal hearing by bone for speech frequencies. Prognosis 8 in 10 chances of a permanent hearing improvement within the 30 decibel practical level (Fig. 1).

**Class B.** Suitable but not ideal Normal hearing by bone except for one of the speech

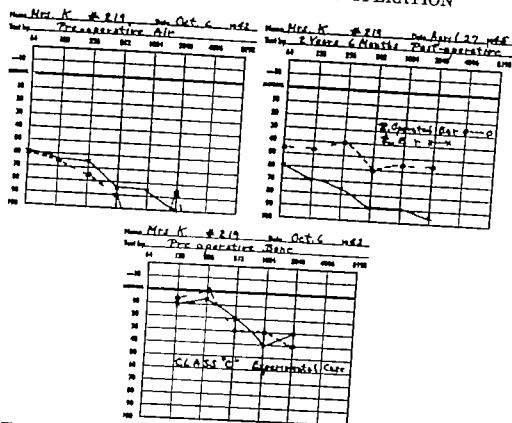


Fig. 4. Preoperative and postoperative audiograms on a patient who regards the operation as successful because she can now wear a hearing aid with excellent results and before operation she could not use a hearing aid because of the profound hearing loss.

frequencies that shows a loss of 30 decibels or more. Prognosis 50-50 chance of sufficient gain to do without a hearing aid (Fig 5)

**Class C Experimental** Two or more of the speech frequencies show a 30 decibel or greater loss by bone, but the Rinne test for the 1024 fork is negative. Prognosis A remote 1 in 10 chance of sufficient improvement to give practical hearing without an aid (Fig 6)

**Class D Unsuitable** due to incomplete stapes fixation or to profound nerve degeneration. Prognosis Operation contraindicated

In all cases in which there is a substantial difference to the patient in the useful hearing in the two ears the poorer hearing ear should be selected for operation. If the poorer hearing ear falls in class B and the better ear in class A the poorer ear should still be operated upon first, and if the operation is successful making this the better ear the second ear may then be operated. As long as the fenestration operation has a chance of making the hearing in the ear operated upon permanently worse we are not justified in risking the patient's better hearing ear. If we cannot always improve the hearing

by the fenestration operation at least we shall not be destroying the patient's useful hearing.

The bone conduction audiogram should always be made with adequate masking of the opposite ear.

In selecting cases for operation the tuning fork tests are a valuable adjunct to the air and bone audiograms. These four tuning fork tests are particularly helpful.

1 If the patient cannot hear the 64 fork at maximum intensity close to the ear the stapes may be regarded as completely ankylosed. If the 64 fork is audible by air at moderate intensity the stapes fixation is only partial and the fenestration operation is not indicated because there is too little to be gained. Later in the disease when the stapes is more completely fixed and the 64 fork is scarcely heard at maximum intensity or is not heard at all by air the operation may become indicated.

2 If the Rinne test with the 1024 fork is negative using masking of the opposite ear the hearing should be improved by the operation even though the patient is a B or C case.

3 If the Rinne test with the 512 fork using masking is positive the stapes fixation is only slight and operation is contraindicated

4 If the 2048 fork is not heard by bone using masking the prognosis is very poor and the patient should be considered a C or D case even with normal hearing by bone for the 512 and 1024 frequencies.

The otologist who is beginning this work will do well to confine his operations to class A cases. As his experience increases and his results improve he may consent to operate on class B cases, but only after the patient clearly understands the definitely limited prognosis. Class C cases are better not operated upon and if possible should be persuaded to wear a hearing aid

#### WHICH TECHNIQUE YIELDS BEST RESULTS

The second question that we should answer in evaluating the present status of the fenestration operation is Which technique yields the best results? This question cannot be answered until accurate statistics are available on the results obtained by the various techniques that have and are being used. It is our belief that the future rapid advancement of the surgical treatment of otosclerosis depends more than anything else upon the complete and accurate reporting of results by all otologists who advocate a new technique. There is no other way by which we may judge the relative merits of different techniques and there is no other way to protect ourselves and our patients from the hasty adoption of a new but inferior technique on the basis of vague misleading incomplete or hasty reports. So important to the future of this work is this question that I wish to devote part of this paper to a consideration of statistical studies as they apply to the fenestration operation

A few years ago a group of otologists interested in the fenestration operation agreed to contribute their records for statistical analysis to compare the results obtained by different techniques. This co-operative undertaking soon proved unsuccessful because of the failure of some to contribute their records. I should like to propose that some larger organization with authority and prestige such as the American Otological Society or the

American College of Surgeons undertake an impartial study and investigation of results obtained by different fenestration techniques.

The surgical treatment of otosclerosis lends itself ideally to a statistical analysis of results because we can measure these results objectively in terms of decibels. First a uniform method of making audiometric tests and of keeping records should be recommended. Second there should be an impartial periodic spotcheck of the records and audiometric tests of each otologist to insure sufficient uniformity and reliability of records and statistics. Third, methods of statistical analysis and interpretation of results should be agreed upon and, fourth a periodic, perhaps annual publication of the results obtained by different surgical techniques will permit an accurate and scientific evaluation of their relative merits.

To encourage such a program to further the improvement and development of the surgical treatment of otosclerosis along scientific lines, my associate, Dr. Juers, and I offer to provide every facility for an impartial study and analysis of our records and results on all of our patients operated upon since we began this work 8½ years ago. The system that we have used for keeping our records and for tabulating our results has proved satisfactory for our own purposes in comparing our own results as we have modified the operation from time to time. This system might be applicable to the larger study that we propose.

To minimize the apparent hearing improvement between the first audiometric test and subsequent tests due to the patient learning how to respond to this examination the preoperative hearing level is determined by 3 preoperative tests made on different days except in rare cases in which patients come from distant places and only 2 preoperative tests may be secured. The threshold of hearing for 512, 1024, and 2048 cycles from the three preoperative audiograms is averaged as the preoperative hearing loss for the speech frequencies. After operation the patient's hearing is tested at approximately 2, 4, and 6 weeks, and 3 months, 6 months, and 1 year after operation, and at least once a year thereafter for the rest of that patient's life. When the patient has come from afar it may be impossible to re-





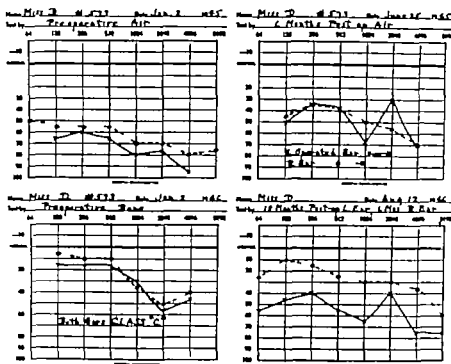


Fig. 6. Preoperative and postoperative audiograms on patient classed as an experimental candidate for the fenestration operation.

bels gained for the speech frequencies with the time after operation of this test and the most recent hearing result with the decibels gained or lost for the speech frequencies the time after operation of this test, and the final hearing level. Every time a patient returns for an audiogram the strip with the above data is replaced with a new strip incorporating his latest test. To facilitate a statistical calculation of results colored indicators are used as follows:

Orange Hearing worse (loss of more than 10 decibels for speech frequencies)

Yellow Hearing unchanged (within 10 decibels of preoperative level)

Green Hearing improved but improvement subsequently lost.

White Hearing gain of 10 to 30 decibels for speech frequencies.

Blue Greater than average gain of 30 to 40 decibels.

Purple Exceptionally great hearing improvement of more than 40 decibels for the speech frequencies.

Pink Hearing within the 30 decibel level

Red Hearing within the 20 decibel level.

By means of these colored indicators one may find at a glance the percentage of good and bad results in the 90 cases tabulated on each board. A change of 1 decibel in a patient's audiogram may shift the result from one classification to another and since repeated audiometric tests always show a fluctuation of a few decibels any statistical calculation will fluctuate slightly from month to month. The general average however remains approximately constant with a given technique.

Until statistical material such as I have described becomes available on all techniques, we cannot answer the important question of which one gives the best results. We can only present our own data and hope that others do likewise. We invite any of you to check our records, our scoreboards, and to examine our cases at any time.

The technique which we are using at Northwestern University Medical School has been described recently in the literature. Briefly it makes use of the Lempert nov-ovalis fenestration operation with the addition of certain features to inhibit osteogenesis. These are

TABLE II.—AUDIOMETRIC RECORD CARD FOR PATIENTS WHO HAVE THE FENESTRATION OPERATION

Name Mrs CVM										Right ea		Date / /		Age y		Left ear				
Date	64	32	36	51	4	3043	4096	80	A average for speech	Change for speech	64	32	36	51	4	3043	4096	80	A average for speech	Change for speech
1/22/40	30	45	50	55	60	50	65	75	55		4	35	4	50	30	5	65	75	50	
1/29/40	35	50	55	60	70	45	70	80	58		40	35	45	50	50	30	65	75	50	
2/7/40	50	40	50	60	60	50	65	70	57		35	30	45	55	50	50	65	75	50	
3/13/40	Times	ratio	Ratio	Ratio	(La rt 3)				(57)										(50)	
3/25/40	35	30	40	45	35	5	70	75	5	+ 5	40	30	45	5	5	45	80	75	48	+ 4
4/8/40	30	5	35	45	35		65		10	+ 7	4	30	40	5	5	45	65		48	+ 4
4/14/40	30	5	35	45	35	5	70		5	+ 5	40	35	45	5	50	50	70	75	50	
4/20/40	40	35	40	45	50	5	70		17	+ 20	40	30	4	50	50	50	70	75	50	
5/4/40	30	30	30	40	40		60		30	+	35	35	40	50	50	45	60	75	48	+ 3
5/18/40	35	30	30	35	40	5	60		30	+ 7	40	35	40	50	50	50	7	80	50	
5/13/40	40	30	35	45	45	5	60	(could)		+	4	40	45	50	50	50	45	75	48	+
6/20/40	35	40	35	45	45	5	65	75	15	+	40	30	40	45	45	45	55	75	48	+ 3
7/15/40	35	5	30	35	40	30	55	80	1	+	40	35	5	45	50	50	65		48	+ 3
8/1/40	35	30	35	45	4	30	60		1	+	40	35	4	50	30	30	65	75	50	
8/13/40	30	20	20	5	30	5	70		3	+ 11	45	30	40	45	5	45	80		47	+ 3
8/21/40		40	5	30	30	5	65		5	+ 33		35	4	45	45	45	60	80	45	+ 5
10/1/40		5	20	35	35	20	60		30	+ 7		35	45	45	45	30	70		47	+ 3
10/1/40	30	20	30	5	3	20	60		1	+ 3	35	30	40	45	45	45	80		45	+ 3
1/31/40	30	20	5	30	30	5	60		5	+ 5	30	20	35	45	50	45	80		47	+ 1
1/23/40	5	5	30	10	10	5	60		5	+ 5	30	5	35	45	45	30	60		47	+ 1

1 Enchondralization of the fenestra. By this we mean exposing the osteogenetically inert enchondral layer of the bony labyrinthine capsule as widely as possible beyond the margins of the fenestra. This is accomplished by removing the osteogenetically more active perosteal layer leaving the fenestra on top of a dome shaped mound

2 Scrupulous removal of all bone chips and bone dust particles from the region of the fenestra by means of (a) the use of continuous irrigation while making the fenestra, (b) careful search with the binocular loupe for bone chips on the perosteal surface of the tympanomeatal skin flap (c) the use of adequate magnification with the binocular microscope to remove the endosteum with its adherent bone particles from the mouth of the fenestra.

3 Avoidance of trauma to the endosteum within the margins of the fenestra, by using

adequate magnification with the binocular operating microscope while removing the endosteum from the mouth of the fenestra.

4 Thorough burnishing of the bone around the fenestra with the 14 karat hard gold burnishing burr

5 Avoidance of bleeding into the perilymph space by (a) strictly local anesthesia, (b) continuous irrigation (c) reinspection of the fistula after the flap has been in place for a short time to be sure there is no active bleeding under the flap at the completion of the operation

During the past year the technique developed by us at Northwestern University has incorporated 2 features to decrease cochlear damage from postoperative serous labyrinthitis (1) elastic absorbent sponge packs kept under continuous pressure against the tympanomeatal skin flap for 6 days, (2) immobili-

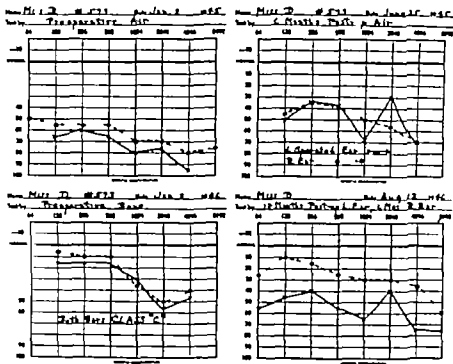


Fig 6 Preoperative and postoperative audiograms on a patient classed as a experimental candidate for the fenestration operation.

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1/20/40	90	45	50	55	60	50	65	75	55			40	35	4	50	50	50	65	75	50			
1/26/40	55	30	55	60	70	45	70	80	58			40	35	45	50	50	50	65	75	50			
3/7/40	50	40	50	60	60	50	65	70	57			15	30	45	55	5	50	65	75	50			
3/13/40	Fenestration Ratio (Left 35)								(57)												(50)		
3/16/40	35	30	40	45	35	5	70	75	5	+ 3		40	30	45	5	50	45	80	75	48	+		
4/2/40	30	5	35	45	35		65		5	+ 7		4	30	40	50	5	45	65		48	+ 3		
4/16/40	30	5	55	45	35	5	70		5	+ 5		40	35	45	50	50	50	70	75	50			
4/20/40	40	35	40	45	50	5	70		7	+ 20		50	40	50	5	5	70	75	50				
5/15/40	30	30	30	4	40		60		30	+ 7		15	35	40	50	80	45	60	75	48	+ 3		
5/18/40	35	30	30	35	4	5	60		30	+ 7		4	35	40	50	50	50	70	80	50			
5/18/40	40	30	35	45	45	5	60	(co id)	5	+		4	40	45	50	50	50	45	75	48	+		
6/30/40	35	30	35	45	45	5	65	75	15	+		4	30	40	45	45	45	55	75	45	+ 5		
7/26/40	25	5	30	35	40	20	55	80	5	+ 5		40	35	45	45	50	50	65		48	+		
8/10/40	35	50	35	45	40	20	60		5	+		40	35	40	30	30	30	65	75	50			
8/13/40	30	30	30	5	30	5	70		5	+ 14		45	30	40	45	50	45	80		47	+ 3		
9/21/40		30	5	30	30	5	65		5	+ 35		35	40	45	45	45	60	80	45	+ 5			
10/1/40		5	30	35	35	20	60		30	+ 7		35	45	45	45	50	70		47	+ 3			
10/20/40	30	30	30	5	5	20	60		5	+ 3		35	30	40	45	45	45	80		45	+ 5		
11/1/40	30	20	5	30	30	5	60		5	+ 3		30	30	35	45	50	45	80		47	+ 1		
12/1/40	5	5	30	30	30	5	60		5	+ 3		30	5	35	45	45	30	60		47	+ 1		

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TABLE III.—STATISTICS ON 415 CASES TESTED 2 YEARS OR MORE AFTER OPERATION

(Nov-Ovals with Enchondralization Irrigation and Microscope)

	No	Per cent
No change	8	4.3
Further loss	7	7
Improved more than   decibels	300	94
Gain subsequently lost		2.9
Gain partly lost	5	3.6
Gain fully maintained	303	87.5

## Breakdown of 300 Cases Improved

Gain subsequently lost		3
Gain partly lost	5	3.8
Hearing fully maintained		
Total	303	93
+ to +9 decibels	58	4.7
+10 to +20 decibels	26	3.3
More than +20 decibels	79	45.9
30 decibels practical level	197	50.5

Statistical analysis of probably permanent hearing results in all patients operated upon by the Northwestern University improved fenestration technique.

zation of the cochlea for 6 days by a head frame to prevent it from being dependent to the fistula.

With this technique the incidence of bony closures has been reduced to less than 5 per cent of cases tested 2 years or more after operation (Table III). During the past year the incidence of postoperative serous labyrinthitis has been materially reduced (Table IV) with a definite gain in the hearing results. The final results with the sponge and head-frame technique must await the passage of at least 2 years.

## HOW DOES THE HEARING AFTER OPERATION COMPARE WITH A HEARING AID?

The third question is: How does the operation compare with a hearing aid? One otologist stated that a hearing aid will do as much or more for the hearing without the discomforts, risks, uncertainties and expense of surgery. However, we have found that many patients who have had the fenestration operation and who regard the results as satisfactory assert without qualification that they hear better now than they did with their aid, and without the distortion, the nuisance and the upkeep expense of an aid. One patient writes: "The ear phone is a poor substitute for normal hearing." If this seems too obvious a statement, it

TABLE IV.—STATISTICAL ANALYSIS OF 300 CASES IN WHICH PATIENTS WERE OPERATED UPON BY THE IMPROVED FENESTRATION TECHNIQUE INCLUDING FEATURES TO DECREASE POSTOPERATIVE SEROUS LABYRINTHITIS

January 1916 to September 1946

	N of cases	30 db practical level	Average age at operation	Improved 10 db or more	Unchanged less than 10 db	Worse 10 db or more
Class A ideal	83	63.6%	28 db	66.3%	3.7%	3%
Class B guarded prognosis	6	26.6%	30 db	66.6%	3.3%	6%
Class C experimental	11	8.1%	30 db	63.6%	18.1%	0%
Total cases	300	64.7%		63.7%	7%	7%

is only that I who have been through the looking glass of the distorted and undistorted reflection can hardly believe my ear now that it has been given back to me.

To try to compare a hearing aid with the operation by objective tests, 3 years ago we carried out speech reception tests in terms of decibels on patients with their hearing aid before operation and without their aid after operation. Even in cases in which the post-operative hearing did not reach the 30 decibel practical level we found that 7 patients who received a gain of more than 20 decibels for the speech frequencies understood speech better after the operation than they could before with their hearing aid. These tests may not have been entirely fair to the hearing aid however since a patient about to undergo the operation is not likely to invest in a new improved hearing aid. Further and more exact studies of this sort are now being made by Dr. Carhart of the Northwestern University School of Speech. The patients are being tested before operation with a well fitted hearing aid and the hearing for speech compared with the hearing after operation.

## CAN OPERATION ARREST OR PREVENT THE NERVE DEGENERATION OF OTOSCLEROSIS WITH STAPES ANKYLOSIS?

The fourth question concerns the effect of the operation, if any, on the nerve degeneration of otosclerosis. This very important ques-

tion we cannot as yet answer with certainty. We can, however, make the following statements:

In cases followed for 5, 6 and 7 years after operation, where the fenestra remains open with a sustained hearing improvement further nerve degeneration in the ear operated upon has rarely been observed even when nerve degeneration had already begun at the time of operation.

When the fistula has closed with loss of the hearing improvement, nerve degeneration in the ear operated upon has continued to progress.

In a few cases with definitely progressive nerve degeneration in the ear not operated upon the ear operated upon has failed to show any evidence of further nerve degeneration.

We have reason to hope therefore that the fenestration operation may in some as yet unexplained way, arrest or prevent the second or any nerve degeneration of stapes ankylosis at least in some cases. The final answer to this important question must await further observations on a large number of patients successfully operated upon over another 5 to 10 years.

#### WHAT ARE THE RISKS?

The fifth question of the risks of the fenestration operation can be answered as follows. In more than 1300 consecutive fenestration operations plus 39 revisions carried out by myself and my associate, Dr. Juers, we have had no deaths and no serious infections.

The most frequent complication is transient facial paralysis coming on about 1 week after operation with complete recovery a few weeks later. This paralysis has occurred in 3 per cent of our operations. In 3 cases recovery was in complete after 1 year but in no case did a complete paralysis remain.

Femoral phlebitis occurred in 4 patients during the first 2 weeks after operation with a pulmonary embolus in one. All recovered. To prevent this complication active and passive leg exercises are now a routine procedure in all cases.

Postoperative pulmonary atelectasis occurred after one of the early operations in which ether was used (Case 15). The patient recovered.

Schizophrenia probably incipient before operation became manifest after operation in one of the early cases (Case 23).

The chief danger of the operation is permanent damage to the labyrinth and particularly to the cochlea with persistent dizziness or with permanent depression of hearing below the preoperative level.

Dizziness sufficient to be annoying as a rule clears up within a few weeks. Rarely it lasts as long as 2 years. In only 1 case has it lasted more than 2 years; this patient complains of persistent ataxia and unsteadiness while walking  $2\frac{1}{2}$  years after operation.

Permanent depression of hearing below the preoperative level has occurred to date in 37 operations (2.9 per cent of all patients operated upon) and in 1 of the 39 revisions.

#### HOW PERMANENT ARE THE HEARING IMPROVEMENTS?

The last question to be answered in evaluating the usefulness of the fenestration operation concerns the permanency of the hearing improvements.

Otologists who opposed the fenestration operation in its early stages of development did so on the grounds that the hearing improvements would never last because sooner or later bony closure of the fenestra would surely occur. As the result of animal experimentation and of clinical observation in many patients successfully operated upon and followed for more than 5 years we may now affirm what we previously hoped and that is that once healing has become complete osteogenesis tending to close the fistula ceases and a fistula still open may be expected to remain open permanently. In the monkey healing is complete and active osteogenesis has virtually ceased 3 or 4 months after operation in most cases. In the human bony closure occurs mostly during the first postoperative year occasionally during the second postoperative year and almost never later than 2 years after operation. A hearing improvement maintained for 2 years after the fenestration operation may be regarded as almost certainly permanent. Study of the hearing of patients successfully operated upon and followed for 5 years or longer shows how the improvement is

generally maintained without significant variations year after year. In some cases the greatest hearing improvement occurred 6 months after operation with subsequent hearing tests slightly lower indicating partial narrowing of the fenestra. After the second year however osteogenesis has ceased and the hearing improvement is maintained at a stationary level.

The ultimate fate of the hearing improvements 10, 20 and 30 years after the fenestration operation must await the passage of time. From our experience to date we are justified I believe, in assuming that the 2 year hearing results are permanent.

An evaluation of the fenestration operation includes a consideration of its limitations and shortcomings.

First, there is the fact known to all otologists but unfortunately not stressed in lay articles, such as appeared in *Hygeia* and the *Reader's Digest* that the fenestration operation virtually never restores the hearing to normal. The operation may be expected to restore about half the hearing that has been lost, provided the patient is suitable for operation.

Second, the results of the operation in any case continue to be unpredictable. With the best of preoperative indications, and the best of operative techniques failures still occur in some cases.

Third, the fenestration operation is technically difficult to learn and its results will vary more with the skill and experience of the individual surgeon than do most operations. The question of training and perhaps certifying fenestration surgeons is a difficult problem that needs attention.

Finally the fenestration operation is a strictly elective procedure. A hearing aid may always be resorted to in cases which are not

suitable or in which surgery is hazardous on account of age, health, or nervous instability.

#### CONCLUSIONS

In our evaluation of the present status of the fenestration operation we have sought answers to 6 questions, as follows:

1. The operation is useful in two types of cases. The ideal case with stapes ankylosis and normal cochlear function where we may expect to restore practical hearing, the suitable, but not ideal case with stapes ankylosis and slightly impaired cochlear function where we may hope to gain enough hearing so that the patient can go without his hearing aid.

2. The judgment as to which technique is the best must await the publication of adequate detailed statistical data. The results obtained by us with the technique developed at Northwestern University Medical School are presented.

3. Subjectively most patients prefer the hearing after operation to a hearing aid and 82 per cent of cases operated upon by us regard the operation as successful and do not use a hearing aid. Preliminary objective tests seem to confirm the fact that patients who experience an average improvement generally understand speech better than they did with their aid before operation.

4. There is evidence that a successful fenestration operation may arrest or delay the nerve degeneration of otosclerosis in some cases but it is too early to be certain of this.

5. With a meticulous aseptic technique the risks of the fenestration operation have proved to be minimal. The chief risks are to the facial nerve and to the labyrinth.

6. The 2 year hearing results of the fenestration operation may be regarded as the permanent hearing results.

# THE USE OF RADIUM IN THE TREATMENT OF CONDUCTIVE DEAFNESS

JOHN E. BORDLEY M D Baltimore, Maryland

**I**RRADIATION of the nasopharynx with radium or with radon is effective in the treatment of that type of conductive deafness which is due to obstruction of the pharyngeal end of the eustachian tube by lymphoid tissue. It is not effective in the treatment of other forms of deafness. This treatment is more effective when instituted early before inflammatory reactions and infections of the mucosa of the middle ear have progressed to the stage of fibrous fixation of the ossicles.

Persons with conductive deafness whatever the cause, hear better by bone conduction than by air conduction (i.e. the Rinne test is negative) and they usually have good hearing by bone conduction. The impairment shown by means of the air conduction audiogram may be essentially flat or may be considerably 'tilted' in the high or in the low tone ranges.

Conductive deafness results from any condition that seriously interferes with the transmission of air borne sound waves to the inner ear. The common causes of conductive deafness are lesions that interfere with normal movements of the middle-ear ossicles. On the basis of pathology three subdivisions may be made of the common lesions that interfere with ossicular mobility. The first is ankylosis of the footplate of the stapes by otosclerosis (Fig. 1) this is an irreversible lesion. The second is fibrosis of the mucosa of the middle ear to such an extent that normal movements of the ossicles are prevented by dense fibrous adhesions (Fig. 2) such lesions also are irreversible. The third common type of lesion the one present during the early period of tubal obstruction is reversible and is the one that can effectively be treated by irradiation of the nasopharynx.

The essential difference between the third type of lesion and the second type is the structure of the mucosal thickenings that interfere with ossicular movements. In tubal occlusion the mucosa is edematous and hyperemic, due to the negative pressure in the middle ear caused by lack of replacement of the air absorbed by the moist walls of the closed cavity. Only after the condition has persisted for a long time and has been aggravated by repeated low grade infections does fibrosis of the edematous mucosa occur to a degree sufficient to interfere permanently with ossicular movements. So long as the thickening of the mucosa is primarily edematous the lesion is reversible if normal aeration of the middle ear can be restored.

Unfortunately it is not possible to present sections of ears which have received irradiations for conductive deafness, because none of our patients has come to autopsy. The next two illustrations, however show what takes place in ears where there has been such failure in function of the eustachian tube. The first section (Fig. 3) is from the ear of a patient who had repeated attacks of otitis media and deafness. At the time of death her hearing was within normal limits. Her tympanic membranes were scarred and retracted and as the sections show the middle ear has a greatly thickened tympanic membrane and the mucous membranes are thickened and infiltrated with inflammatory cells. The second section (Fig. 4) is from a 16 year old boy with normal hearing. Otoscopic examination showed marked retraction of the tympanic membrane. The sections illustrate minimal changes with some thickening of the tympanic membrane and definite thickening of the mucous membranes of the middle ear especially over the promontory. Neither of these cases shows irreversible changes around the ossicular chain. It is quite easy to visualize how the first case could develop deafness when further

From the Otolaryngological Laboratory of the Johns Hopkins University School of Medicine.  
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generally maintained without significant variations year after year. In some cases the greatest hearing improvement occurred 6 months after operation with subsequent hearing tests slightly lower indicating partial narrowing of the fenestra. After the second year however osteogenesis has ceased and the hearing improvement is maintained at a stationary level.

The ultimate fate of the hearing improvements 10, 20 and 30 years after the fenestration operation must await the passage of time. From our experience to date we are justified I believe, in assuming that the 2 year hearing results are permanent.

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swelling took place and secretions became backed up into the tympanic cavity.

The selection of patients suitable for treatment with radium can only be done with any accuracy by taking into consideration the history, the otoscopic examination, the nasopharyngoscopic examination and hearing tests. A very careful history must be taken. Fluctuating hearing and hearing much affected by upper respiratory tract infections or by changes in altitude or humidity are some of the common symptoms. Occasionally there is a history of frequent attacks of otitis media or a feeling of fullness in the ears. These symptoms are not necessarily bilateral. There does not have to be a history of mouth breathing. The deafness is usually progressive over a long period of time in spite of its fluctuations. The otoscopic examination may reveal a slightly thickened and retracted tympanic membrane, some retraction of Shrapnell's membrane, and a fluid level or the chicken wire appearance of mucous bubbles behind the tympanic membrane. The nasopharyngoscopic examination most frequently reveals hypertrophied lymphoid tissue in the fossa of Rosenmueller and around the eustachian orifice. Figure 5 illustrates a normal eustachian orifice which can be compared with one covered by such an overgrowth of lymphoid tissue (4). Occasionally very little more than congestion or mucoid discharge can be seen around the orifice. Hearing tests made with the audiometer and tuning forks are necessary to establish the diagnosis of conductive deafness. The audiograms usually contribute very little toward a differential diagnosis except in those few early cases which show an exaggerated high tone loss superimposed on the usual flat loss. About half of our patients show equivocal or just negative Rinne tests, with a 512 d v tuning fork.

Radium emanations are employed in the nasopharynx to reduce the amount of lymphoid tissue and combat the chronic infections involving the pharyngeal end of the eustachian tube (1). It is this tissue which acts as a focus of infection pointing toward the middle ear and likewise acts as a mechanical obstruction to the proper drainage and aeration of the middle ear. The backing up of infected secre-

tions into the middle ear results in a low-grade inflammation with edema of the membranes and excessive secretions. In time, this obstruction of the tube builds up a negative pressure within the tympanic cavity and causes retraction of the tympanic membrane. Such changes result in interference to the normal movement of the ossicles and a conductive type of hearing loss. Such conditions, if allowed to persist, lead to the formation of scar tissue and a permanent limitation of ossicular movement. The nasopharynx, then, is the danger spot that must be treated to relieve the symptoms of reversible conductive deafness. It is just as important to clear up the infection as to remove the mass of the tissue itself. Use of antibiotics in conjunction with irradiation is definitely indicated in some cases. Radium has been chosen by our clinic, first, because as Helneke showed in 1905 lymphoid tissue is highly sensitive to irradiation and second, because it offers a means of applying such rays locally in high concentrations without first passing them through normal surrounding tissues in which many of them will be absorbed. Thus the maximum dose can be delivered at the desired point and the possibility of injuring surrounding structures reduced. The action of radium is on the germinal centers of the lymphoid tissue. Also Burnam in a personal communication states that radium has a powerfully destructive effect upon the bacteria growing within this tissue.

To obtain maximum results, it has usually been necessary to administer repeated treatments with radium. We now use a series of three irradiations spaced 2 weeks apart. The dose used is calculated at 25,000 milligram seconds for the standard monel metal Army applicator or 17,000 millicurie seconds for the stainless steel radon gas applicator made by the Kelly Clinic. This difference in the calculated doses is due to the larger proportion of  $\beta$  rays that pass through the stainless steel. Both applicators are applied by simply inserting them along the floor of the nostril into the nasopharynx in close proximity to the eustachian orifice. Thousands of irradiations have been given in our clinic with no single serious reaction. Likewise, no serious reaction followed any of the 14,000 treatments given in the





Fig. 3. Section showing fibrosis around the ossicles, a thickened tympanic membrane, and edema of the mucous membranes of the middle ear. This section is from a 37 year old woman with history of reversible conductive deafness but with normal hearing at death.



Fig. 4. The middle ear of a 6 year old boy showing thickened mucous membranes over the promontory and slight fibrous thickening of the tympanic membrane. The hearing was normal when it was tested during his final illness.

tually able to determine this, the incidence of good results will show a marked increase.

Two cases have been chosen to illustrate reversible conductive deafness and what may happen when irradiation therapy is given. The first case (Fig. 6) is a boy aged 9, one of identical twins, who had begun to fail in school and who had a speech defect. He was thought to be mentally defective. His identical twin was leading the first division of this child's class. This child had had two adenoidecto-



Fig. 5. Photographs made through nasopharyngoscope showing, left, a normal eustachian orifice and, right, a eustachian orifice overgrown with lymphoid tissue. (From Hendricks and Lieberman 4.)

mies and a tonsillectomy. At times his family felt he had some deafness. There was no history of previous ear trouble. His tympanic membranes were severely retracted with scarring of Shrapnell's membrane. A mass of adenoids in the nasopharynx had completely overgrown the eustachian orifices. The bone conduction was excellent. The Rinne test was negative on both sides. An adenoidectomy was performed with no change in his hearing. At the end of July he received his first irradiation and shortly afterward began to improve. By January his hearing was much improved (Fig. 6 second audiogram). His Rinne had become positive. Within 1 year his speech defect disappeared and he was with his twin in the first division of his class.

The second example (Fig. 7) is a 12 year old boy who had been deaf since infancy but the family had noticed a marked fluctuation of his hearing with colds. He had had no otitis.

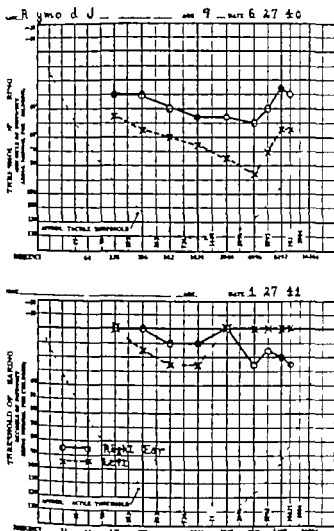


Fig. 6. Audiograms showing hearing improvement which was gained in a 9 year old boy 5 months after first irradiation treatment of eustachian orifices was administered for conductive deafness.

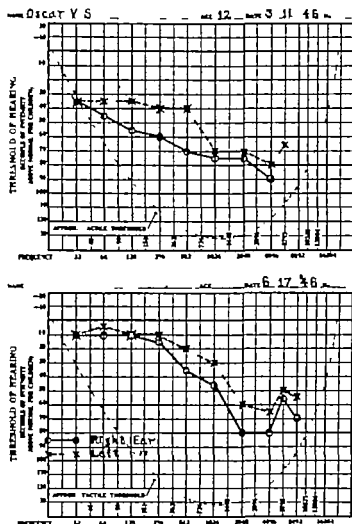


Fig. 7. These audiograms illustrate the improvement in hearing resulting from treating a conductive lesion which was superimposed upon a congenital nerve deafness. In this case, bone conduction remained poor.

The tympanic membranes were dusky in color not retracted. The eustachian orifices were peppered with lymphoid nodules. His hearing showed an accentuated high tone loss. Bone conduction was shortened on both sides, but the Rinne test was negative on both sides. Following irradiation, it could be seen that he had nerve deafness with a typical Manasse type curve in his audiogram (Fig. 7) which had been depressed by a superimposed conductive lesion. His Rinne test became positive, but he still had a shortened bone conduction

#### CONCLUSIONS

The use of radium or radon offers an important additional type of therapy in the otologist's struggle against deafness. Like other methods of treatment, however it has definite

limitations and in order that its usefulness may be realized radium must be used within these limits. Treatment of deafness due to permanent ossicular fixation with radium is just as futile as doing a fenestration operation on a patient with no bone conduction. The key to the successful employment of radium is the careful and correct selection of cases. The history is as important as the examination. The earlier a patient is treated the better are the chances for improvement. The younger the patient, the more effective the irradiations will be. It is important to remember that radium treats the cause of eustachian obstruction and infection. It does not treat connective tissue lesions in the middle ear. It is effective in the nasopharynx, not at the oval window niche or the attic.

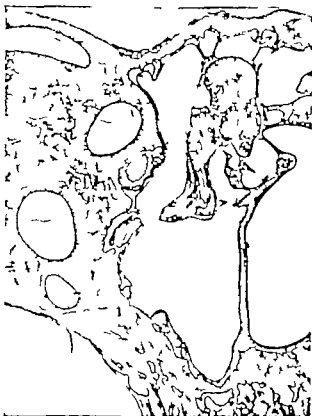


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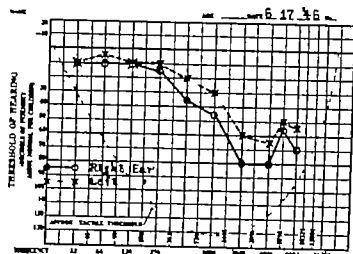
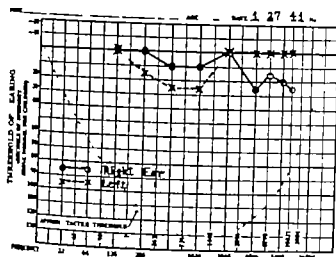
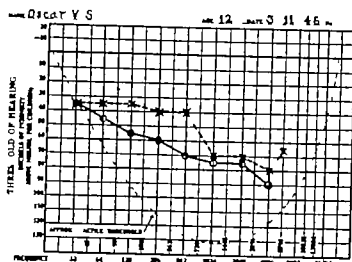
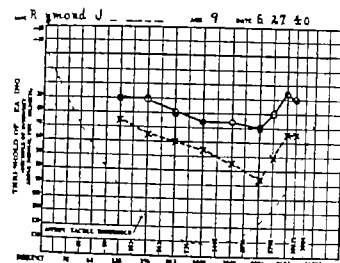


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The danger to the future of radium therapy is in its overenthusiastic use by otologists not willing to take the care and the time to study each individual case. The indiscriminate use of this technique may bring it into disrepute. Its future is bright if we remember that a great number of patients lose their hearing each year as a result of nasopharyngeal infection and lymphoid hyperplasia, and it was for the prevention of such deafness that the radium applicators were first designed.

## REFERENCES

1. CROWZ, S. J. *Arch. Otolaryn.*, 1941, 33, 6 8-6 2.  
CROWZ, S. J. and BURDAM, C. F. *Ann. Otol. Rhinol.*  
94, 50, 5-31.
3. HAINES, H. L., and HARRIS, D. J. *Ann. Otol. Rhinol.*,  
1946, 55, 347-37.
4. HEDGECOCK, J. E., and LIEBERMAN, A. T. *Ann. Otol.*  
*Rhin.*, 945, 54, 662-683.
5. HEIDRICH, H. *Mittb. Grenzgeb. Med. u. Chir.* 1905,  
14, -94.
6. Combined Report by the Officers participating on the  
Use of Radium in the Acrotitis Control Program of  
the Army Air Forces. *Ann. Otol. Rhinol.*, 945, 54,  
649-724.

# CONSIDERATION OF HEARING IMPAIRMENT IN THE TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA

J H MAXWELL, M D F.A.C.S Ann Arbor Michigan

THE degree of hearing impairment as associated with chronic middle ear suppuration varies greatly in individual cases. The amount of damage done to the middle and internal ear structures by acute infection at the onset, the extent of bone necrosis, and the interference with the sound conduction mechanism of the middle ear resulting from the healing process influence the loss of hearing acuity. There may be a conductive type of hearing loss of mild or severe degree, a mixed type of deafness if there is associated cochlear damage, or in some instances, a profound nerve deafness.

In the management of middle ear suppurations, the improvement of hearing or at least the preservation of residual hearing usually is not the major problem. The otologist is more concerned about the dangerous potencies of the infection from the standpoint of possible extension into the otic capsule or intracranial cavity. The patient's chief concern is more often associated with the annoying malodorous discharge. Although the hearing loss may not be the most important aspect of a case of chronic middle ear infection, it is not a factor to be ignored. In the case of bilateral middle ear disease the hearing loss may be of tremendous importance to the patient who may have to go through a complete rehabilitation program if further hearing impairment should develop.

How then should the otologist consider the problem of hearing impairment in his management of chronic middle ear suppurations? This question can be answered I believe by stating that first consideration should be given to the determination of the extent and dangers of the infection. Then other factors being equal, the treatment advocated should be that which will while dealing adequately with the

infection tend to preserve all residual hearing or even improve the patient's hearing acuity. This can be accomplished only by individualizing each case and adapting the therapeutic procedure to the individual patient. Many of us will agree that there has been a tendency to use rather routinely some form of drops or powder as 'conservative treatment' in cases of chronic otitis media. Then if the ear does not stop discharging a radical mastoidectomy is considered. Too many times this conservative form of neglect has been continued until intracranial extension of the infection has ensued. This form of treatment suggests that deplorable practice of adapting the patient to a routine therapeutic procedure.

In discussing individualized treatment from the standpoint of preservation of hearing it is necessary that we understand the various major types of chronic suppurative otitis media and that we be able to recognize them clinically. It would be absurd for instance to use the same routine type of treatment in a case of so-called tubal ear as in a case of attic cholesteatoma. In each instance however the patient may complain only of moderate hearing loss and chronic discharge which may be continuous or intermittent.

The first uncompromising demand then in the management of a case of chronic suppurative otitis media is a thorough and painstaking clinical examination.

The history should if possible reveal facts regarding the onset of the discharge. It is well to know if the infection began before the age of complete pneumatization of the mastoid, if the infection originally complicated measles or scarlet fever or if the onset was insidious. One should ascertain any unusual symptoms accompanying acute exacerbations and bear in mind that intracranial complications usually develop during such recrudescences. The history of these episodes should reveal information relative to the typical danger signs of such

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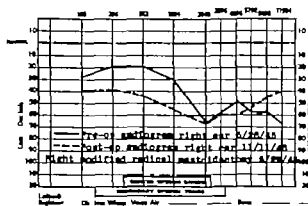


Fig. 1. Audiogram in patient W. E. aged 22 years.



Fig. 2. Second audiogram in patient W. E.

infection. These general signs and symptoms which have no place in a case of uncomplicated chronic suppurative otitis media and mastoiditis are as follows (1) hemicrania or generalized headache, (2) chills, (3) convulsions, (4) changes in sensorium, (5) extraocular muscle palsies (6) vertigo (7) nausea and vomiting (8) leucocyte count over 20 000 in adults and (9) marked disproportion of symptoms and signs. The existence of these signs past or present usually suggests an infection of serious nature.

Physical examination should include a complete and detailed study of the nose, nasopharynx, throat, and ears. The significance of the various types of perforations in the drum membrane and the various types of discharge must be understood by the otologist.

The therapeutic management should depend upon the position and extent of pathological changes present and upon the likelihood of extension of infection to the fallopian canal the inner ear or the intracranial contents. This information must be obtained from the clinical examination and not from an X ray report only.

In the typical tubal ear demonstrating an anterior inferior perforation and a mucoid discharge the hearing loss is usually not profound, and if the ear becomes dry with concomitant thinning of the hyperplastic tympanic mucosa, the hearing is likely to improve. Since the major pathologic changes are hyperplasia, edema, and round cell infiltration in the tympanic mucosa, one need not be concerned immediately about the possibility of mastoid complications. Treatment should be directed

first to the nasopharynx from which hypertrophic adenoid tissue should be removed. In many instances the application of radium to the region of the eustachian tube orifices will have a beneficial effect. The local treatment to the ear should have cleanliness as its chief objective. Antiseptic solutions may be instilled daily by the patient. A saturated solution of boric acid in 70% alcohol used as ear drops is of value.

If there is fairly good evidence that the mastoid inflammation is minimal and that the tympanic mucosa is intact but secreting an abundance of mucus, x ray therapy is often of considerable value. The prognosis on such conservative treatment is good even though there may be recurrence of the discharge during upper respiratory infections.

In the case of the large marginal perforation with granulations on the promontory but without granulation tissue or cholesteatoma in the attic there is, of course, hearing loss but if the ossicular chain is intact and the region of the stapedial footplate is free from granulation tissue, the hearing loss is usually around 30 to 40 decibels a level of rather serviceable hearing. In such an instance conservative local treatment may be continued indefinitely. The granulation tissue

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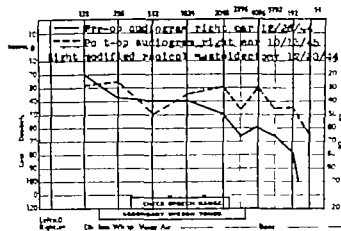


Fig. 3. Audiogram in patient B. M. aged 22 years.

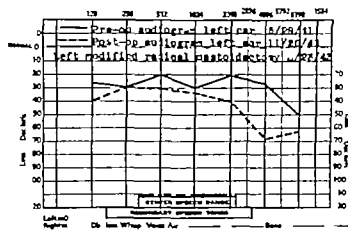


Fig. 4. Audiogram in patient O. A. aged 28 years.

fection of serious potentialities. The ossicular chain usually has been interrupted by necrosis of its component parts. The stapes or perhaps only its remaining footplate may be embedded in a mass of scar and granulation tissue. This type of otitis media is associated in most instances with bone necrosis, granulation tissue and perhaps cholesteatome formation in the tympanic antrum and neighboring mastoid cells. Hearing loss is greater than in the preceding type. Usually there is a loss of at least 50 or 60 decibels. In such a condition conservative therapeutic measures are of little value since the pathologic changes are deep seated. Radical mastoidectomy is frequently indicated, and this operation must be a precision type of procedure in which all diseased tissue is removed. One should expect to obtain complete healing in over 95 per cent of adult cases. The hearing will not be restored but it may be improved slightly 10 decibels or so if there is a large mass of granulation tissue in the middle ear before operation and if after healing the mesial wall of the tympanum becomes covered by thin skin. If there is but little granulation tissue in the region of the stapes before operation and after healing the promontory and region of the stapes is covered by a thick layer of scar the patient will suffer some increase in hearing loss. Occasionally a radical mastoidectomy may produce total loss of hearing in the ear operated upon. However if the disease is of such severity and extent that a radical mastoidectomy is indicated one should not procrastinate for fear the required operation may add to the patient's hearing impairment. To do so invites intracranial com-

plications. There is at least an even chance of preserving the residual hearing and this chance must be taken even if the disease is bilateral and of sufficient severity and extent to demand bilateral radical mastoidectomies. Too many times patients have been permitted to develop severe complications while a useless conservative medical form of treatment is being given a prolonged trial. The extension of infection along a pathway created by bone necrosis or by pressure atrophy due to cholesteatome formation takes place insidiously. The lack of pain or other untoward symptoms gives the physician a false sense of security while continuing the medical therapy. One must bear in mind the fact that the indications for radical mastoidectomy are present and must be discovered *before* a complication occurs. When the patient who has an old chronic suppurative otitis media develops a labyrinthitis, sinus thrombosis, facial paralysis, meningitis or brain abscess the physician knows and perhaps too late that he should have recognized the indications for operation weeks, months and perhaps even years before. Increasing hearing loss, profuse foul seropurulent discharge and episodes of pain and mastoid tenderness in a case of chronic otitis media almost always mean extending infection and impending complications. Mastoid tenderness is a most important sign of severe extending infection in the case of a small sclerotic mastoid. Roentgenograms should be made of course and they are of great value if well exposed and expertly interpreted but the indications for operation are to be discovered in the clinical examination.

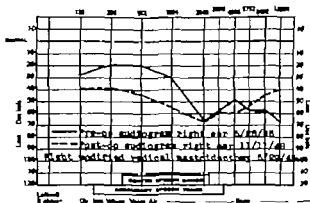


Fig. 1. Audiogram in patient W. E. aged 22 years.

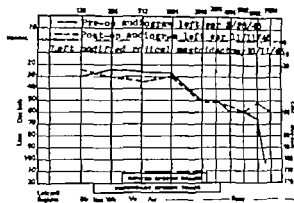


Fig. 2. Second audiogram in patient W. E.

infection. These general signs and symptoms which have no place in a case of uncomplicated chronic suppurative otitis media and mastoiditis are as follows: (1) hemicrania or generalized headache, (2) chills, (3) convulsions, (4) changes in sensorium, (5) extraocular muscle palsies, (6) vertigo, (7) nausea and vomiting, (8) leucocyte count over 20,000 in adults, and (9) marked disproportion of symptoms and signs. The existence of these signs past or present usually suggests an infection of serious nature.

Physical examination should include a complete and detailed study of the nose, nasopharynx, throat, and ears. The significance of the various types of perforations in the drum membrane and the various types of discharge must be understood by the otologist.

The therapeutic management should depend upon the position and extent of pathological changes present and upon the likelihood of extension of infection to the fallopian canal, the inner ear, or the intracranial contents. This information must be obtained from the clinical examination and not from an X-ray report only.

In the typical tubal ear demonstrating an anterior inferior perforation and a mucoid discharge, the hearing loss is usually not profound, and if the ear becomes dry with concomitant thinning of the hyperplastic tympanic mucosa, the hearing is likely to improve. Since the major pathologic changes are hyperplasia, edema, and round cell infiltration in the tympanic mucosa, one need not be concerned immediately about the possibility of mastoid complications. Treatment should be directed

first to the nasopharynx from which hypertrophic adenoid tissue should be removed. In many instances the application of radium to the region of the eustachian tube orifices will have a beneficial effect. The local treatment to the ear should have cleanliness as its chief objective. Antiseptic solutions may be instilled daily by the patient. A saturated solution of boric acid in 70% alcohol used as ear drops is of value.

If there is fairly good evidence that the mastoid inflammation is minimal and that the tympanic mucosa is intact but secreting an abundance of mucus, X-ray therapy is often of considerable value. The prognosis on such conservative treatment is good even though there may be recurrence of the discharge during upper respiratory infections.

In the case of the large marginal perforation with granulations on the promontory but without granulation tissue or cholesteatoma in the attic, there is, of course, hearing loss, but if the ossicular chain is intact and the region of the stapedial footplate is free from granulation tissue, the hearing loss is usually around 30 to 40 decibels, a level of rather serviceable hearing. In such an instance conservative local treatment may be continued indefinitely. The granulation tissue should be removed with great care after which the patient should be instructed to use local medication in the form of drops or powder of antiseptic, antibiotic, or digestive material.

The presence of a posterosuperior marginal perforation associated with foul smelling seropurulent discharge and cholesteatoma or granulation tissue filling the attic indicates an in-



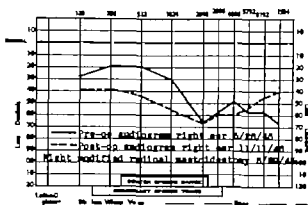


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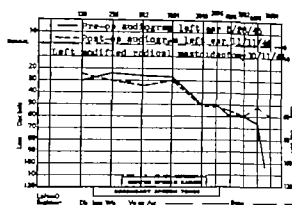


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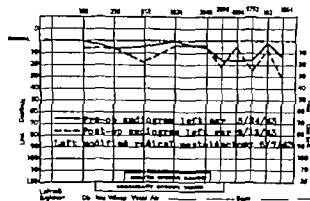


Fig. 5. Audiogram in patient J M, aged 17 years

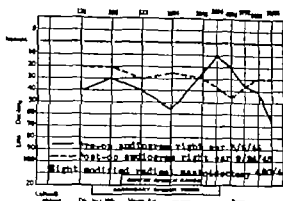


Fig. 6. Audiogram in patient M G, aged 23 years

Less common but most important, particularly in this discussion of chronic suppurative otitis media in relation to hearing impairment is the primary acquired form of cholesteatoma. There is apt to be a very small perforation in the flaccid portion of the tympanic membrane. There may be minimal and even unnoticed discharge except during exacerbations of the infection when there is characteristically a thin, foul smelling exudate. The attic contains a mass of cholesteatoma which may surround the head of the malleus and the body of the incus. In old cases the cholesteatoma may extend through the aditus into the antrum or expand downward into the tympanic cavity. The membrana tensa may be intact and show normal landmarks. A gray lusterless somewhat bulging membrane may indicate the presence of cholesteatoma in the lower portion of the tympanic cavity. The hearing acuity varies of course but in many cases in which the suppuration and mass of cholesteatoma are confined to the region of the attic, aditus,

and antrum there is less than 30 decibels of hearing loss. With the exception of those cases which are discovered at a time when only the attic is involved and which may respond to repeated attic irrigations this type of infection must be treated surgically. Obviously the installation of drops or the insufflation of powder will be futile. The standard radical mastoidectomy will serve to cure the infection but will certainly cause an increase in hearing loss if the hearing in the involved ear is at a serviceable practical level. The operation of choice in such a case is a modified radical mastoidectomy. The atticomastoidectomy as described by Lempert has many advantages. This operation, which may be done by either the postauricular or endaural approach, permits of thorough excavation of the epitympanum after removal of the incus and amputation of the head and neck of the malleus. By severance of the tendon of the tensor tympani muscle the drum membrane may be retracted to give adequate exposure of the lower portion of the tympanic cavity if this is required. Preservation of the tense portion of the drum membrane which forms part of the tympanomeatal flap to be turned into the mastoid cavity assures the maintenance of a tympanic air space about a stapes which has not been disturbed. In well selected cases one can expect to obtain a perfectly dry healed ear and to preserve the hearing at a serviceable level.

Figures 1 to 7 demonstrate the preoperative and postoperative audiograms of patients on whom a modified radical mastoidectomy has been done for attic suppuration. In each case

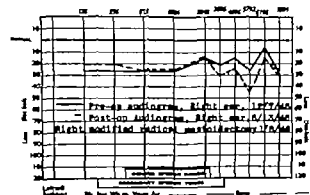


Fig. 7. Audiogram in patient N C, aged 3 years.



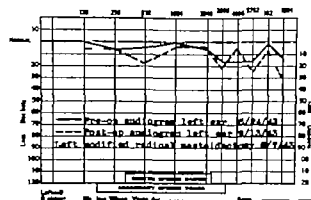


Fig 5 Audiogram in patient J. M. aged 7 years.

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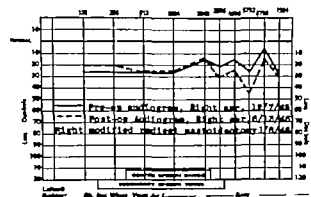


Fig 7 Audiogram in patient N. C., aged 3 years.

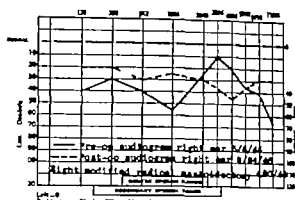


Fig 6 Audiogram in patient M. G., aged 23 years.

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## INDICATIONS FOR SURGERY IN THE LIGHT OF THE USE OF ANTIBIOTICS

HARRY P. SCHENCK, M.D., F.A.C.S., Philadelphia, Pennsylvania

THE indications for sinus surgery have become greatly modified during a single decade because widespread clinical trial has demonstrated the ability of the sulfonamides, and later of the antibiotics, to modify profoundly the course of many acute and some chronic infections. Of the many known antibiotic substances only penicillin, streptomycin and tyrothricin have attained a position of therapeutic importance. To each of these can be assigned a specific therapeutic sphere on the basis of accumulated laboratory and clinical data.

In the treatment of some infections the sulfonamides and the antibiotics supplement each other. The antibiotics cannot be regarded as entirely replacing the sulfonamides. Fortunately the drugs of one or the other group may replace each other if the infecting micro-organisms develop resistant strains or the patient exhibits sensitization. The advantages of economy and plentiful supply of the sulfonamides are generally outweighed by the comparative safety and absence of toxicity of penicillin and streptomycin especially in extremely ill or debilitated patients with liver and kidney damage.

The definite reduction in the number of sinus operations performed in the United States during the past 2 years is attributed to the effective use of chemotherapy in acute and chronic infections as well as in certain types of traumatic fractures of the paranasal sinuses. On the other hand the indications for surgical intervention in the presence of neoplasms or tissue alterations due to allergic phenomena have been little affected by the introduction of chemotherapeutic agents.

The antibiotics are of no value in uncomplicated allergy but they have been employed effectively against secondary infections complicating allergy of the upper and lower respira-

tory tracts. There is reason to expect therefore that bacterial sensitization may be forestalled in those instances where infection in an allergic individual can be arrested or eradicated by antibiotic therapy. On the other hand allergic patients are prone to become sensitive to the antibiotic drug itself and this is especially apt to occur when the drug is administered as a prophylactic measure over a long period of time. Sinus surgery continues to be necessary in the presence of advanced irreversible tissue changes in the nasal passages and sinus cavities if attributable to allergic influence alone and on the same basis as existed prior to the introduction of the antibiotics.

Certain advantages of properly applied antibiotic therapy are apparent during the preoperative period, the period of operation and the postoperative period of sinus surgery. In infectious sinus diseases effective antibiotic therapy during the *preoperative period* depends upon early and accurate diagnosis (especially accurate bacteriological identification) followed by selection of the antibiotic most lethal to the invading micro-organism, given in adequate dosage by the most effective route of administration and over a sufficient interval of time. Because antibiotic therapy frequently impedes or completely arrests the spread of infection minimizes the occurrence of bacteremia and the toxic effects of active and overwhelming infection there is an appreciable prolongation of the interval of safety between the onset of symptoms and the need for surgical intervention. The value of such delay is obvious in providing the opportunity for more thorough and detailed clinical studies—roentgenological, serological, and bacteriological.

A sense of false security may be engendered by the prompt therapeutic effects of the sulfonamides and the antibiotics especially in sinus infections in which irreversible tissue reactions have already occurred. Here recurrence is the rule as soon as chemotherapy is with-

Presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 16-20, 1946.

drawn and although recurrent attacks may subside under further chemotherapy eventual surgery is inevitable in the majority of patients.

The administration of antibiotics in mild and transient sinus infections may eventually be regarded as poor therapeutic practice. It has long been recognized that immunity fails to develop when infections are promptly controlled by chemotherapy. Prompt arrest of bacterial activity prevents stimulation of immunological responses. As a result there are frequent recurrences at very short intervals. The tendency to readminister chemotherapy at each recurrence appears justified by the success attending its use in the first attack. Under these circumstances however repetition of chemotherapy fails to prevent progressive tissue changes, fosters the development of resistant strain of micro-organisms, and may sensitize the patient to the drug. In the latter event the drug is then disqualified for the treatment of a subsequent and perhaps more serious infection.

During the *period of operation* antibiotics used locally or systemically appear to have considerable prophylactic value by preventing meningitis, controlling bacteremia and protecting uninfected tissues in the operative wound from contamination.

In the *postoperative period* antibiotics limit the spread of infection to freshly exposed tissues and in most instances shorten the healing period.

Meningitis almost invariably follows fractures of the paranasal sinuses with a tear of the overlying dura. This complication can now be avoided by the prompt administration of the antibiotics and prompt surgical repair of the dura. When meningitis has already followed a fracture through the sinus wall with tearing of the dura, antibiotic therapy permits repair of the dural defect to be carried out after recovery from meningitis. Under these circumstances better clinical results are obtained by awaiting recovery from meningitis before proceeding with dural repair. Under continuing antibiotic therapy, fractures of the paranasal sinuses heal by primary union. Bone fragments, surrounded in part or entirely by viable soft tissues, exhibit amazing viability. However

bone fragments lying free within the sinus cavities require eventual removal. Sequestrum formation has been greatly minimized by antibiotic therapy.

The generally accepted rule that as little surgical intervention as possible should be employed in *acute sinus infections* has become even more rigid since the introduction of chemotherapy. Exceptions to this rule have been conceded in the presence of orbital extension, bacteremia and retrograde thrombophlebitis but the therapeutic use of the antibiotics has almost eliminated these exceptions because penicillin rapidly controls orbital cellulitis of sinus origin, clears the blood stream of viable organisms and impedes the progress of intravenous infection. More than ever before should acute sinus infections be permitted to become chronic before deciding upon surgical intervention. In many instances the antibiotics eradicate the infection before a chronic process can develop.

Antibiotic therapy in acute sinus infections must be confined to those induced by micro-organisms sensitive to the drug and it has become obvious that sensitivity tests should be carried out if possible prior to administration of the drug. Treatment of acute sinus infections due to resistant strains of micro-organisms fails to prevent progression to a chronic status and the eventual need for surgery. Prolonged therapy with a single drug may render the strain resistant, thus making it possible for infection to affect a previously uninvolved sinus during the course of antibiotic therapy.

*Chronic sinus infections* are resistant to antibiotic therapy because the drug penetrates with difficulty the abnormal tissues resulting from repeated or prolonged infection. Tyrothricin lacks the ability to penetrate tissue and its limitation to surface use renders its value in chronic sinus infections questionable. Even though penicillin and streptomycin temporarily control the infection, recurrence often follows soon after antibiotic therapy is discontinued and ultimate surgical drainage is required. When surgery alone is unsuccessful in eradicating chronic infection in the sinuses antibiotic therapy is sometimes capable of playing a decisive rôle. The combined local and intramuscular use of penicillin after surgi-

cal failure brings about the disappearance of exudate and of viable micro-organisms. In most instances of chronic sinus infection in which irreversible tissue changes are extreme, a successful result can be obtained only by the combined use of surgery and chemotherapy.

In *meningitis* the ears and the paranasal sinuses are the most frequent primary foci. In the past, surgical drainage of the primary focus has been axiomatic in the treatment of meningitis. In most instances an initial attack of meningitis may now be controlled by antibiotic therapy with or without surgical drainage of the primary focus. This has led many clinicians to doubt the value of drainage of the primary focus when chemotherapy is available. At least it has become apparent that surgery can be safely delayed until the meningitis is under control. When surgical drainage of the primary focus is then attempted, precision laboratory and roentgenological studies have been completed and the patient has become a better surgical risk.

Relapsing cases of meningitis occur with more frequency in sinus infections than in mastoid infections. Even though operation may be of little value in the acute phase of meningitis, it continues to deserve consideration in the treatment of a relapsing case. It must be conceded that the full recovery of many relapsing cases can be attained with chemotherapy alone but the fact that the chronic focus consists of a formidable collection of pus, and perhaps sequestra, as well cannot be completely disregarded. Eventually such a focus must be dealt with surgically and especially when reinfection of the meninges coincides with discontinuation of the chemotherapy. Attempts to prevent relapse by sur-

gical attack upon an extradural source of infection have frequently been disappointing. Such failures seem more likely to be due to incomplete surgical drainage of a single focus or the presence of multiple foci which escape recognition. In the presence of an extensive focus surgical intervention cannot as yet be discarded in favor of chemotherapy alone. The concurrent use of chemotherapy and surgical drainage appears to be the best policy at the present stage of development.

Frank *osteitis* accompanying acute sinus infections has been generally controlled promptly by adequate doses of penicillin. Unfortunately reactivation of the infection may appear upon withdrawal of penicillin and extension to the meninges follows. When systemic penicillin is again administered, the effective control of the meningeal infection permits delay in operation. In fact surgical intervention appears to be most effective if postponed until the meningitis is controlled.

Penicillin rarely effects a cure in osteomyelitis of the frontal bone with or without brain abscess. Surgical intervention with maintenance of adequate drainage is imperative. The concurrent administration of intrathecal as well as intramuscular penicillin however has effected some remarkable recoveries. In spite of antibiotic therapy all necrotic bone must be removed before healing can occur. While the antibiotics exhibit a peculiar ability to relieve the pain associated with osteomyelitis, their main value lies in their ability to prevent sequestration and arrest progressive extension of the infection. In osteomyelitis secondary to sinus infection, the antibiotics seem capable of reducing the extent of radical surgery upon the skull to a remarkable degree.

# EXTERNAL SINUS SURGERY

FRANCIS L. WEILLE M D Boston, Massachusetts

A REALISTIC approach to the problem of external sinus surgery is a prime requisite in any symposium on sinusitis. There are two reasons for this: the fear of the average layman engendered by advice for any sinus surgery especially by the external route and the necessity for the rhinologist to evaluate clearly just what he is offering the patient.

There is no question but that with modern chemotherapy many sinus operations—both intranasal and external—will be avoided. Yet in the presence of convincing evidence of necessity for an unavoidable external operation the rhinological surgeon must not only know certain common techniques thoroughly but also be able to evaluate them carefully before doing them.

In recently discussing the problem of external sinus surgery with a young well trained rhinologist who had graduated from one of the best otolaryngological hospital services about ten years ago, certain points of importance developed.

1 Although this doctor had had adequate training in both external ethmoidal and external frontal technique he felt far more confident of the excellence of his work in the former.

2 He had recently been compelled to do a Lynch frontal because of an orbital abscess which had failed to improve with chemotherapy. At operation he had done a complete ethmoidectomy and had drained a large frontal space which he had supposed to be the frontal sinus but which later turned out to be a very large frontoethmoidal cell. The frontal sinus itself was not entered at all. (But the very thorough ethmoidectomy was followed by uneventful cure of the patient!)

3 In several years army service in the recent war this same doctor had seen a number of cases in which simple trephination of the

frontal sinus had been done by civilian doctors *through the anterior diploetic wall*.

4 This led him to assume that many civilian specialists not only rarely do external surgery of the frontal sinus but that some rhinologists may not be too familiar with present day external techniques.

During the war the writer acted as consultant and assistant to a young rhinologist at a Lynch frontal operation and found it necessary to lend him technical aid. It was pointed out that the operator had opened a large frontoethmoidal cell which he had assumed was the frontal sinus; that there was inadequate exposure of the frontoethmoidal bony structure because of attempting to do the frontal sinus work first, independently of the ethmoid; that good exposure of the medial orbital wall was best obtained by detaching the medial palpebral ligament and elevating the periosteum; that in the Lynch frontal the easiest way into the frontal sinus is from the ethmoid by removing the lacrimal bone, and following the lacrimal and adjacent anterior ethmoid cells upward into the floor of the frontal sinus; that by having the patient sitting in a chair instead of lying on an operating table, he had in some respects made his task harder, etc.

In teaching internes external sinus surgery some of our more mature staff members have indicated their desire to review their technical skill. It may be desirable therefore to recapitulate briefly some of the surgical techniques used in external surgery of the sinuses.

## THE FRONTAL SINUS

A *The Lynch operation*. Every rhinologist is familiar with the Lynch type of frontal operation. In the 15 years between 1930-1944 at the Massachusetts Eye and Ear Infirmary this was done 192 times in 447 frontal sinus operations on 276 patients (6). Therefore, in our hospital it is the commonest operation on the frontal sinus, with obliteration running second with 123 cases.

From the Department of Otolaryngology, Massachusetts Eye and Ear Infirmary.  
Presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-10, 1946.



for a very few days or for many weeks and heavy dosage with penicillin used for the control of infection.

The cleaner the healing field (less infection) the better. It is the infection factor which is a major cause for the proliferation of granulations (inflammatory and osteoid) and the inhibition of epithelial growth. The opposite process is required in surgical healing.

#### THE CONTRACTURE PROBLEM

Early and late contracture are probably important in causing closure of the nasofrontal opening in both primary and secondary Lynch type operations. Late contracture is caused by shrinkage of collagen fibrils, the less the granulation tissue and the quicker epithelization occurs in the region of the surgical nasofrontal communication the less likely is such contracture to be a factor. Early contracture begins after about 2 to 5 days, progresses rapidly for several days, and then gradually subsides. It is early contracture which obturator-drains are supposed to lessen since such devices are removed in from 2 days to about 2½ weeks (1) by the majority of surgeons.

Anthony feels that such a device should be left beyond the secondary contracture phase of healing. The writer has a case with a permanently implanted tantalum tube in an unobliterated frontal sinus for over 2 years with no recurrence of trouble. A tantalum covered nasofrontal catheter left 4½ months in a tuberculous rhinitis case complicated by frontoethmoidal sinusitis and orbital abscess failed to establish satisfactory drainage and further surgery was required.

Primary or secondary contracture may be lessened by attention to the following: granulation tissue surrounded by a circle of bone tends to contract toward the periphery of such a circle (Kazanjian) whereas granulation tissue surrounded by soft tissue only tends to contract centrally. The more nearly a nasofrontal opening in the Lynch procedure has a bony circumference the more likely it is to stay open. This merely means that so far as is consistent with thorough and adequate technique, the upper end of the ascending process and the nasal bone should be preserved.

In summary secondary revisions of Lynch frontals without obliteration require a certain amount of ingenuity, a fundamental knowledge of surgical anatomy and of the surgical healing of connective tissue, bone and epithelium if obliteration is to be avoided.

*C Obliteration.* Failure of the Lynch or Lynch type revision causes many experienced rhinological surgeons to consider obliteration as a solution to the problem. This means the collapse of the soft tissues of the anterior wall against the bony posterior wall or dura so that (a) no air space or gross mucoperiosteum remains in the sinus, and (b) the frontal ostium is sealed off by scar tissue with the result that (c) obliteration of the sinus results, together with (d) deformity relatively slight with a shallow frontal and severe with a large deep sinus. Sometimes obliteration is undertaken as an original procedure e.g. in the Mosher technique for excision of an osteomyelitic frontal squama, both sinuses were usually obliterated with removal of all walls. (The writer has not been compelled to remove the frontal squama in osteomyelitis since the release of penicillin for general use, but has had to obliterate the frontal sinuses in osteomyelitis limited to the sinus area.)

In every obliteration the anterior wall is removed from the frontal sinus. In addition, the floor may be removed or partly removed, the posterior wall may be removed and in bilateral obliterations the interfrontal septum is removed. Mosher believes removal of the anterior and posterior walls and a little of the floor is most likely to succeed.

In obliteration it is desired to seal off any communication between the frontal sinus and the nasal cavity. If this is not an easy problem obliteration may not be necessary. In contrast the Lynch type of procedure makes every effort to establish a nasofrontal communication surgically. It is surprising that in Lynch or Killian operations, postoperative mucocoeles (or pyocoeles) were found to be commoner (13 cases) than after obliteration (3 cases). In a review of 276 external frontals at the Massachusetts Eye and Ear Infirmary between 1930-44. Such mucocoeles or pyocoeles are, in my opinion, due to absence of nasofrontal drainage with secreting mucoperioste-

teum in the frontal area which produces a cyst

In 77 obliterative cases having osteomyelitis at the Massachusetts Eye and Ear Infirmary, 25 required further surgery. In 46 others having no osteomyelitis, 8 required additional operations directly upon the frontal sinus. This equals about 27 per cent failure for this type of procedure, as compared with 34 per cent for the entire group reviewed by the author in which all frontal operations of all types are included.

Incidentally, 71 of 123 obliterative cases required about 1.5 plastic procedures each for the repair of deformity, with an average of about 1 year's time for such work. The longest time was just over 5 years for 3 plastic operations in one of the cases.

D. Simple trephination of the floor of the frontal sinus with establishment of external drainage is useful in combination with chemotherapy in dealing with certain fulminating acute infections occasionally encountered. The frontal floor has no diploe except near its anterior and external margins and the trephine opening is made without disturbing this diploe. The frontal sinus lining is removed only at the point where the drainage tube is placed. Local and systemic penicillin therapy are carried out when the penicillin can be freely irrigated from the drainage tube into the nasal cavity and external drainage ceases, the tube is withdrawn.

After patient has recovered completely, he should have his nasal cavities made as mechanically and physiologically perfect as possible and further external surgery avoided if possible.

MacKenzie Brown (6) has reported treating certain chronic frontal sinus cases by simple trephination also.

E. The Jesberg and Lothrop operations are not commonly used in our hospital and will be omitted from this discussion.

#### THE ETHMOID AND SPHENOID SINUSES

External surgery of the ethmoid is no different technically from that of the Lynch frontal except that the frontal area is left undisturbed and the problem of making a nasofrontal communication surgically is thereby deleted. In both the Lynch frontal and the external ethmoid operations the sphenoid may

be opened and explored from its ethmoidal relationship if desired.

#### THE MOURE OPERATION

The Moure operation for excision of malignant tumors of the sinuses is a formidable undertaking. Its risks may be lessened by the following considerations:

1. Anesthesia is best given intratracheally with a balloon corking the glottis. Since oxygen is easily exploded by a diathermy apparatus, its use must be avoided. That is, air-ether mixtures are employed, not oxygen ether. This is accomplished by discarding the usual ether machine and substituting a large ether can which has several large holes made into its top, each hole being about the size of a dime. The intratracheal tube is attached to the mouth of the ether can and the patient's normal respiration sucks in air over the ether in the can with enough ether vapor to maintain surgical anesthesia. While the ether can be exploded by the diathermy apparatus, this risk is relatively slight with careful use of the machine. Both the nasopharynx and hypopharynx are packed with postnasal plugs secured externally through the mouth.

2. Both plasma and saline for intravenous use should be set up in the operating room and administered alternately throughout the operation. The anesthetist can most conveniently do this. Arrangements for transfusion to be done if necessary should be made prior to operation.

3. A highly efficient coagulation and cutting diathermy apparatus should be part of the equipment utilized. The writer prefers the large Davis Bovie machine.

4. The Moure incision is improved cosmetically and for practical exposure of the underlying field by making it slightly S-shaped. Its upper end starts at the lower aspect of the inner margin of the eyebrow and proceeds downward anterior to the tear sac region, then near the posterior margin of the lateral nasal surface to the posterior aspect of the ala nasi. It continues onward until the posterior margin of the ala nasi has been cut through and the nasal vestibule freed posteriorly almost to its medial aspect, the incision ending near the nasal columna posteriorly, but

not involving the upper lip directly or opening into the vestibule. It is this last portion of the incision which allows very free mobilization of the soft tissues of the cheek to expose the pyriform aperture and upper jaw anteriorly. It will almost always avoid the necessity for making a transverse incision in the cheek. Bleeding is carefully controlled.

A line of cleavage around the pathological mass can usually be found by blunt dissection and this, plus diathermy cutting and coagulation will greatly limit blood loss. After getting the mass as widely dissected and freely mobilized as possible it is very quickly excised without regard to hemorrhage for the two or three minutes required for gross removal with the largest usable destructive instruments. Then hemorrhage is again quickly controlled and the removal continued until the tumor has been grossly excised and all suspicious areas coagulated with surgical diathermy. Adequate drainage into the nose is obtained if this has not already been accomplished by the excision of the mass. The wound is closed with plastic sutures without drainage externally.

Any sinus the nasal cavity and nasopharynx can be reached as desired by this approach as described or slightly modified. If the hard palate and alveolus are involved with the antrum alone, it is possible easily to reach as high as the orbital floor through appropriate mouth incisions and excise the mass without any external incision.

With highly radiosensitive tumors the Moure operation need not be done, since the simple provision for sinus surgical drainage plus adequate irradiation will suffice. In any event, a radiosensitive sinus tumor should be adequately irradiated whether or not the Moure operation is done.

#### POSTOPERATIVE CARE IN EXTERNAL SINUS SURGERY

In the hospital period of convalescence, ordinary surgical principles are followed for supportive treatment, including chemotherapy as seems necessary. If the wound has been

closed the sutures are removed about the third or fourth day if possible. If at operation the decision is made to leave the wound open because of the imperative need for control of sepsis, the surgeon *should be in no hurry to close it*. The patient's safety is of first importance. Incidentally surprisingly good cosmetic results are common in wounds left open for considerable periods of time.

Mosher's dictum "once a sinus always a sinus" does not correspond to the writer's experience if adequate follow up care is given the individual patient. Swimming and recurrent acute upper respiratory infections are common causes of acute exacerbations of sinusitis, which can be avoided or brought under control.

In polypoid sinusitis cases undue reliance is often placed upon the management of allergy. While every aid should be gratefully accepted the polypoid degenerative tissues will nevertheless sometimes recur massively. This problem is, at the present time, best solved by the use of coagulation diathermy to destroy such tissue as it appears, or removing small such areas periodically.

#### SUMMARY

The technique of several external surgical operations useful in sinus surgery has been summarized particularly the Lynch frontal operation secondary revision of postoperative frontal sinuses by a Lynch type procedure obliteration of the frontal sinus simple trephination of the frontal sinus incidental techniques for the external ethmoidophenoid approach and the Moure operation. Some experience has been cited in evaluating these procedures. The Moure technique, for radical antrum surgery has been discussed.

#### REFERENCES

1. ARTHUR, D. H. Southern M. J. 940, 33 949.
2. BROWN, J. M. Laryngoscope, 946, 56: 6.
3. GOODALE, R. L. Ann. Otol. Rhinol., 942, 5: 618.
4. LYNCH, R. C. Tr. Am. Laryng. Rhin. Otol. Soc., 940, 36: 60.
5. MOSHER, H. P. Discussion of reference 6, in press, Tr. Am. Laryngol. Ass., 946.
6. WELLS, F. L. Ann. Otol. Rhinol., 946, 55: 372.

## INTRANASAL SURGERY

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**T**HE fundamental principle of intranasal surgery is the re-establishment of normal ventilation and drainage of the sinuses and when this can be accomplished by intranasal surgery it is preferable to radical surgery.

### ANESTHESIA

Local anesthesia is preferable for intranasal surgery. The patient should be buffered with a substantial dose of the barbiturates and a sedation dose of morphine. Whether atropine or scopolamine is used depends upon the operator's choice for the difference between the two is academic. A committee appointed by the American Medical Association reported in 1920 that they diligently studied the question of mixed local anesthetics and found that a single anesthetic was safer than combining a local as cocaine and infiltration such as novocain. Ether is a poor anesthetic for intranasal surgery but is safer for children than is any form of intravenous medication. Sodium pentothal combined with a local anesthetic is an ideal anesthesia for nervous patients.

### SUBMUCOUS RESECTION

The correction of nasal obstruction constitutes more than 60 per cent of the intranasal surgery of today. Too often a rhinologist unconsciously asks himself during a nasal examination, "What do I see that I can correct?" His eye may discover a deflected septum or a hypertrophied turbinate and immediately that but of pathology is considered the cause of the patient's complaint. Early obstructions tend to retard the pneumatization of the sinuses and the normal growth of the alae nasi and upper maxilla. The paranasal sinuses can pneumatize normally with a complete occlusion of the vestibules or the choanae. On the other hand an early septal deflection which jams the middle turbinate against the lateral nasal wall will obstruct the infundibulum

blocking the nasofrontal duct or the ostium of the antrum thereby arresting pneumatization of the sinuses which have their origin from this region.

Deviated septa occur more frequently in civilized races than among savages. Schaeffer states: "The nasal septum encroached upon more and more by the forward cranial extension incident to brain growth as one passes from the anthropoids to the ultra-civilized races of man."

Headaches which are caused by nasal obstruction vary from slight nasal discomfort to severe neuralgias. The simple thickening of the septum high between the middle turbinates will interfere with the normal physiologic swelling of these turbinates. These patients appreciate their obstruction when they remain out-of-doors during cold weather or during an acute cold. This type of case receives a good result from a well performed submucous resection.

There is a deformity caused by a backward development of the sphenoidal process of the septal cartilage on a spur of the vomer. This large spur crowds the posterior fourth of the middle turbinate and is capable of persistent trouble. Whenever the middle turbinate enlarges, contact will be made and pressure exerted directly upon Meckel's ganglion. This is very noticeable during the menstrual period. The growth of this spur interferes with the size and shape of the middle turbinate and by extending laterally will encroach upon the ostium of the antrum. This deformity favors maxillary sinusitis by blocking the ventilation and drainage of the antrum. A good thinker needs a clear head. A dull child of hypertrophied adenoid is but an exaggeration of the adult with a blocked nose. The inability to breathe through the nose slows the cerebration and clouds the memory. As expressed in the words of Shakespeare: "A man so dull, so dead in looks, so woe begone."

The method and degree of packing after a submucous resection has ranged from none

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through light, to metal clamps and tight packings capable of being kept moist. If there occurs a small perforation or tear no precaution is necessary but if there is a bilateral tear whose edges are opposite it is recommended that a piece of Cargile membrane be placed between the flaps to serve as an arbor and also a barrier to the formation of a permanent perforation.

#### ETHMOIDAL LABYRINTH

An anterior ethmoidal cell migrates into the frontal to pneumatize the frontal sinus. In inflammations, allergic reactions or chronic degenerations of the anterior ethmoidal cells will block the frontal duct producing frontal sinusitis. The inward displacement of the middle turbinate is the simplest procedure to improve the drainage of the frontal sinus. Probing and irrigation of the frontal sinus was once a major procedure and before the days of good roentgenograms was hazardous and only attempted by the masters.

#### INTRANASAL FRONTAL OPERATION

The resection of the anterior end of the middle turbinate and the removal of hypertrophies and polypi of the middle meatus will give immediate drainage to a mildly blocked frontal sinus. If rupture of the sinus is eminent with a risk of an orbital cellulitis an external trephination should be done for immediate drainage. When the frontal empyema is chronic, the hypertrophies about the nasal frontal duct must be removed to maintain drainage. The resection of the middle turbinate is performed by resecting its anterior attachment and the removal of the tip with a cold snare. If there is a high septal deflection this must be resected to obtain sufficient operative space. The removal of the hypertrophied uncinat process and the adjacent ethmoid cells contribute to the exposure of the frontal duct. It is not considered good surgical practice to interfere with the lining of the duct for fear of future contractions. The post-operative treatment consists of irrigation of the sinus with antibiotic solutions. Many rhinologists initially irrigate with a peroxide solution as the offending bacteria are frequently anaerobic.

#### HALLE OPERATION

Halle's method depends upon the resection of a mucoperiosteal flap and the thorough removal of the agger nasi and sometimes a part of the process of the superior maxilla. The diseased anterior ethmoidal cells are thoroughly exenterated and the duct enlarged by burrowing and a resection of the floor of the frontal sinus. The flap is tamponed into the outlet and allowed to heal. This operation cannot replace the radical operation of Lynch when the lining of the frontal sinus is diseased but if a radical must follow the intranasal approach will be an added advantage.

Ingals designed a self retaining gold cannula to keep the nasofrontal duct patent and lately strips of tantalum have been advocated by Goodale to maintain the patency of the duct.

#### INTRANASAL OPERATION UPON THE ETHMOIDAL LABYRINTH

The appreciation that infections of the posterior ethmoidal cells and the sphenoid sinus were the causative factors in many of the optical nerve disorders prompted the perfection of operations designed at their exenteration. Mosher advocated removal of a portion of the middle turbinate to enter the ethmoidal labyrinth. The cells were curetted backward from above down passing from the anterior into the posterior group. This operation was the first of the American procedures to receive international recognition.

Ballenger's operation attempted to remove as much as possible of the ethmoidal labyrinth *en masse*. With a specially designed knife the ethmoidal labyrinth was carved free around its posterior superior and anterior borders and the resected mass was drawn from the nose.

The sphenothmoidal labyrinth is too delicate and its relationship to the meninges is too close to sanction such a radical procedure *en masse*. Then too there are so few perfect labyrinths, and the anatomic variations are so great that the method is limited to only selected cases in the hands of a very few surgeons. Hajek resected the middle and superior turbinate with his hook and reduced the anterior wall of the sphenoid and the posterior ethmoidal cells with the same hook, by insert

ing the hook posteriorly and drawing it forward, and removing the shreds with forceps. Sluder improved this technique by the use of his knife and removal of incised cells with a sharp biting forceps. Yankauer eliminated much of the bleeding by ligating the terminal branches of the sphenopalatine artery.

J. A. Pratt demonstrated that the exenteration could be accomplished without sacrificing the middle turbinate. When the middle turbinate and the ethmoidal cells were extensively removed the pathological process was eliminated but the ventilation of the nose was changed and the unrestricted air currents striking against the sphenoidal area frequently produced a hypertrophy of the anterior wall of the sphenoid sinus which obliterated it.

#### ANTRAL DRAINAGE

The resection of the nasointral wall for drainage of the maxillary sinus is the simplest but frequently the best intranasal operation. The insertion of a hard rubber drain minimizes the size of the window and makes this operation acceptable for children. Robinson advocates compression of the antral membrane by a balloon for the cure of allergic sinusitis. Whether the anterior end of the inferior turbinate be amputated or displaced must vary according to the position of the floor of the antrum with relation to that of the antrum or the degree of hypertrophy of the turbinates. The operation can be spoiled by insufficient drainage or excessive ventilation with a loss of the physiological function of the turbinate.

#### POSTOPERATIVE CARE

The immediate complication of intranasal surgery is hemorrhage and the best method of its prevention is a well placed pack. The type of packing used should be impregnated with an oil and if it is to remain in over 48 hours it should contain some form of antiseptic. The ideal packing is so placed that the free ends remain outside the vestibule and folded within the nose to form a sac that cannot slip down into the nasopharynx.

If there has been free bleeding during the operation the terminal branches of the internal maxillary artery can either be coagulated or clamped off with small silver dural clips.

The center of the pack may be a cotton roll or splint capable of being saturated with a vasoconstrictor. If oozing continues after 30 minutes or begins freely after an hour it can be controlled by the administration of 5 minims of surgical pituitrin given hypodermatically every 15 minutes for 3 doses. Surgical pituitrin is also of value when administered before and after the nose is unpacked. Fortunately infections seldom complicate intranasal surgery but when they do occur must receive careful attention. Late secondary hemorrhage results from the separation of scabs and should be handled by the thorough cleansing of the nose of all clots, the control of the bleeding by adrenalin packs and the cauterization of the bleeding granulations. The use of oxycel, an absorbable oxidized cellulose as an intranasal packing has the advantage of not requiring removal and is recommended for the invisible hemorrhage especially those from beneath the inferior turbinate.

#### CONCLUSIONS

The fundamental principle of intranasal surgery is the re-establishment of normal ventilation and drainage of the sinuses and when this can be accomplished by intranasal surgery it is preferable to radical surgery.

The generation of surgeons trained in intranasal surgery is fast fading and the number of these operations has been reduced by a better knowledge of the physiology of the nose and the therapy of antibiotics.

#### REFERENCES

1. FENTON, RALPH A. *Ann. Otol. Rhin.*, 1937 46 393.
2. HILDEBRAND, A. C. *Am. J. Physiol.*, 1900 664-670.
3. *Idem.* *Arch. Otolaryng.*, 1932 16 8.
4. LITTLE, DEAN V. *Arch. Otolaryng.*, 1934, 19 55-65.
5. *Idem.* *Ann. Otol. Rhinol.*, 1935 44 671.
6. MOSIER, HARRIS P. *Laryngoscope*, 1913.
7. PRATT, J. A. *Tr. Am. Acad. Ophth. Otolaryng.*, 1919.
8. PROETZ, ARTHUR W. *Physiology of the Nose*. Chapter 31. *Clinical Applications—Nasal Surgery*.
9. SCHAEFFER, The Nose and Olfactory Organ. P. 84.
10. SHEA, JOHN J. *Tr. Section on Laryngology, Otolaryngology and Rhinology, Am. M. Ass.*, 1922 pp. 24-36.
11. *Idem.* *Tr. Section on Laryngology, Otolaryngology and Rhinology, Am. M. Ass.*, 1926 P. 59.
12. *Idem.* *Tr. Am. Acad. Ophth. Otolaryng.*, 1931 199-205.
13. SLUDER, G. *Arch. Laryngol.*, 1913 369.
14. *Idem.* *Tr. Am. Laryngol. Ass.*, 1926.
15. YANKAER, SIDNEY. *Laryngoscope*, 1931 31 831.

## THE CLOSURE OF SURFACE DEFECTS WITH FREE SKIN GRAFTS AND WITH PEDICLE FLAPS

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**I**N the Medical Department report of World War I, about 300 pages are devoted to plastic surgery no mention is made of free skin grafting however except that in one sentence a graft inside the mouth is suggested. Also no mention is made of the treatment of burns. In contrast to this, in World War II roughly one-third of the work in the centers for plastic surgery was the treating of wounds by free skin grafting and in addition a large volume of work was done in treating burn defects.

After World War I plastic surgeons in civilian practice developed methods and services for the repair of extensive burns, and except for a short time during which excessive attention was focused on the irreversible sealing methods of treatment (tanning) steady progress has been made in a basic philosophy of treatment of deep burns, viz. to make open areas as clean as possible as soon as possible and to restore skin that has been lost. Still further progress has been made in the concepts of treatment that aim at the start toward keeping burned areas clean. However the essential point remains that deep burns are apt

to become infected and certainly in military surgery they cannot all be kept ideally clean. There have been cared for in the plastic centers patients by the hundreds with no skin on their heads, faces, or hands and with large open areas over the body and extremities, with sloughs, contamination, infection, pain, and when evacuation has been delayed with the usual "blown" contamination that results from lack of change of dressing.

These patients present all the problems of nutrition chronic shock, blood chemistry and wound healing that may occur and these complications are all dependent on open wounds. Therefore the basic surgical consideration is to get the wounds healed as soon as possible, by means of free skin grafts. Any spontaneous healing that may occur is welcome, but long delay in waiting for spontaneous healing adds pain contractures, and fixation of joints, as well as a chance for further depletion. As large open wounds heal either spontaneously or by grafting the general condition improves proportionately. In some instances grafting has been done in spite of the presence of local infection uncontrolled by chemotherapy such a graft to close the wounds has been life-saving. Raw open areas as large as 200 square inches are frequently successfully grafted at one operation. These extensive procedures as well as others for the restoration of function in the words of one World War I surgeon would have been fantastic at that time.

While free grafts have been used most extensively in repairing burns, they have been applicable and valuable also to cover large open areas for other causes, such as gunshot and shell fragment wounds. One of the most important areas to benefit from free grafting is the hands. By early closure of burns and other defects of the hands, there have occurred many dramatic results in which function that otherwise would have been lost has been preserved. This statement applies to other ex-

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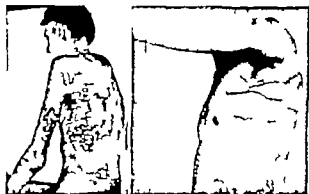


Fig. Widespread burn restored in minimum number of operations with split skin grafts.

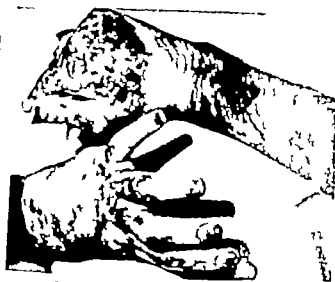


Fig. 2. Complete crippling of hand restored in a single operation of free skin grafts.

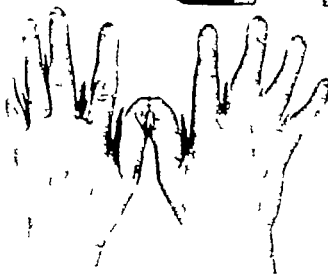


Fig. 3. Widespread loss from shell fragment. Restoration in one single operation with free skin grafts.

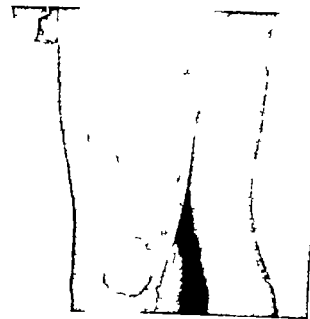


Fig. 4. Chronic traumatic ulceration of both legs. Disabled many years. Complete healing following single operation with free skin grafts.

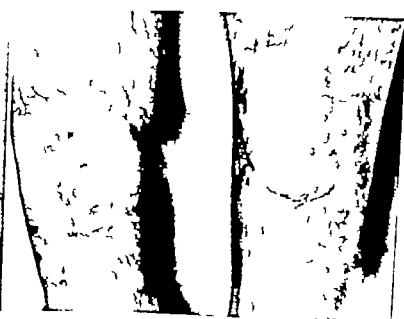






Fig. 5. Restoration of eyelids with full thickness grafts from clavicular region.

tremities. In some plastic centers, most of the work has been on the hands and extremities and only about one-third of the work has been on the face.

For making very extensive repairs, the split skin graft, or some version of it, must be used so that the donor site will heal promptly. In cases in which 250 square inches are transferred at one time it is essential that a method of grafting be used in which prompt healing of the donor site can be had. If grafts are cut too deep much added crippling may occur. In some instances it has been necessary to discharge patients because of trouble in donor sites that exceeded the original lesion.

A special area about the face may be mentioned and that is the eyelids. When eyelids are burned and contractures follow the eyeball is left exposed and impairment of vision may result. In hundreds of instances satisfactory protection of the eyeball by the lid has been regained with a free skin graft to resurface the lids. A special type of graft has been used for this work that is adaptable in function as well as color and appearance. Such a graft is of full thickness and is taken from the clavicular region—the supply is limited, but it affords the best color match and because of its character—presumably from its position in the platysmal area, gives excellent function.

Homografts have been used frequently to tide seriously ill patients over critical periods. These grafts, of course, are not permanent, usually lasting from 3 to 12 weeks. The wounds are literally "dressed" in the homografts. These grafts can be taken at autopsy if complete releases for the procedure can be obtained from the relatives and the patient. Such grafts have been taken as long as 4 hours after death and have been stored refrigerated for 6 more hours so that successful homografts have been done after as much as 10 hours delay. Longer periods have been recorded but the use of refrigerated skin has not been developed into a routine procedure.



Fig. 6. Direct flap restoration of full length of forearm. 8 days' fixation to the abdomen.

In the use of free skin grafts (as in other procedures in plastic surgery) a tendency has been noted to suppose on one hand that perfection can be obtained in difficult restoration of features and surface smoothness and on the other hand to neglect simple procedures in grafting that could result in healing of long standing lesions or deformities. For example one soldier was seen who had been off duty practically all of 9 years with traumatic ulcers of both leg. These were grafted in one operation and the patient was sent to duty.

In lesions for which free grafts will not suffice, such as gunshot and shell fragment wounds and in cases in which features are lost, restorations with pedicle flaps must be done. Whereas in the past the majority of flap repairs have been done with tubed flaps, it has been demonstrated in hundreds of patients that direct (or delayed) flat flaps can be used successfully. The principle of a short broad pedicle is substituted for that of a long narrow tubed one, and if the application can be made as a direct transfer (that is without delaying the flap) a procedure may be completed in days that otherwise might require months. This has accounted for the saving of thousands of patient hospital months.

One of the main usages for the direct flap is in the repair of hand and arm defects. The flaps can be put on at early dates following the injuries or later after the extremity has healed. It is possible to cover practically a whole forearm with a direct flap from the abdomen in 18 to 20 days and many seriously damaged extremities have been saved. It might be said that these procedures are the opposite of amputation. When applied early union of un-

derlying fractures has been found to progress more rapidly and successfully and function is necessarily established at the earliest date.

In late deformities with surface scarring and with defects of nerves, tendons, bones and joints, it is essential to obtain adequate surface 'healing' with a flap before satisfactory deep restorations can be done. The deep healing can be no better than the surface healing and patients have been seen with wire foil screws, plates, bone grafts and bone fragments protruding through wounds that did not have adequate surface healing. By removing dead and foreign material dissecting scar back to an adequate minute blood supply and making a repair with a flap of suitable thickness, so that the deeper tissues can be approached through good viable tissue that will heal promptly and protect whatever repair has been carried out on nerve tendon, bone or joint, the orthopedic or neurological surgeon has been afforded valuable assistance in his work.

There are details and variations of work too burdensome for this report but it is of importance to call attention to the fact that thousands of wounded soldiers have been successfully restored from serious surface defects by direct methods of free grafting and flap transfers.

The work has been done by many different civilian surgeons working in the services and in amount far in excess of any other period. Amputations have been practically nil as has also the operative death rate. Good team work is necessary between surgeons, nurses, anesthesiologists, rehabilitation workers and, of most importance, the wounded patient.

# NEUTRALIZATION OF COLOR IN CAPILLARY HEMANGIOMAS OF THE FACE BY INTRADERMAL INJECTION (TATTOOING) OF PERMANENT PIGMENTS

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**I**N the treatment of capillary hemangiomas of the face the goal is the obliteration of the lesion so that appearance approximates normal. The authors' observations to date have led to the opinion that current methods of treatment including electrocoagulation, cauterization, radiation, sclerosing agents, and carbon dioxide snow are not satisfactory. Moreover, the plastic excision of such lesions from the face leaves much to be desired since usually it is necessary to resort to the use of a free graft of skin. Small grafts of skin taken from the postauricular area or from the supraclavicular area match the color of the skin of the face very well but if a larger graft is used this must be taken from a protected surface of the body the color match of which is not acceptable. Often such skin grafts on the face must be treated by the permanent injection of insoluble pigment (tattooing) into the derma in order to effect improvement in appearance. Therefore, the possibility of injecting pigments into the skin overlying capillary hemangiomas has been suggested. Results following permanent pigment injection of 7 cases of capillary hemangioma on the face are reported herein.

The process of tattooing for religious, ornamental or identification purposes is reported as far back as 2000 B.C. in Egypt and 1100 B.C. in China. Today mankind continues to practice tattooing for these same reasons. Natives of the jungles still use this practice as a method of tribal identification and civilized peoples still employ tattooing for physical decoration. The use of tattooing as a form of medical therapy can be traced to 1835 when

Pauli employed it in the treatment of nevi, congenital purple plaques and other lesions of the skin. Cordier (1848) advocated the tattoo treatment of nevi and Schuh (1858) had the idea of using skin previously tattooed and then transplanted to the site of repair in the practice of cheiloplasty. In 1879 de Wecker used India ink successfully in coloring the corneal parenchyma. Thirty-two years later (1911) Kelle reported the use of tattooing with rose pigment to change the contour of the vermilion border of the lip. He also pointed out that nonadherent, flat, white scars were improved in appearance by the use of tattooing. Knapp (1925) and Duggan and Nanavati (1936) used gold and platinum chloride to tattoo scars of the cornea. Pickrel (1946) has demonstrated evidence in color photographs of excellent results following the tattooing of the cornea. Credit is given to Morestin to Mauclair, to Dufourmentel and to Passot by Bankoff (1943) for introducing the treatment to general plastic surgery. In the recent literature Hance Brown Byars and McDowell (1944) called attention to the value of tattooing in the color matching of skin grafts and flaps on the face and in the simulation of the vermilion of the lip. Byars (1945) also reported successful intradermal pigment injection for color matching purposes in 60 cases of free skin grafts and flaps of tissue on the face. Brown Cannon and McDowell (1946) reported improvement in appearance of one patient with a capillary hemangioma of the face following permanent injection of tattoo white and Chinese white.

## TECHNIQUE

The area to be injected is washed with soap and water, painted with aqueous solution of merthiolate and draped with sterile towels. Instruments and pigments are sterilized. The

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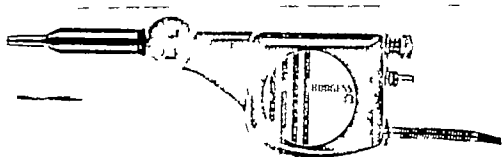


Fig. 1. Electromagnetic device with six needles which is used in the permanent pigment injection of capillary hemangiomas.

technician wears sterile rubber gloves. The area should be free from infection. It has been found expedient to use the standard electromagnetic device to which six needles are attached. This is shown in Figure 1. With sterile water the pigments are mixed into a thick paste which is picked up in the cup of the needle holder when the needles are withdrawn into its shaft. The current which causes rapid oscillation of the needles is operated by a foot control. The needles are inserted into the skin at an angle of approximately 60 degrees so that the pigment will be injected obliquely at varying depths in the derma. In the tattooing of skin grafts bleeding from the needle holes is minimal. Bleeding may be bothersome when injecting capillary hemangiomas. The basic pigments which are in use at present include the following

White  
Yellow  
Red  
Blue  
Black  
Green

Titanium (or zinc oxide U.S.P.)  
Oxide of iron  
Mercury sulphide (or cinnabar)  
Cobalt blue  
Black oxide of iron  
Hydrated chrome oxide

Combinations of these pigments usually will produce the desired tints. In addition ochre sienna, and other earthy metallic oxides may be used. All of these pigments are insoluble and they may be sterilized in 70 per cent alcohol or may be autoclaved. The mixture of colors varies with the individual case. For the covering of capillary hemangiomas white is the basic pigment, occasionally mixed with a very small amount of red or green. At the first treatment, a small area is injected and a record is kept of the color combination. Three



Fig. 2. Low power photomicrograph of capillary hemangioma after injection of pigment. Note that the particles of pigment are deposited chiefly in the upper layers of the derma, superficial to the capillary dilations.



Fig. 3. Low power photomicrograph of normal skin tattooed for decorative purposes by a commercial artisan. In comparison with Figure 2 the pigment is more dense. It is scattered indiscriminately but is concentrated in the deeper layers of the corium.

TABLE I.—CAPILLARY HEMANGIOMAS TREATED BY TATTOOING

Case No	Diagnosis	Size of lesion	Pigments used	No. treatments	Result
	Capillary hemangioma (cheek)	6 5 cm	White	3	Marked improvement
	Capillary hemangioma (cheek)	5 5 cm	White Green		Marked improvement; lesion barely perceptible
3	Capillary hemangioma (cheek)	8 cm	White	5	Marked improvement; lesion barely perceptible
4	Capillary hemangioma (cheek and eyelids)	9 cm	White Green Red	13	Result excellent
5	Capillary hemangioma (neck and cheek)	3 7 cm	White Green		Marked improvement; some scarring of skin
6	Capillary hemangioma (cheek)	3 7 cm	White		Marked improvement. Another treatment will be necessary over entire lesion
7	Capillary hemangioma (cheek)	20 0 cm	White	4	Improvement; still under treatment. One-third of lesion has been excised

to four weeks are allowed to elapse before judgment is passed on the effect of treatment. Usually there is some absorption or desquamation of pigment and a second or a third treatment over the same area may be necessary before the desired result is obtained. Following the treatment a sterile dressing is applied. The patient is seen in 24 hours at which time a crust is present over the area which has been injected. As this peels away during the next 6 to 10 days the effect of the injection may be observed. Once the proper combination is decided upon treatments may be given at 2 week intervals until the entire lesion is injected. An area of 2 to 3 square inches may be injected in a 1 hour sitting by a skilled technician. The number of treatments depends upon the size of the lesion. The injection causes some discomfort but the average individual tolerates this without anesthesia. In 1 case in the series, that of a child  $3\frac{1}{2}$  years old, the patient was admitted to the hospital and the treatment was given under avertin anesthesia.

#### OBSERVATION ON THE DEPOSITION OF PIGMENT

Figure 2 shows a low power microscopic section taken from a portion of a capillary he-

mangioma which had been tattooed (Case 1). The section shows a strip of skin with extensive tattooing and a rather fibrous corium. As noted in other examples, all colors of pigment appeared black occasionally with a reddish brown tint, on microscopic examination. It is impossible to distinguish the different colors either in stained or unstained sections. The pigment is scattered mostly in phagocytes in the upper layers of the corium. This figure is in contrast to Figure 3 which shows a low power microscopic section of skin taken from an area tattooed on the arm for decorative purposes by a commercial artisan. Here the pigment is much more dense. It is scattered more indiscriminately but is chiefly in the deeper layers of the corium and is massed about the ducts of the sweat glands. Study of microscopic sections of capillary hemangiomas leads to an understanding of the mechanism of color in these vascular abnormalities. The melanin which gives color to the skin is in the stratum germinativum of the epidermis. The vascular channels of the capillary hemangioma are in the subcutaneous tissue and to a lesser extent, in the deeper layers of the derma. The intensity of the red color of the great numbers of erythrocytes in the hemangioma reflected to the surface through the normal

Fig. 4. Case 4. a, Capillary hemangioma of cheek and eyelids. At the time of this photograph the lower portion of the lesion had been given treatments of pigment injection. b, Result after patient had been given 3 treatments. There was moderate, transient edema of the eyelid following the injections of pigment into the skin of these areas.

Fig. 5. Case 5. a, Hemangioma of the skin of the neck and cheek. b, Appearance after series of treatments

consisting of the injection of permanent pigments into the derma.

Fig. 6. Case 6. a, Capillary hemangioma of the cheek in a child  $3\frac{1}{2}$  years old. b, Appearance after one treatment consisting of intradermal injection of pigment. Avertin anesthesia was necessary. It was possible to cover the entire area in one treatment but complete obliteration of the color of the hemangioma was not effected. Further treatment is planned for this case.



Fig. 4.



Fig. 5.



Fig. 6.

*Neutralisation of Color in Capillary Hemangiomas of the Face by Intradermal Injection (Tattooing) of Permanent Pigments —Herbert Conway and John P. Docktor  
(Legend on opposite page)*



pigment of the skin in its upper layers thus giving the effect of dark red to purple. In order to overcome the abnormal color of the capillary hemangioma it is desirable to concentrate the pigment in the derma, deep to the stratum germinativum of the epidermis and superficial to the vascular dilatations of the capillary hemangioma. Since Figure 2 and microscopic sections from other tattooed capillary hemangiomas have shown the concentration of tattoo pigment to be in the upper layers of the derma it is believed that any pigment which may have been deposited in the epidermis subsequently is lost through desquamation and that pigment which may have been injected into the capillary sinuses is carried off in the blood stream.

#### CASE REPORTS

Cases 1 to 7 are examples of port wine stains or capillary hemangiomas. As described by Lister these are sharply defined areas of intense erythema usually about the face and neck and not elevated above the surrounding skin. Present at birth they do not extend to involve new areas of the skin and they show no tendency to spontaneous regression. Table I lists the size and location of lesions, the number of treatments, the combination of pigments and the results.

#### SUMMARY

Report is made of 7 cases in which intradermal injection of insoluble pigment through electromagnetic needles (tattooing) has been used in the neutralization of the color of capillary hemangiomas. The management of these cases required a total of 40 treatments.

With one exception these treatments were done without anesthesia. The exception is the case of a 3½ year old child in which the single treatment was done under avertin anesthesia. There have been no complications. Microscopic sections of capillary hemangiomas so treated have shown that the desired result is obtained by injection of the pigments into the upper layers of the derma. All of the patients with capillary hemangiomas have been satisfied with the result of treatment. The technique of administration and a description of apparatus and pigments are given. Opinion is advanced that the intradermal injection of permanent pigments (tattooing) is a method of treatment which satisfactorily neutralizes the color due to capillary hemangiomas.

#### REFERENCES

1. BANKOFF, GEORGE. Plastic Surgery. London Medical Publications, Ltd., 1943.
2. BROWN, J. B., CANNON, B. and McDOWELL, A. Surgery 1946, 1: 106.
3. BYARS, L. T. Ann. Surg. 1945, 121: 644.
4. CORDIER. Cited by A. Lacaze and E. Magitot in Dictionnaire des sciences médicales, 1886. Vol. 95: 103.
5. DE WICKER, L. Chirurgie oculaire. Paris O. Doin 1879.
6. DUGAN, J. N. and NAMAVATI, B. P. Brit. J. Ophth. 1936, 20: 419.
7. HANCE, G., BROWN, J. B., BYARS, L. T. and McDOWELL, F. Surg. Gyn. Obst. 1944, 79: 624.
8. KRAFF, P. Klin. Mbl. Augerh. 1925, 75: 22.
9. KOLLE, FERDINAND STRANGE. Plastic and Cosmetic Surgery. New York D. Appleton & Co. 1911.
10. LISTER, W. A. Lancet, Lond. 1938, 1: 1429.
11. PAULI. Application de tatouage à la cure des naevi materni. In Siebold's Journal 1835, 15: 1.
12. PICKEREL, K. Presentation before the annual meeting of the American Society of Plastic and Reconstructive Surgery Inc., Kansas City Mo. Nov. 16, 1946.
13. SCHUB. Application de tatouage à la cheiloplastie. Wien med. Wochr., 1858, 8: 809.



## PRESERVATION OF JAW FUNCTION FOLLOWING SURGERY AND TRAUMA

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**O**PERATIONS on or trauma to the jaws, the adjacent cheeks, or in the neighborhood of the joints may jeopardize function. The mandible, being the moving member is the part usually causing the most concern.

Removal of a section of the mandible creates an immediate and serious problem in management of the remaining fragments (1). If not controlled and held in proper relationship the attached muscles may pull the fragments medially and backward allowing the tongue to fall back in the throat and shut off the airway (Fig. 17). When such a patient survives the initial breathing and feeding hazards, the secondary repair of the bony defect is needlessly complicated by the necessity of laboriously restoring the fragments to their original relationship before the bone graft can be done (Figs. 7-12). This is particularly difficult when the posterior fragment has been pulled up into the temporal fossa and fixed there by

shortened muscle and scar. An unnecessary oral fistula may further complicate the problem, prolong the rehabilitation, and make the patient miserable. Such operations often entail the loss of soft tissue with the formation of binding scar. Even resection of the part thickness of the mandible may produce this same result, if not this extreme, at least causing a loss of the buccal sulcus and inability to wear a denture.

Mandibular resection is usually performed as a planned procedure so that an adequate scheme is prepared in advance (1). Occasionally however one may be faced with the traumatic loss of bone creating the same problem. Where available, the simplest and best procedure is simply to wire the teeth of the fragments to their corresponding maxillary teeth (Fig. 12). Table IA indicates the mechanical possibilities where both fragments contain teeth. When partially or wholly edentulous, or in children where the teeth are not adequately developed the problem is more difficult and the schemes available without preliminary preparation are few. The appliances adapt

From the Department of Surgery, Division of Plastic Surgery, Washington University School of Medicine. Presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-20, 1946.



Fig. 1. Result following resection of the mandible for early osteogenic sarcoma. The mandible was resected and an internal bar inserted, the patient leaving the hospital entirely healed within 4 days. The bar is in place as shown 4 months after operation. There is no drainage and no evidence of bone reaction. Patient is allowed to chew soft foods. The mandible feels reasonably solid to palpation and there is only slight deviation of the chin on opening of the mouth. Eventually bone graft will be required if the malignancy proves to be controlled.





Fig. 2. Result following upper neck dissection, resection of the mandible and a large area of buccal mucosa for a carcinoma arising on the alveolus. Internal bar was inserted at operation as shown. Patient was healed within 3 weeks and returned to work within 6 weeks after operation. The bar is present without reaction or drainage 10 months after operation. Eventually the bar will probably be removed or supplemented with a bone graft.

ble to this problem are outlined in Table I—B and C.

TABLE I.—APPLIANCES USED TO CONTROL FRAGMENTS OF MANDIBLE AFTER RESECTION

- A
- Appliances which utilize teeth (intraoral) posterior fragment contains teeth
- Interdental wires.
  - Arch bars.
  - Swaged metal splint (with or without jack-screw)
  - Splint on teeth with dependent part separating bone
- B
- Appliances which utilize bone and teeth (intraoral and extraoral) short edentulous posterior fragment
- Wire teeth in occlusion and use modeling compound in molar area to keep posterior fragment down.
  - Arch bar or splint with posterior fork to keep posterior fragment down.
  - Arch bar or splint on mandible with posterior portion accurately fitted to junction of body and anterior border of ramus. (Herpin splint with or without jack screw)
  - As in (c) except arch bar or splint applied to maxilla with interdental wiring.
  - Arch bar or splint with posterior part attached
    - Directly to bone.
    - To bone screw
  - Wire passed through drill hole near angle of mandible and attached posteriorly to head cap and wire rest of jaw in occlusion.
- C
- Appliances which utilize bone (intraoral and extraoral) Number of teeth and size of posterior fragment not necessarily a consideration
- Bone screws (and bar) inserted with each fragment. (Stader Berry Griffin, etc.)
    - Intraoral.
    - Extraoral (preferred)
  - Kirschner wires (modified) passed through fragments.
  - Bar interposed between ends of fragments (Figs. 1 & 2 4, 5 6 17)
  - Open bite splint attached with circumferential wires.
- Also controls fragments adequately for insertion of bone graft.  
 †Not ideal for bone graft because of local osteomyelitis around bone screws and subsequent loss of stability of splint.



Because of the difficulties involved in repair following jaw resections it is desired to call attention to the operation of subperiosteal resection (2). It has frequently been observed that the mandible will regenerate with surprising adequacy after the sequestration of large segments following osteomyelitis (Fig 16). Similar regeneration will occur following subperiosteal resection (Figs 3 4 5).

Obviously this procedure cannot have widespread application. Subperiosteal resection is inadequate in the treatment of many tumors; it could rarely be safely performed in the treatment of any of the malignancies. Occasionally in dealing with adamantinomas, os



Fig. 3. a, Photograph of 8 year old child before operation showing enlargement of right jaw. b, 11 months after subperiosteal resection of the mandible. Microscopic diagnosis of tumor removed was ossifying fibroma. (I and Reconstructive Surg. 1946, 1: 235.)



Fig. 4. a, Preoperative roentgenograph of tumor. b, Immediate result of subperiosteal resection. c, X-ray film taken 8 weeks following subperiosteal resection and insertion of internal bar. A strand of lingual periosteum was preserved which supplied regeneration as shown in this

short period of time. Wound has healed 10 days after operation. There has been no subsequent inflammation or drainage, and at the end of 26 months, the bar is still in place and the mandible strongly healed. (Plastic and Reconstructive Surg. 946, 1 238.)

sifying fibromas, osteomas or even with more simple tumors which have caused extreme expansion of the bone, the entire thickness of the bone must be removed but some strands of periosteum can be left bridging the gap between the ends. If the fragments are adequately controlled regeneration will readily occur especially in children (Figs. 3 4 5)

In dealing with children splinting or interdental fixation is unsatisfactory. The same may be true in adults if the fragments are wholly or partially edentulous. In such cases holes may be drilled in the ends of the bones and a bar of stainless steel inserted to bridge the defect (Figs. 1 2 3 4, 5 6 17). Surprising rigidity results from this procedure and al-



Fig. 5. a, Tumor of mandible in a 9 year old boy. At operation it was found that the entire thickness of the mandible was expanded and it seemed impossible to remove the tumor adequately and retain any bone at the tumor site. The periosteum was not involved except near the alveolus. A subperiosteal resection was performed and an internal bar inserted. The wound was completely healed in 10 days. No interdental fixation was required. b, Regeneration present 7 weeks following operation. Repeated x-ray films have been made to date over 18 months' time. No evidence of bone reaction is present. Wound is healed. The bar is still in place and there is no external deformity. (Plastic and Reconstructive Surg. 946 37)

Fig. 6. Roentgenogram of mandible of an 83 year old man following operation for carcinoma of the buccal mucosa and alveolus with metastasis to the upper neck. Oral portion of dissection was done with the cautery. An internal bar was inserted as shown. The neck wound was packed open because of the cauterized wound which was present. This healed down to a very small oral fistula which was closed 4 months after the operation. Although there was no reaction around the bar it was removed at that time, having served its purpose of maintaining normal position of the fragments during the period of soft tissue healing. Especially in older people it is important to maintain the rigidity of the mandible during the immediate postoperative period to minimize respiratory difficulties.

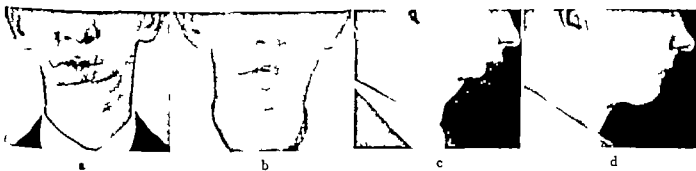
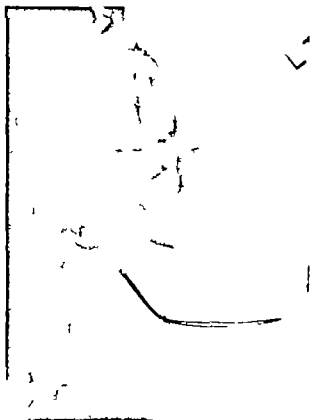


Fig. 7. a, c, Front and profile photographs of a patient who had lost anterior portion of the mandible from bicuspid to bicuspid area and soft tissue of the lip, chin, and floor of the mouth as the result of a gunshot injury. Note the narrowness of the face over the region of the angle of the mandible, the result of the remaining portions of the mandible being pulled inward by scar. Two previous attempts

at bone graft elsewhere had been unsuccessful because of the inadequacy of the soft tissue covering. b, d, Front and profile views of the same patient following restoration of soft tissue lining of lip and floor of mouth and covering of the chin and successful bone graft as shown in Figure 8. The lower lip was filled out by a triangular flap rotated from the center of the upper lip. Patient is wearing dentures.

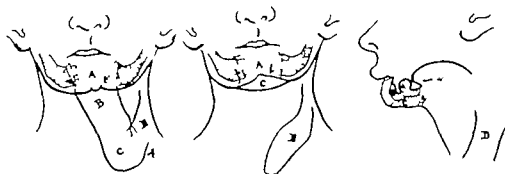


Fig. 8. Diagram illustrating source and use of the soft tissue flap for restoration of soft tissue loss in patient shown in Figure 7.



Fig. 9. a, Huge ameloblastoma of the right mandible of 5 years duration. b, Result following hemisection of mandible. There has been no bone restoration. The deviation of the remaining portion of the mandible from the midline is minimized by accurate closure of the wound, and maintenance of remaining fragment in normal position during the period of healing and subsequent scar tissue pull (Surg. Gyn. Obst., 943, 5-577)

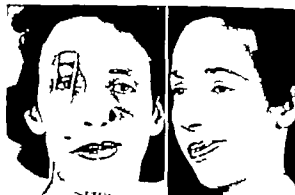


Fig. 10. a, Defect of face, palate and lining of cheek resulting from radical operation for carcinoma of the antrum. Patient has inability to open the mouth because of fixation of the coronoid process in operative scar. Applicator sticks are inserted in skin lined pocket underneath forehead flap which has been prepared for use in soft tissue repair. b, Final result obtained by restoration of half of the palate and buccal mucosa, letting in the flap through the hole in the cheek. Mouth opening was obtained by intraoral resection of the coronoid process. Another section of the same flap was used to fill the cheek defect after severance of the pedicle from the portion reconstructing the palate.

though additional fixation is desirable for a time, if available, it is not essential. Where possible, the mucous membrane should be accurately closed to exclude the neck wound from mouth contamination.

Following the conventional resection of the mandible the space retention apparatus must be worn long enough to insure that the fragments may be easily restored to their proper positions at the time for bone grafting. At such time some other scheme for fixation may be employed, possibly even utilizing the graft for partial fixation.

Soft tissue considerations before a bone graft to the mandible is done, adequate soft tissue covering for the graft must be present (Fig. 7). At the time of injury or resection all possible soft tissue must be preserved. This entails accurate closure of wounds and avoidance of continued infection with resultant wasting of tissues (Figs. 9-14). If the quality or amount of soft tissue is inadequate to cover the graft easily and heal readily afterward it

must first be supplemented with a skin graft, pedicle flap or by mobilization of local tissues (Figs. 7-8).

Because of the nature of the defect following resection of the mandible, the graft must be of the onlay type applied along the inferior and lateral borders of the mandible and overlying the bodies of the fragments. If it is desired to place the graft between the ends of the bones, anatomically replacing the resected segment, then a pedicle flap must be used intraorally between the ends of the bones to provide a good strong covering which will not be torn at the time of the dissection for the placement of the graft (Fig. 8).



Fig. 11. a, Front and profile view of a man 35 years old who has had ankyriosis of the left temporomandibular joint since childhood. b, Correction of asymmetry of the mandible

with cartilage transplant to make the chin more prominent and alleviate flatness over right mandible. Mouth opening was gained by resection of left temporomandibular joint.





Fig. 6 a, Osteomyelitis of the mandible with pathological fracture. b, Beginning regeneration of mandible following spontaneous sequestration and control of infection by conservative means. c, Adequate regeneration of the

mandible 4 months after acute infection. There is no external deformity. Radical surgery with removal of bone before spontaneous sequestration could surely have resulted in lack of continuity of the bone necessitating bone graft.

of such a scar and covering the enlarged defect with a free skin graft if it is superficial or a pedicle flap if deep will give permanent relaxation (Fig. 10).

Subsurface scarring in the region of scant clearance between coronoid process and zygomatic arch may cause firm fixation in a closed position. This may result from operation, infection, or the use of radium in this neighborhood. Adequate resection of the coronoid to release one point of scar anchorage will give relief (Fig. 10).

Not infrequently mandibular resection with widespread soft tissue destruction is performed in cancer patients where restoration of mandibular continuity is not contemplated. Here it

is desirable to maintain function as far as possible. Internal bar fixation as described under subperiosteal resection has been very valuable under these circumstances, inasmuch as the remaining fragments are retained in normal relationship, preventing immediate pharyngeal collapse with its dangers. Such fixation has been maintained without difficulty for several months eventually working free. During this period, however, the open wound has healed without the contracture which would pull the remaining fragment well out of position had not such fixation been maintained. Even though the patient's age and disease may not warrant complete repair, the disability has been minimized (Figs. 2, 6, 17).



Fig. 17 a, Roentgenograph of Osteosarcoma of the symphysis. b, c, Roentgenogram showing resected area of the mandible with stainless steel internal bar fixation. The retractor around the hyoid bone and holds the larynx

forward to permit normal breathing. Resection of the symphysis region are especially hazardous when this scheme is utilized to maintain the function of the genioglossus and geniohyoid muscle groups.

Surgery, trauma, or infection in the neighborhood of the temporomandibular joints may result in either bony or fibrous ankylosis of these joints (Fig. 11). The intraoral use of radium or radon in this area may lead to such a condition. Frequently in addition to the joint obliteration the coronoid may be anchored to the zygoma (Fig. 10). In such conditions adequate resection of the joint, including the coronoid process if necessary, will give relief. More dependence should be placed in the adequate removal of bone at the site of resection than in the application of some substance between the resected ends. If adequate bone is removed the masseter muscle on the outside and pterygoid muscle on the inside will naturally fill the dead space between the cut ends, the amount of bone removed preventing reankylosing.

Under some circumstances this resection may be done from within the mouth. It is often more practical to make the approach from in front of the ear, reflecting the facial nerve downward, outward and forward or from the neck, elevating all soft tissues including the facial nerve from the ramus of the mandible and beginning the resection on the ramus above the angle and working up to include the condyle and coronoid process. In

some cases of ankylosis this is not too much bone to remove. Resection of the ramus of the mandible above the angle causes very little dysfunction and does not disturb dental occlusion as does resection of the body.

To wear dentures successfully the following factors must be considered: adequate mouth opening, mandible in continuity, adequate alveolar ridge and buccal sulcus to seat the denture, soft tissue of adequate quality covering unavoidable irregularities, upper and lower arches of proportionate size (Figs. 13, 14).

The presence of other anchoring teeth may be of help in making up for some other deficiencies.

Following loss of soft tissue within the mouth or local removal of part thickness of the mandible the prominence of the alveolar ridge may be lost. In such an instance an adequate incision in the buccal sulcus and application of a split thickness skin graft may be adequate. One must plan for considerable shrinkage in such a graft.

#### REFERENCES

1. BYARS, L. T. and SARMAT, B. G. *Surg. Gyn. Obst.*, 1945, 81: 575-584.
2. BYARS, L. T. *Plastic and Reconstructive Surg.* 1946, 1: 236-239.



# STUDIES IN THE ANATOMY AND REPAIR OF CLEFT PALATE

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WE did not have a clear understanding of the anatomy of the palate and particularly of the physiology of the muscles associated with the palate until we dissected the palate and structures associated with it. In fact we did not comprehend the abnormal physiology of the cleft palate until we had dissected a cleft palate specimen and studied the deficiency in the bony anatomy of the palate in clefts. Apparently no one else understood it until the explanation of how velopharyngeal closure is produced was brought out in the literature Wardill and Whillis, and Dorrance and Shirazy—all at about the same time—described how this function was performed. Hitherto it had been thought that in cleft palates the soft palate was grasped in some way by the superior constrictor muscle much the same as an obturator is grasped by the superior constrictor when a cleft exists.

Our anatomical studies show that closure is produced by the contraction of the superior constrictor muscle. Nowhere in the body that we know of is an orifice closed except by a complete circular muscle.

Material from America: Ochsner Hospital and Doctors Hospital, Philadelphia.  
Presented before the Clinical Congress of the American College of Surgeons, Cleveland, Ohio, December 6-10, 1945.



Fig. 1. a, left Superior constrictor before contraction. Opening between nose and pharynx open. b, Superior constrictor in contraction. Opening between nose and pharynx closed.

The action of this so-called superior constrictor muscle is peculiar in that there is a compound action. If you will refer to Figure 1, a, you will get a more graphic conception of this muscle. The superior constrictor in the posterior pharynx is one muscle, having attachments on either side as it comes forward one part goes to attach to the hamular and pterygoid processes the other splits off and is mesially attached to the soft palate, extending so far mesially that the fibers interlace with fibers of the opposite side. Figure 1 b shows these muscles in contraction—that is the superior constrictor has within its grasp the salpingopharyngeus muscle as well as part of the levator palatini. This perhaps is better shown in Figure 2. Here you can note that the palate is fixed to the posterior nasal spine and posterior border of the bony palate. If this is so then there can be practically no retroposition of the normal or cleft palate and its attachments during normal speech. If Figures 2 and 3 are studied it will be noted that when the fibers on the outer edge of the superior constrictor muscle which are attached to the hamular process contract, they draw the posterior wall of the pharynx forward. In this way they put the inner portion or circular fibers of the superior constrictor in position so that, when they contract, they produce velopharyngeal closure. As previously stated it is not possible to pull the palate backward because the superior constrictor muscles and the tensor palatine muscles are inserted into the palatine fascia, which in turn is inserted into the posterior border of the hard palate and to the posterior nasal spine. Now after the repaired cleft soft palate has been displaced backward to its normal position then this inner muscle which is marked on Figure 2 as the palatine fibers of the superior constrictor acts as a circular muscle and produces the closure. This is the

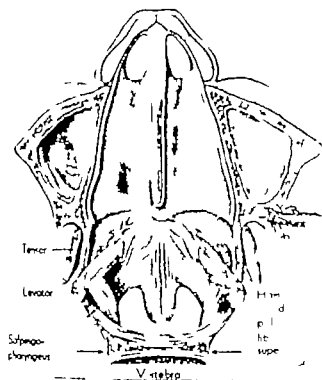


Fig. 2. Superior constrictor muscle at rest

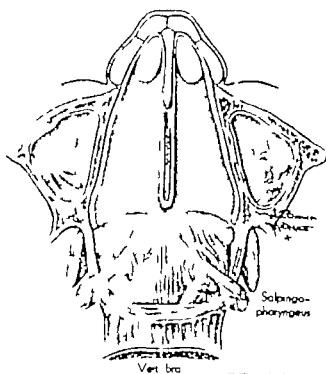


Fig. 3. Superior constrictor muscle in contraction.

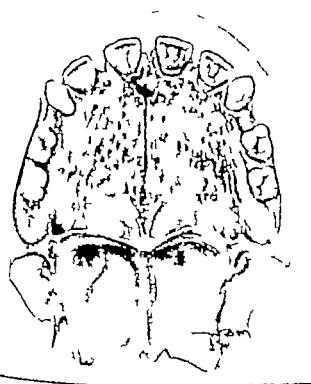


Fig. 4. Normal bony palate showing posterior nasal spine.

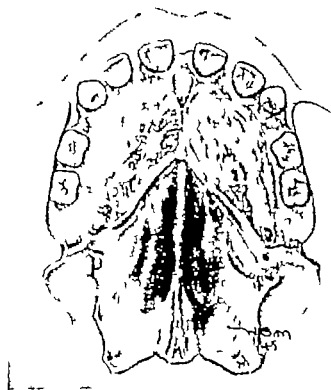


Fig. 5. Bony palate in cleft of the hard and part of the soft palate.

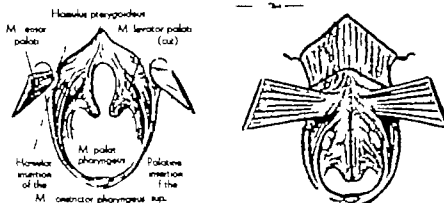


Fig. 6 a, left Note size of opening before push-back. b, Note size of opening after push-back.

normal physiological action for closing off the nose from the pharynx.

To recapitulate This physiological closure of the nose from the mouth was not understood by us until these studies were made. The normal closure is caused by the contraction of the outer fibers of the superior constrictor muscle which runs to the hamular process on either side pulling the posterior wall of the pharynx forward thus permitting

the inner portion of the superior constrictor muscle to act as a sphincter and produce closure. This anatomical physiological development was worked out by Dorrance and Shirazy (Figures 2 and 3).

If one knows the normal anatomy and then looks at a skull or better a dissection of a cleft palate case as shown in Figures 4 and 5 one will note that in the normal palate there is a posterior nasal spine and that the palatine

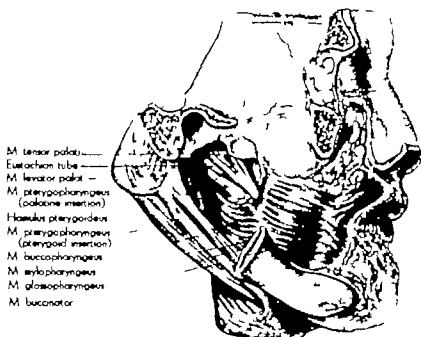


Fig. 7 N to size of the tensor palatine muscle.

aponeurosis is inserted into this area, as shown in Figure 4. In Figure 5 in which there is a partial loss of the hard palate it will be noted that the palatine aponeurosis is inserted along the margin of the cleft palate and if Figure 6 a, is studied it will be noted that the space back of the palate is so great in diameter that the anterior ends of the inner portion of the superior constrictor can not close this opening because the palatine aponeurosis has been drawn too far forward into the cleft. This Figure 6 a and b illustrates a point that we particularly want to bring out. If the palate is retrodisplaced so that the portion of the palate which was normally attached to the spine is now put in the position where it would be if the spine were present then the outer portion of the superior constrictor muscle can draw the posterior wall of the palate forward thus allowing the circular portion of the superior constrictor to produce closure.

A study of Figure 4 shows the normal posterior nasal spine. Figure 5 shows the point at the apex of the defective bone. It can be easily understood how that portion of the aponeurosis which is normally attached to the spine is now pulled forward and attached along either border of the defect. In this position if the two edges of the cleft were sutured together there would be an extremely long space for the circular muscle to close whereas, if you take the aponeurosis from each side of the bony cleft and retrodisplace it so that it would be where the normal spine should

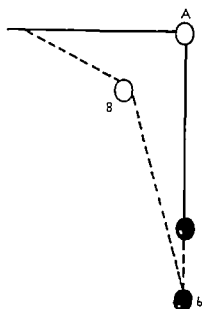


Fig. 8 a, Represents normal pull of tensor palatine muscle. b After division of the hamular process, muscle becomes an elevator.

be then you put the circular portion of the superior constrictor in a position to produce closure. This really is the physiology of the push back operation.

It is well known that suturing together the two sides of a cleft palate as in a Langenbeck operation usually does not produce normal speech yet if you take these patients and retrodisplace the palate so that the attachment of the palatine aponeurosis is displaced backward the circular muscle portion of the superior constrictor is capable of obtaining velopharyngeal closure and normal speech ensues.

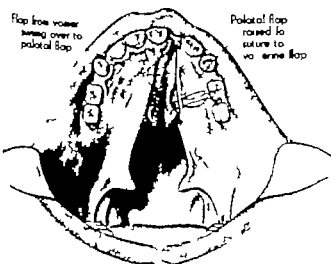


Fig. 9.

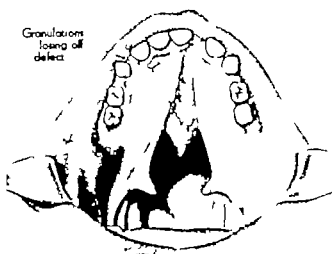


Fig. 10.

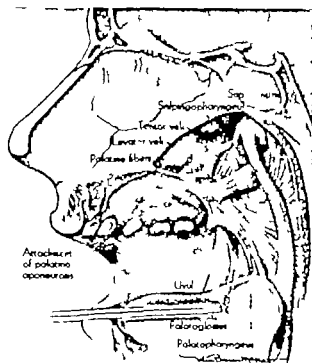


Fig. Not pull of levator palati before push back.

Recognition of the existence of this anatomical defect automatically excludes the use of the turn-over flap operations, such as those advocated by Lane

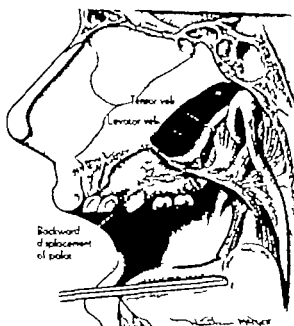


Fig. Not pull of muscles after push-back.

In clubfoot it is pretty well known that in certain cases there is a shortening of the tendons so that they must either be divided or lengthened before one can overcome the deformity. Well, a somewhat similar condition exists in the palate where the tensor palatine muscle due to the cleft, is shortened

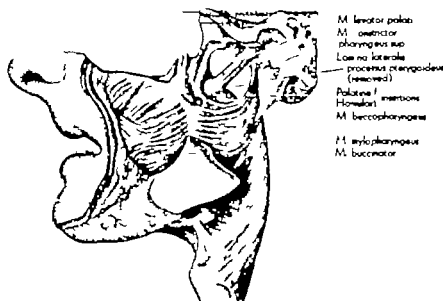


Fig. 3. Note insertion of palatine and hamular process.

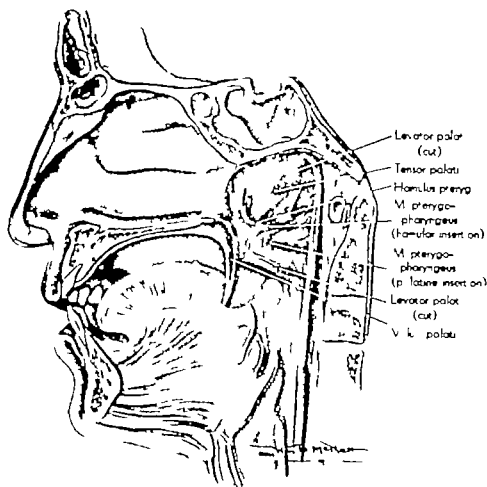


Fig 14. Note two divisions of the superior constrictor one going to the hamular one going to the palate

Surgeons wondered for many years why a hole developed in the middle of the palate following operations. If for one moment you would examine a cadaver and see this extremely large muscle, the tensor palatine (most of us are inclined to think of it as a little muscle) it would be easily understandable why such separation occurs especially when there is a considerable pull (See Figure 7). For instance when a child is under an anesthetic these palatine muscles are stretched to get approximation of the palate then when the child comes out of the anesthetic this shortened muscle which has been abnormally drawn over into the midline becomes active and naturally there is a pull on the suture line which may give way and a hole results. In our push back operations, we relieve this tension by dividing the hamular process as recommended by Whitehead or if you prefer

by dividing the tensor palatine muscle as recommended by Pollock. In this way you eliminate a big factor causing the failure of the sutures to hold. This pull of the tensor palatine muscle was mentioned as early as 1846 by Liston. We have seen no harm from dividing the muscle but think better of dividing the hamular process (Figure 8) which makes the tensor palatine muscle become an elevator instead of an abductor—that is instead of being two sides of a right angled triangle it now becomes the hypotenuse.

These anatomical studies long ago proved to us that in cleft palate cases each type is different. The main objective is to return the aponeurosis which is normally attached to the posterior nasal spine to its normal position then closure is possible and normal speech becomes possible. As previously stated the reason for defective cleft palate speech is



Fig. 5 Cleft palate splint with packing in place.

operation is that the speech mechanism is defective with this retroposition of the tissues to their normal position we are now able to give the child a normal speech mechanism with which he may articulate properly. In other words, if you don't have a good speech mechanism you can't expect good speech.

This in turn brings up a fact which we think should be strongly emphasized and which after many years of experience in this type of surgery we feel is correct. It is this in the average case you have only one chance to produce a perfect palate therefore, extreme care and study should be given to the case. We have long since realized that early operations are not at all essential—in fact, failure in cleft palate repair in very young children is so common that now we do not advise operative work being done on a child until about the fourth or fifth year. We formerly had many partial failures and complete failures, whereas now that we are doing the operations later we are having fewer failures. Nowhere else in surgery is the value of delayed

flaps so essential for if you lose a flap you have difficulty in finding other material to take its place. We frequently raise flaps and suture them back, and then wait several weeks or months before completing the flap transfer. We are not unmindful of the advice given by others that the earlier these patients are operated upon the better the speech will be. We know that this is not true and yet many surgeons say "If only I had operated on the patient earlier I then could have gotten a better result." This in our opinion is erroneous. Our feeling at present is that the most favorable time to operate is from the fourth to the sixth year. We find that the speech in our average case is better than when we operated earlier. In our experience there are less anatomical failures, less loss of flaps, and speech is much superior to that which was obtained with the earlier operation.

In the past, the mortality rate of cleft palate operations was high. It still is higher than it should be. It can be definitely stated that the mortality rate is lower at the fourth year than at the first year and the speech is better when the operation is delayed. We can see no justification for a hurry up operation the statement that the case should be operated on early and that, if it is not operated on before the time for the development of speech, the child will never develop normal speech is not true—in fact the reverse is nearer the truth.

We take it for granted that some form of push back is essential in almost every palate case. We know that it is the only operation that is of value in cases of congenitally short palates. We know that in clefts of the soft palate it gives extremely satisfactory results. That leaves cases of complete clefts, unilateral or bilateral, to be considered. These, again must be divided into those that have a vomer attached to one side of the cleft and those that do not have a well developed vomer. In those that have the vomer attached we use our own vomer flap operation, as illustrated in Figures 9 and 10.

In our anatomical descriptions, we would like to show you Figures 11 and 12 which illustrate very definitely the change in insertion and pull of the palatine muscles,

before and after their retrodisplacement. We are now able by our push back operation to obtain good speech for those cases which had been repaired by the von Langenbeck method where velo-pharyngeal closure was not obtained. In these cases we are using a modified push-back in which we first raise the flap and cover the raw surface with a skin graft so as to produce a freely movable palate. We think the skin graft prevents scar and contracture.

Sometimes we have a hole remaining in the anterior part of the mouth. If this does occur it gives us very little concern, as a plate will cover it without much difficulty (Figures 13 and 14).

Figure 13 illustrates by a photograph of the dissection how the superior constrictor muscle goes into the hamular process and its circular portion swings around the levator palatine. Figure 14 shows the superior constrictor one portion going to the hamular process and the other portion going over to the palate. It also shows the large size of the tensor palatine muscle.

We would like to add that in all cleft palate operations where teeth are present, we are now using a splint as a means of protecting the suture line. This is true in vomer surgery as in any other surgery of the palate (see Figure 15).



## GRADUATE TRAINING IN SURGERY

CHARLES R. REYNOLDS M.D. Major General U.S. Army (Retired) Chicago, Illinois

**D**ISCUSSIONS of graduate training in general surgery and the surgical specialties at the Clinical Congress at Cleveland centered chiefly in two aspects. One was the development of additional programs of residency training to meet the present extraordinary requirements. The other was the importance of the medical school in graduate training particularly the methods of incorporating the basic medical sciences into training programs.

In tracing the progress made in the manner of treating the basic medical sciences since even the more recent prewar years, several important tendencies are evident. Among these are greater emphasis on the basic sciences other than anatomy and pathology which include biochemistry physiology bacteriology and pharmacology and upon clinical rather than didactic teaching. The review courses have given way to the study of these more or less exact sciences as they bear directly on clinical procedures. The necessity of adequate knowledge of the applied basic medical sciences being established, the problem shifts to the hospitals in which the training programs are prepared and carried on. Frequently this calls for co-operation between the hospital and the medical school.

A panel discussion of graduate training in general surgery and the surgical specialties from the standpoint of the American College of Surgeons, the university-connected hospital the hospital not connected with a university the Veterans Administration hospitals and the graduate medical school, being open to hospital representatives as well as surgeons, developed free exchange of ideas by practically all agencies involved.

Representatives of the Department of Graduate Training in Surgery of the American College of Surgeons described the existing situation as to approved residencies and the work of the College in assisting hospitals possessing potentialities to develop graduate

training programs and those hospitals now conducting residency programs of 2 years duration to rearrange them to conform with present requirements as to content and duration. The interest of residents now receiving training of inadequate scope was emphasized. The benefits accruing to hospitals by modernizing their programs were described. They can by so doing maintain their status as modern teaching institutions and will be enabled to meet the situation when the wartime supply of residents will have become exhausted and hospitals may then be on the lookout for residents instead of the reverse order of today. Internes of the future will be looking for residencies which meet the requirements of accrediting agencies.

Having in mind the probability that more hospitals might be brought into the sphere of graduate training in surgery if assistance of medical schools were made available, a member of the staff of the Department of Graduate Training in Surgery has visited more than fifty medical schools throughout the United States and Canada. He developed interest in collaborative programs and discussed at each medical school particular problems. Surveys were made of hospitals offering the best opportunities for development of co-operative programs in order to ascertain the amount and character of assistance required by each. As a result of these efforts it has been possible in many places for the medical school to become the center of a collaborative regional effort.

At the present time thirty medical schools are offering varying types of assistance in co-operative graduate training. Others are preparing to do so. Such assistance will not only increase the number of approved programs but will tend to improve the quality of training in many programs which have already been approved by bringing the hospital permanently into the sphere of influence of the medical school.

The university-connected hospitals are situated more fortunately than any others in availing themselves of medical school re-

sources. The methods of supplying this need which centers chiefly around the basic medical sciences have changed recently because of the added burden falling upon medical schools. Some schools formerly carried on this training by distributing its component parts to the undergraduate departments. Recently the tendency has been to develop a comprehensive course in the applied basic medical sciences and closely allied clinical training under central authority. By this means uniformity of training is insured and can be made available to larger numbers of trainees including those from affiliated hospitals. These courses have been lengthened from several months to as much as nine months because of this added requirement coming especially from returning medical veterans. Perhaps a more difficult problem is to supply the more or less limited or special needs of residents in hospitals capable of providing the other elements of the residency program. Chief among these is surgical anatomy. In such instances no procedures of universal application are possible. Recourse to the preclinical department of the medical school is often necessary but with the necessity of practical teaching ever in mind.

It is the consensus that the graduate medical school course, usually of eight or nine months duration, provides the most satisfactory training in the applied basic medical sciences and allied principles of surgical technique as the basis for continued study and work connected with this important feature of surgery throughout the years of residency. Just when an academic year at a graduate school is most advisable has not been generally agreed upon. Graduate schools are furnishing some of their graduates to hospitals. Others are receiving residents who have completed part of their training usually the first year.

Opening the field of graduate training to such smaller hospitals as are found capable of making a contribution of a supplementary nature to training programs centering in larger institutions will broaden the training and supply missing elements in programs particularly in the surgical specialties. This is exemplified by some children's hospitals which can provide one year of training in children's ortho-

pedic surgery needed to round out the program confined largely to adult orthopedic surgery and fractures in another hospital. This project had occupied the attention for several years of the Joint Committee of the American Orthopedic Association and the American Academy of Orthopedic Surgeons and the American College of Surgeons has formally approved a number of such programs as well as others in pediatric surgery under similar circumstances.

The educational policies of the newly established Medical Department of the Veterans Administration emphasize a trend in medical education which will be of great importance in years to come. The basic feature is the close association of Veterans Hospitals with nearby medical schools whose faculties have been drawn upon to improve professional service and to supervise or conduct training programs substantially meeting the fundamental requirements of the American College of Surgeons. Today fifty seven medical schools are working through their Deans committees with fifty two Veterans Hospitals. Consultants from the faculties of these schools and associate attendings have contributed to the establishment of a system of residency training that has won the admiration of the profession. About 1500 medical veterans are now receiving graduate training in these hospitals. This is relieving a serious situation confronting medical veterans in need of training at a time when civilian hospitals are overtaxed. The expected mass hospitalization of veterans may be utilized eventually in graduate training on a correspondingly large scale.

Virtually the same principles are being put into effect in the graduate educational procedures of the Army, Naval and Public Health services and as already noted these policies are spreading to all communities where such cooperation is found practicable. The improvement in the care of veterans and assurance of the continued association of highly trained consultants under an improved system of hospitalization means that there will be a continuation of the high esteem in which the public now holds the medical profession for the unprecedented service which it provided during World War II.

## GENERAL REVIEW 1946 CLINICAL CONGRESS

MALCOLM T MacEACHERN M D Chicago, Illinois

THE Clinical Congress in Cleveland was an event that adds another bright memory to the record of successful episodes in the history of the American College of Surgeons. Meeting rooms overflowed interest ran high and the education of the surgeon was advanced through the presentation of talks, clinics, demonstrations, and discussions covering developments that have occurred in the five years since the last Congress was held. Neither the time—the week before Christmas—nor the postponement from the September dates originally planned for the Congress in New York—were deterrents to the surgeons who wished to take advantage of the opportunities for learning about new ideas and techniques.

The Committee on Local Arrangements, of which Dr. Thomas E. Jones was Chairman is to be highly commended for its help in arranging the excellent clinical program which was developed in the local hospitals, and for its many other activities in connection with the planning and conduct of the Clinical Congress.

The setting in the Cleveland Public Auditorium made the Congress quite different from preceding meetings, usually held in hotels. Arrangements for display of exhibits in the Arena were ideal and meeting rooms were ample in number and with a few exceptions sufficiently large to accommodate the audiences. Two of the noteworthy exceptions were the symposia on Fractures and on Cancer attendance at which overflowed the capacious fourth floor Ballroom. The experience demonstrated the desirability of again giving great emphasis to these two subjects in the 1947 Congress.

It is customary to select a dominant note about which to focus the impressions of any meeting. In connection with the Cleveland Congress, that is hard to do. There were many subjects concerning which interest was especially keen. Doubtless developments in the field of cancer attracted the most notice, al-

though since cancer is a disease which attacks any part of the body discussion of its treatment consequently comes up in meetings devoted to almost any specialty.

Since this special issue of SURGERY Gynecology and OBSTETRICS carries most of the papers which were presented at the more formal scientific sessions, it will be unnecessary here to mention their content. It would be very advantageous if in addition we could present summaries of the excellent panel discussions which were held but this is not practical mainly because of lack of space.

The forums on Fundamental Surgical Problems have won an established place of great importance on the Clinical Congress program. It would be impossible to overestimate their value as an incentive to the younger surgeons and an avenue for the reporting of the results of the latest research. A few of the presentations are published in this issue.

The sessions of the Hospital Standardization Conference were interesting and stimulating. The meetings were successful in giving opportunities for helpful discussion of the many pressing problems that must be met in hospitals today. Nursing service naturally occupied a foremost place among the subjects listed, and solutions to the problem of short ages were presented in suggestions to improve personnel policies, to stimulate recruitment of student nurses, and to train a secondary group to assist the graduate nurse. The improvement of medical records, the education of the hospital trustee, the responsibility of the administrative staff in handling emergencies coming to the hospital and occurring within it, and the training of hospital personnel were other subjects to which entire sessions were devoted.

A preliminary summary of the 1946 Hospital Standardization report was presented by Dr. Irvin Abell, Chairman of the Board of Regents, at the opening General Assembly. The report showed 3,118 hospitals approved—79.3 per cent of the 3,934 which were under survey during the year.

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## THE CLINICAL CONGRESS TECHNICAL EXHIBITION

**L**EADING manufacturers of and dealers in surgical instruments, hospital apparatus and supplies, diagnostic and therapeutic apparatus, pharmaceuticals, and publishers of medical and surgical books represented in the Technical Exhibition at the Cleveland Public Auditorium, Cleveland, Ohio December 16-20 1946

Acme Engineering Co. Inc. Greensboro, N.C.  
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# SURGERY

## GYNECOLOGY AND OBSTETRICS



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### TREATMENT OF TRICHOMONAS VAGINALIS VAGINITIS

WALTER J REICH M D F A C S HELEN L BUTTON M D and  
MITCHELL J NECHTOW M D Chicago, Illinois

THE treatment of *Trichomonas vaginalis* vaginitis was approached for the investigation here reported as a problem involving (1) the effectiveness of the therapeutic agent under test and (2) the effectiveness of the steps taken against recurrence.

The work was done in the outpatient gynecological clinic at Cook County Hospital Chicago and in the private practice of the investigators participating 2080 patients were examined for presence of *Trichomonas vaginalis* infection 541 were found to be positive 205 were available for study and 153 were followed with sufficient completeness for report.

#### PROCEDURE AND RESULTS

*Differential diagnosis and examination* A history was taken and a preliminary examination made of the vulva with particular attention to the character amount, color and odor of the discharge

Irritation and itching usually were complained of in association with a leucorrhoea and pruritis bladder indications of frequency and urgency often were present and occasionally dyspareunia vaginospasm and sensation of heaviness

Examination of the vulva revealed skin manifestations of infection ranging from normal skin to extensive vulvitis (Figs. 1 and 2

insert) Perirectal irritations and occasionally accompanying condylomata acuminata were found The common finding was that of an inflamed mucous membrane with pin point petechiae dispersed over the cervix Examination of Skene's glands and the openings of the Bartholin glands showed evidence of infection in more than 50 per cent of the strongly positive trichomonas cases Cervicitis endocervicitis with erosions polyps and nabothian cysts frequently were found as incidental pathology Tender indurated sacrouterine ligaments were found in approximately 5 per cent of the apparently acute strongly positive cases

*Unlubricated speculums* were used for the vaginal examination After noting all pathology pH determinations were made with nitrazine paper Next the type of vaginitis was identified through microscopic examination of a hanging drop of vaginal secretion and frequently an undiluted wet smear and Gram stain

The specimen for microscopic examination was prepared by releasing onto a drop of normal saline on the cover slip a drop of secretion obtained from the posterior fornix by means of an 8 inch glass tube tapered at the sampling end and with a rubber bulb to provide suction at the other

The number of trichomonads was counted under high power magnification A field containing only an occasional trichomonad or less than 3 was classified as + A field con

From the Gynecological Division of the Faustus Clinics, the Cook County Graduate School of Medicine and the Hektoen Institute for Medical Research Cook County Hospital





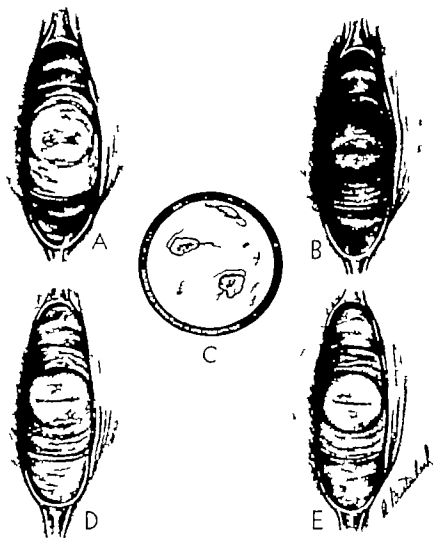


Fig. 1. Clinical appearance of *Trichomonas vaginalis* vaginitis and the results of treatment. A. Typical picture. B. discharge wiped away exposing petechial spots on the cervix caused by the *Trichomonas vaginalis*. C. microscopic view of *Trichomonas vaginalis* under high power. D. clinical appearance of vagina after 1 week of therapy. E. clinical appearance of vagina after eradication of infection.

*Treatment of Trichomonas Vaginalis Vaginitis —*

Walter J. Reich, Helen L. Sutton, and Mitchell J. Nechtow

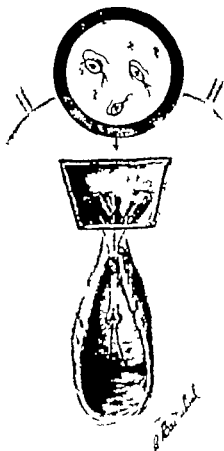


Fig. 2. Contiguous gonitis due to *Trichomonas vaginalis* vaginitis.

*Treatment of Trichomonas vaginalis Vaginitis—*  
 Walter J. Reich, Helen L. Sutton and Mitchell J. Nechtow

taminated tub, pool toilet seat, linens or sexual congress may provide a reasonably safe means of protection.

The possibility of the male as a source of infection has been forcefully emphasized by Feo (4) who states that 'the male is not only responsible for the reinfection of women but is the principal agent of transmission. Allison terms *trichomoniasis* the 'seventh venereal disease. Proper feminine hygiene measures should be taken particularly where reinfection is suspected and later proved to have come from the marital partner.'

**Safety.** The instruction to return for re-examination at the end of each consecutive week of treatment permitted close observation of progress and also at the beginning of the study, the very necessary assurance that the treatment was altogether safe for continued use. No indication of harmful effect was found

Dr J. Lester Wiley of the Genito-Urinary Department of Cook County Hospital, Chicago, has observed (peritru communication) in a series of 6 instances of *Trichomonas vaginalis* infection in the male, the presence of urethral strictures derived from an earlier gonorrheal infection, and suggests that such strictures may act as dams behind which trichomonads may be harbored. The treatment given consisted of prostatic massage with urethral dilatation once weekly followed by anterior-posterior insufflation of 5 per cent solution of mild silver protein, with precaution against reinfection. A 5 per cent solution of mild silver protein was prescribed for intrarethral injection by the patient twice daily.

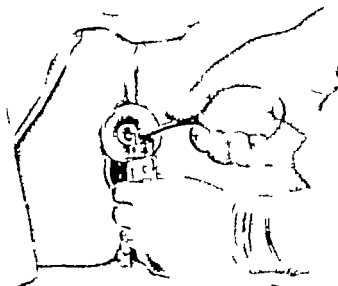


Fig 3 Insufflation of argyrol compound powder front view

at any time and no instance of sensitivity to type or method of treatment. No argyria was seen. (Long continued use of any silver preparation carries with it a risk of argyria and should be avoided. A search through the published records up to 1939 by Hill and Pillsbury found record of no

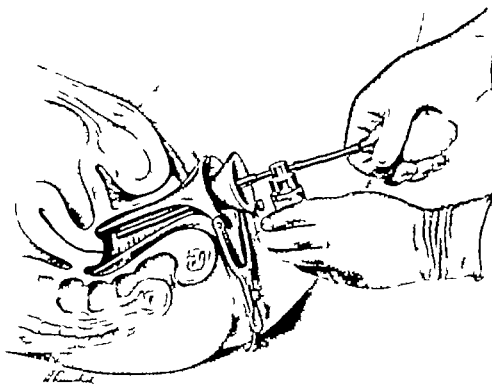


Fig 4 Insufflation of argyrol compound powder lateral view

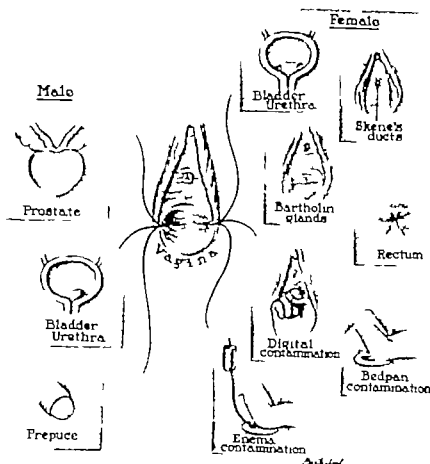


Fig 5 Composite drawing showing possible sources of reinfection

instance of generalized argyria associated with the use of mild silver protein as the only form of silver given, in the genitourinary region but did find report of one instance following a combined use of mild and strong silver protein as a urethral irrigation. The duration of use was reported to have been 6 weeks.)

*Re-examination and continuation of treatment*  
Few of the patients adhered, without lapse to the schedule of return for re-examination and continuation of treatment that was requested of them. This schedule required in the absence of recurrence a total of 8 reports to the clinic weekly during the month of treatment at 3 week intervals during the next  $2\frac{1}{4}$  months and again 3 months later. Treatment was not interrupted during the menstrual period.

Following each re-examination during the period of treatment, an additional insufflation

was given and 6 additional capsules, for use as before with instructions to return again for examination at the end of the week, etc.

As is reported in Table I the infections with an initial classification of +++ or ++++ required longer treatment on the average than those with an initial classification of + or ++ and had a greater tendency to recur. The number of weeks of treatment given in the absence of recurrence was between 3 and 4 and in the presence of 1 or at most 2 recurrences, between 5 and 7. The percentage of patients successfully treated was 98.

The outcome in the unsuccessfully treated patients, was one suggesting failure, not on the part of the therapeutic agent but of the precaution against reinfection (Fig 5).

Results approximately equivalent to those obtained by the combined use of insufflation and capsule insertion were observed following



Fig. 6. Comparative bacteriostatic power of the argyrol kaolin, lactose powder against gram-positive *Staphylococcus aureus*, A and *Streptococcus pyogenes*, B, and gram-negative *Escherichia communior* C, *Pseudomonas aeruginosa*, D, and *Eberthella typhosa*, E. Tests made by a modification of the agar streak plate dilution method described by Waksman and Relly.

Agar plates containing: I no argyrol, kaolin, lactose powder; II the powder in a dilution of 1:5000 and, III in a dilution of 1:500. Note the complete restraint of growth at 1:500 and the marked restraint even at 1:5000.

the use of capsules alone. However, the return of the patient for insufflation provides for an automaticity of re-examination and control not possible through the use of capsules alone.

A study was made by one of us (M J N) of the rate of disintegration and dispersion of the capsule following its placement high in the vaginal vault. Hourly observations were made and the process was found to be rapid, resulting in an apparently uniform distribution of the contents throughout the vagina within 3 to 4 hours.

#### MODE OF ACTION

The action of the powder would appear to be of the type exerted by the sulfonamides and by penicillin against the infections for which they are most effective—a mild, checking action, gradually depriving the pathogen of its foothold. Mild silver protein has been demonstrated to exert an additional germicidal effect but that effect is secondary in importance to the checking effect imposed. A direct killing of *Trichomonas vaginalis* by 0.5 per cent mild silver protein *in vitro* has been observed by Shelanski which was reported to be complete in 8½ minutes. Morgan and Campbell observed a similar effect by 1 per cent mild silver protein versus *Trichomonas foetus*. Buca found mild silver protein to be lethal for the gonococcus in a dilution of 1:50,000.

The photographs in Figure 6 indicate graphically the extent to which mild silver protein-kaolin lactose powder checks the

growth of representative gram positive and gram negative bacteria. There would seem to be little question of its capacity to control either *Trichomonas vaginalis* or the disturbed bacterial flora associated with it in the production of *Trichomonas vaginalis* vaginitis.

#### DISCUSSION

In our clinic, we have tried and had experience with all of the classical approaches to the treatment of *Trichomonas vaginalis* vaginitis.

TABLE 1.—DURATION OF TREATMENT IN RELATION TO INITIAL CLASSIFICATION AND FREEDOM FROM SOURCES OF RECURRENCE

Group	Initial classification	Number of recurrences	Number of cases	Average total no. of weeks of treatment	Per cent of group responding successfully to treatment
Negro	TV+ ++		36	7	97.6
			3	6.7	
	TV+++ +++++		33	3.7	
			8	3.3	
		multiple		—*	
	Combined		84		
White	Series A†		9	3.5	98.6
			4	6	
	Series B†	0-8	43	3-4	
		multiple		—*	
	Combined		69		

\* Not responding effectively. Indication for further search for source of recurrence rather than extension of treatment.

† Series A, clinic patients; Series B, office patients, studied over the same period.

Cleansing the external genitalia with tincture of green soap and warm water with drying of the vaginal tract followed by treatment with a stream of warm air has proved to be time-consuming and cumbersome with fractional results even though trichomonadocidal agents were applied following the procedure and prescribed nightly for the patient. The substances used for this purpose were picric acid (1 per cent) methylene blue (1 per cent) gentian violet (2 to 5 per cent) and saturated solutions of sodium perborate.

Various types of insufflation powders were explored containing pentavalent arsenicals or silver picrate. Supplementary to the use of these preparations in the clinic the patient nightly at home used the same drugs in tablet or suppository form. An acid douche usually vinegar was also prescribed twice a day mornings and afternoons along with the clinic and home medication. Quinine sulfate oxyquinoline sulfate and the lactic acid oxyquinoline jellies also were given thorough trial.

Fairly good results followed from the use of all these procedures with however failures which led to a review of basic principles and the development of the method of approach described.

*Work of others.* A thorough review of the background of the problem appears in the report of the American Medical Association Council on Pharmacy and Chemistry on status of treatment of *Trichomonas vaginalis* vaginitis (10). Authoritative conclusions on the pathogenicity of *Trichomonas vaginalis*

have been brought forward by Trussell and Plass, Hesselstine and Feo Rakoff and Stabler (5). Comprehensive information on incidence is given by Peterson.

#### SUMMARY

A combined use of mild silver protein, kaolin and beta lactose in powder and vaginal capsule together with search for and elimination of foci and sources of reinfection gave a successful result against *Trichomonas vaginalis* vaginitis in 97.6 per cent of a group of 84 negro patients and 98.6 per cent of a group of 69 white patients studied under both clinic and office conditions and with infections varying in initial severity and extent over the usually encountered range.

#### REFERENCES

1. ALLISON, C. G. South M. J. 943, 36 831-8 J. BLAND, P. B. and RAKOFF, A. F. J. Am. M. Ass. 1937 108 803.
2. BUCCA, M. A. J. Bacteriol. 943, 46 31 166.
3. FEO, L. G. Am. J. Trop. M. 1944, 24 95-98.
4. FEO, L. G., RAKOFF, A. E., and STABLER, R. M. Am. J. Obst. 94, 43 76-80.
5. HESSELTINE, H. C. Am. J. Obst. 940, 4 64.
6. HILL, WILLIAM R., and PILLBURY DONALD M. *Argyria, the Pharmacology of Silver* Baltimore Williams and Wilkins Co. 930.
7. MORGAN, B. D. and CAMPBELL, H. M. Am. J. Vet. Res. 1946 7 45.
8. PETERSON, PAUL. Am. J. Obst. 933, 33 601-609.
9. Report of the Council on Pharmacy and Chemistry J. Am. M. Ass., 943, 123 48 483. SECLAMER, H. A. J. Lab. Clin. M. 936, 1 790-793.
10. TRUSSELL, R. F. and PLASS, L. D. Am. J. Obst., 940, 40 883.
11. WAKEMAN, S. A., and REILLY H. C. Ind. & Eng. Chem. Anal. Ed., 945 7 556-558.

# EXTENSIVE HEMANGIOMA

## Report of Cases

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Atlanta Georgia

REPORTS appear in the literature of extensive hemangiomas for which multiple or radical operations have been performed for their cure. Since the lesion although rarely malignant progressively enlarges, the necessity for its removal is apparent. Many methods of therapy have been instituted, but only in those instances which result in the total eradication of the lesion can one hope for permanent success. At the onset these lesions may produce only cosmetic deformities but eventually functional impairment and pain will result. Hemorrhage, malignant degeneration and progression to true cirsoid aneurysms are further indications for radical extirpation.

### **PATHOLOGY**

Hemangiomas are tumors of independently growing blood channels which probably have their origin as embryonic rudiments of mesodermal tissue. The concept that they result

from dilatation of blood vessels or organization of hemorrhage has long been discarded (5, 7).

Classification is usually of two types: cavernous hemangioma, and capillary hemangioma. The point of division between the two types is frequently difficult unless the specimen is carefully examined before fixation. Watson and McCarthy have classified them into eight groups: (1) capillary hemangioma, (2) cavernous hemangioma, (3) angioblastic or hypertrophic hemangioma, (4) racemose hemangioma, (5) diffuse systemic hemangioma, (6) metastasizing hemangioma, (7) nevus venosus or port wine stain, and (8) hereditary hemorrhagic telangiectasis.

The microscopic picture is one of endothelial spaces of varying size surrounded by interstitial connective tissue (Fig. 1). The amount of lipid and fibrous tissue varies markedly; the proportion of these elements will determine the compressibility and consistency of the mass (Fig. 2). Many of them have the appearance of lipoma. It may be well encapsulated, occupying a position between muscle



Fig. 1: Photomicrograph of a typical cavernous hemangioma.

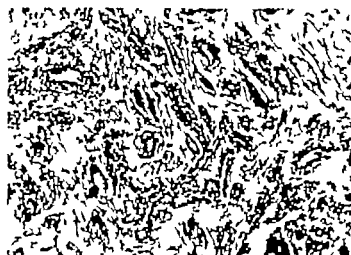


Fig. 2: Photomicrograph of a hemangioma with large amount of connective tissue and small vascular channels.





Fig. 7 a, left, Hemangioma of forearm with rapid growth. b Result after excision

Following trauma or thrombosis of a major venous channel leading from the tumor rapid enlargement may occur. The tumor then may become painful and simulate an acute inflammatory process.

Due to the variation in consistency and compressibility of the mass other conditions such as large dilated varices, lymphangiomas, and lipomas are to be differentiated from it. The deposition of fat about the vascular channels may be so great as to give the tumor the appearance of a lipoma even at the time of operation. In occasional instances the expansile quality may be absent. The true nature of the tumor is then appreciated only if it is incised exposing the vascular spaces. A lymphangioma may be compressible but is reduced in size less readily and expands less rapidly when released. Large masses of var-

ices confined to a single area are differentiated by the greater ease with which they are emptied on compression and by the tests for varicose veins.

#### TREATMENT

Complete removal of the tumor is the ideal treatment. This is not always possible, for in lesions about the head loss of facial expression may result from associated injury to the facial nerve. Extensive removal of muscles about an extremity may destroy the function of the part, and at times the major nerves are so intimately involved in the process that removal of the tumor without injuring them is not possible. It is believed that in so far as it is compatible with essential functions of the individual every attempt should be made completely to excise the lesion for these tumors increase steadily in size and frequently undergo changes of distressing or even fatal nature.

**Excision.** All cases in this series were treated by excision. The overlying skin was excised if it was involved and if a satisfactory closure could not be obtained skin grafting was done.

Irradiation was employed only in instances in which surgical excision was inadvisable or incomplete after exploration of the lesion. The use of sclerosing solutions would seem futile in large cavernous tumors and such treatment was not employed.

**Review of cases** (Table I) In the cases reported in this series all patients were treated by surgical excision. Many other hemangiomas were seen but those of small size and



Fig. 8 a, left, Hemangioma of hand with involvement of intrinsic musculature, median and ulnar nerves. b, Postoperative result after excision of portion of the mass.



Fig. 9 a, left, Hemangioma of parotid region and temporal muscle with expansion as head is depressed. b Photograph following partial excision of the tumor

involving only the skin are not included. Other instances of port wine blemishes involving large areas were not excised. Tumors of the parotid region except for 1 instance in which it was believed that the mass was superficial were uniformly referred for irradiation therapy.

History of trauma was present in 14 cases. It is believed that trauma is frequently the

factor initiating increased growth in an underlying congenital lesion.

Pulsation was present in 3 instances and in 2 of these a bruit was audible and was interpreted as evidence of large arteriovenous communications.

In 1 instance the median and ulnar nerves were infiltrated making excision impossible without removing the nerves.



Fig. 10 a, left, Hemangioma of frontalis muscle with communicating diploic veins. b Postoperative result showing method of reflecting flap to permit excision.

TABLE I.—REVIEW OF CASES

No.	Location	Pain		Trauma		Rapid enlargement		No interval treatment		Complete excision		Results	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Cured	Improved
—	Buttock and thigh												
—	Parotid region												
3	Chest, all												
4	Cheek												
5	Hand and wrist												
6	Femur												
—	Calf of leg												
8	Fourth finger and hand												
9	Ankle and chest wall												
—	Scalp												
—	Arm												
—	Foot												
—	Cheek												
—	Scalp and ear												
5	Chest wall												
6	Leg												
7	Thigh												
8	Cheek									?			
9	Forehead												
—	Total		14							12-1	6		7

In 12 instances the tumor was completely excised. In 7 the mass was removed but a small amount was left. 1 case involved the masseter muscle alone and although this muscle was removed the complete extirpation of the origin of the muscle was not confirmed. All muscles of the shoulder girdle were infiltrated in 1 instance and the tumor could not be removed without sacrificing the arm. In 2 instances the masseter and temporal muscles were involved and left after excision of the major portion of the mass. The remainder of the failures were associated with extensive port wine blemishes in which the expansile portion of the tumor was removed but in which it was not felt justifiable to do widespread skin excision. Postoperative irradiation therapy was employed in 3 patients.

#### SUMMARY AND CONCLUSIONS

1. Nineteen cases of extensive hemangiomas treated by surgical excision are reported.

2. The preoperative evaluation of the probability of complete removal is difficult because of the fact that the tumors are deceptive as to extent and involvement of adjacent structures.

3. Cures were effected in 63 per cent of cases and improvement obtained in the remaining 37 per cent.

#### REFERENCES

- ANDERSON, C. RUMELL. *J. Am. M. Ass.*, 944, 35, 302.
- BAILEY, W. and KIRKADDER, WILLIAM S. *Radiology* 942, 38, 553-561.
- D'VIA, JOHN S., and KITLOWEY, EDWARD A. *Arch. Surg.* 930, 20, 30-60.
- JENKINS, KILMER P. and DELANEY, P. ARTHUR. *Surg. Gyn. Obst.*, 932, 55, 454-480.
- MACCALLUM, W. G. *A Textbook of Pathology*. Philadelphia: W. B. Saunders Co., 942.
- ROYSTON, M. *Virchows Arch.*, 94, 307, 678-70.
- WATSON, WILLIAM L., and MCCARTHY, WILLIAM D. *Surg. Gyn. Obst.*, 1940, 7, 560-583.
- WEAVER, JAMES B. *J. Bone Surg.*, 938, 20, 73-749.
- WEAVER, JAMES B. and RUMOLD, MERVIN J. *Am. J. Surg.*, 943, 60, 140-50.

# THE CHOICE OF OPERATION FOR THE TREATMENT OF ARTERIOVENOUS FISTULAS

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**Q**UADRUPLE ligation with excision of the fistula has been the classical operation in the treatment of arteriovenous aneurysm for many years. Holman, Herrmann and Reid and Elkin have advocated this procedure as being the most useful and effective technique. Recently however reports have appeared which indicate that although patients treated in this manner may not develop gangrene after operation nevertheless a good many of them will show evidence of chronic vascular insufficiency distal to the ligated vessels. Symptoms such as intermittent claudication, ischemic pain, numbness, tingling, atrophy of muscles, or coldness of the skin may develop to plague the patient even though a successful quadruple ligation has been accomplished. Mayberry, Bigger and Freeman all have stressed that these untoward postoperative conditions may be avoided by closure of the fistula and repair of the artery. In a recent report, Heringman, Rives, and Davis studied 53 cases of arteriovenous fistula for evidence of postoperative vascular insufficiency. It was found that there was no instance of vascular inadequacy following transvenous arteriorrhaphy as compared to an incidence of 27.5 per cent following quadruple or sextuple ligation and an incidence of 71 per cent following obliterative endoaneurysmorrhaphy. It was stressed that restoration of normal arterial circulation is the primary objective of the surgeon whenever possible.

Unfortunately there exist at the time of operation many complicating conditions which may prevent the repair of the artery. Therefore one must resort all too frequently to quadruple ligation or at times to obliterative endoaneurysmorrhaphy in order to eliminate the fistula. It is the purpose of this paper to discuss those factors which are the basis for

the choice of operation in a patient with arteriovenous fistula. Although these factors are known to the vascular surgeon relatively little has been said about them in recent discussions and it is considered worthwhile to re-emphasize their importance. Certain appropriate cases taken from the group of 53 analyzed in the original paper (7) are used as examples to illustrate how these factors influence the choice of operation.

## OPERATIVE PROCEDURES

In general there are three main types of operative technique available to the surgeon when dealing with an arteriovenous aneurysm. The first and most frequently used is a ligation procedure either quadruple or sextuple ligation with excision. The second is a restorative procedure utilizing some method of arteriorrhaphy or a technique requiring the use of vitallium tubes with a venous graft (3). The third is an obliterative procedure—the intrasacular endoaneurysmorrhaphy advocated by Matas (10).

The advantages and disadvantages of these procedures merit a brief discussion.

## LIGATION PROCEDURES

*Quadruple ligation with excision.* The advantages of this operation are derived from the fact that when properly performed it is a relatively safe procedure and effectively eliminates the fistula without causing gangrene. It is frequently the operation to which one must resort if a restorative procedure cannot be done. However there are certain definite disadvantages inherent in this operation.

1 It requires ligation of the main arterial pathway which should not be done unless it is absolutely necessary.

2 Dissection around the sac necessitates ligation of some collaterals which may be essential for maintenance of blood flow to distal parts.

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3 The dissection of the sac is often time consuming requiring the ligation of innumerable bleeding points caused by increased pressure in the veins around the fistula

4 It is not physiological

5 It is followed in many cases by evidence of postoperative vascular insufficiency

*Sextuple ligation* This is a procedure required for an arteriovenous fistula which occurs between an artery and its two venae comitantes. It is fundamentally a ligation and excision operation with disadvantages which theoretically do not differ from those mentioned under quadruple ligation and excision. However this technique is ordinarily the only one of advantage in the presence of dual fistulas.

#### RESTORATIVE PROCEDURES

*Transvenous arteriorrhaphy* (Matas-Bickham, 1) This procedure is performed without difficulty if the fistula occurs in a region where the blood supply can be controlled either by a proximal constrictor or by temporary ligatures on the artery and vein proximal and distal to the fistula

The advantages of this operation are well known

1 It preserves the main arterial pathway which is especially important in certain regions such as those supplied by the common carotid, internal carotid and popliteal arteries.

2 It provides a rapid approach to the fistula, which can then be closed under direct vision

3 There is minimal interference with the collaterals because little dissection is required around the fistula or the sac.

4 Patients who can be treated successfully by this method show little evidence of postoperative vascular insufficiency

Disadvantages inherent in this procedure stem chiefly from local contraindicating factors, which become apparent only at time of operation

1 It requires an arterial wall which has not undergone advanced pathologic change and has not become involved in dense scar tissue (The presence of such findings creates insurmountable technical difficulties.)

2 Sufficient normal arterial wall must be present in order to permit closure of the fistula without a serious reduction in the lumen of the artery

3 It requires control of circulation which at times may be difficult or impossible to obtain

4 Occasionally the repair of the artery will result in a marked reduction or even complete obliteration of the lumen. This is a technical error and every effort should be made to avoid it.

5 Should postoperative infection supervene, the suture line may give way causing serious secondary hemorrhage

6 Occasionally recurrence may follow restoration of the arterial pathway. This complication has been reported by Reid, Pemberion and Black, Bigger and Freeman

7 Thrombosis of the artery may occur at the site of repair

8 Unless the artery is exposed completely and carefully examined a weak point in the arterial wall may be overlooked which may result in the subsequent development of an aneurysm.

*Transverse suture* This technique has been advocated recently by Freeman. Since both artery and vein must be completely exposed to permit their detachment at the site of the fistula, there is little likelihood that a weakened area in the artery will be overlooked.

This complete exposure of artery and vein is an advantage over transvenous suture because with a direct approach to the fistula through the vein complete exposure of the vessels is not necessary and a pathologic area in the arterial wall can be easily overlooked. Another advantage of this procedure has been demonstrated by Freeman who used this method of repair successfully even though the wound may involve as much as three-fifths of the arterial wall. Such a wide defect obviously cannot be eliminated by the transvenous technique employing longitudinal suture without encroachment on the lumen of the artery

The disadvantages of this operation are essentially the same as those of transvenous arteriorrhaphy. Furthermore, a long slit like opening between artery and vein cannot be closed transversely



Fig. 1 a, left, Arteriogram taken of a patient of Dr. Urban Blas shows a large popliteal arterial aneurysm with the artery entering the upper pole. b Arteriogram of same patient following an obliterative endoaneurysmorrhaphy. Note two large branches which have been preserved despite their origin close to the sac. If ligation of the artery had been done, these collaterals undoubtedly would have been lost.

*Vitallium tube venous graft method (Blake more and Lord)* The development of this technique offers a new approach to the problem of restoring the artery to normal function. It seems advantageous for the following reasons:

- 1 It permits complete excision of the fistula, sac, and that portion of the artery which has undergone pathologic change.
- 2 Despite excision of the involved segment, the main artery is restored to function by means of a venous graft.
- 3 It is relatively simple and does not require suturing of blood vessels.
- 4 It is actually a combined quadruple ligation and restorative procedure thus presenting the advantages of both.

The disadvantages of the operation may arise from the fact that dissection of the sac and fistula may seriously interfere with collateral circulation. Because of this vascular insufficiency may result if early thrombosis should occur in the venous graft.

#### OBLITERATIVE PROCEDURES

*Intrasaccular obliterative endoaneurysmorrhaphy* designed primarily for the treatment of true or false aneurysms has also been used successfully in the treatment of arteriovenous

aneurysms. This operation requires adequate proximal control of circulation by a constrictor.

The advantages of this procedure are

- 1 It cures the fistula.
  - 2 It preserves the collaterals because no dissection is required around the sac. Figure 1 shows an example of how collaterals are preserved by this method.
  - 3 It is extremely useful in the presence of a large sac with numerous communications.
- The disadvantages of this procedure are
- 1 It obliterates the main arterial pathway.
  - 2 It can be done only in an area where proximal control of circulation by a constrictor is possible.
  - 3 It may be followed by a high incidence of vascular insufficiency.
  - 4 The lesion may recur if one of the openings in the sac is overlooked or if one of the suture lines breaks down.

#### CHOICE OF OPERATION

The decision as to what technique should be used is frequently difficult. Since no two cases are alike a number of complicating conditions present themselves at operation and require individual consideration.

The great variability of these factors prevents any attempt at rigid classification. However a satisfactory division can be made by grouping them under two main headings, depending on whether they are local or general in nature. The classification as presented in Table 1 indicates the more important factors.

TABLE 1 —FACTORS INFLUENCING THE CHOICE OF OPERATION

Local factors	General factors
Scarring around the vessels secondary to the original trauma.	Cardiac status of the patient.
2. Local pathologic changes in the walls of the involved vessels.	Presence of generalized arteriosclerosis.
3. Anatomic location of the fistula.	3. Occupation of the patient.
4. Factors relative to the aneurysmal sac: <ul style="list-style-type: none"> <li>a. Presence and location of the sac in relation to the fistula.</li> <li>b. Size of the sac.</li> <li>c. Condition of the sac wall.</li> </ul>	
5. Collateral circulation.	

### Local Factors

*Scarring around the vessels secondary to the original trauma.* Here the nature of the injury and the presence of coincident infection are important. If the walls of the vessels or of the sac are involved in dense scar tissue dissection is often hazardous and may produce severe hemorrhage. Matas (11) points out that repair of the artery is practicable only in recent injuries in which adhesions are not so dense as to prevent mobilization of the vessels. One of the cases in the series previously reported exemplifies the difficulties that may occur because of dense scarring found at operation.

**CASE 1.** A. B. was admitted to Touro Infirmary in 1938 with an arteriovenous fistula of the left common femoral vessels resulting from a gunshot wound of the left groin incurred 11 years earlier. At operation on a considerable amount of scarring was found involving the walls of the vessels as well as the surrounding tissue. Dissection of the vessels in the region was attempted but accidental opening was made into a large venous channel. The ensuing hemorrhage was so severe that the operation was discontinued and a pack placed in the wound for hemostasis. About 10 days later ligation of the external iliac vessels was performed. After removal of

the pack from the original operative wound, severe infection developed causing profuse secondary hemorrhage, which was controlled with difficulty. The patient ran a markedly septic course for approximately one month and finally recovered. Fortunately evidence of the fistula disappeared and the patient was discharged from the infirmary with no further complications.

The choice of operation was determined by the local factors. The technique was an improvisation at best. Ligation of the external iliac vessels eventually produced a cure, but secondary infection, thrombosis, and thrombophlebitis probably were contributing factors in the disappearance of the fistula. This also serves to emphasize the importance of obtaining control of the proximal and distal circulation before dissection in the area of the fistula is begun. If temporary control of circulation can be achieved before the fistula is attacked directly, unfortunate complications may be frequently avoided.

*Presence of local changes in the wall of the involved vessels.* This factor must be carefully determined before a decision can be made as to the proper procedure. When pathologic changes occur in the arterial wall, such as marked thinning and dilatation, calcification, or fibrosis, transvenous arteriorrhaphy may be dangerous. In such cases quadruple ligation and excision of the involved vessel segments with the fistula is the procedure of choice. This is exemplified in the following case.

**CASE 2 (Fig. 2).** A. M. was admitted to Touro Infirmary with an arteriovenous fistula of the popliteal vessels as a result of a gunshot wound incurred 5 months earlier. When the wound was explored considerable scarring was found and the wall of the artery opposite the fistula was thin and bulging. The fistula and the involved vessels were isolated by careful dissection and the lesion excised by means of a quadruple ligation. The patient suffered no untoward effects postoperatively.

Obviously arterial repair in this case would be hazardous because of the weakened arterial wall. Even if arteriorrhaphy could be accomplished the thinned area would remain as a possible site for early rupture with dangerous secondary hemorrhage or late aneurysmal dilatation.

*The anatomic location of the fistula.* The relationship between proximity of the fistula to the heart and subsequent development of car-



Fig. 2. Arterial wall opposite the site of fistula was thin and bulging. Quadruple ligation and excision of the fistula with the weakened portion of the artery was performed.

diac changes is too well known to merit more than a passing reference. Management of the local lesion however will vary according to the vessels involved. For example a lesion of either one of the main arteries at the wrist can be treated by ligation and excision because there is always an adequate secondary arterial circulation. This is also true of other regions where collateral circulation is known to be adequate.

On the other hand lesions of large main vessels present a much more serious problem. The choice of operation for a fistula involving the common or the internal carotid artery requires careful judgment. Collateral circulation usually does not develop satisfactorily in such cases, and with a quadruple ligation or obliterative procedure there is always the risk of hemiparesis especially in older individuals. This unfortunate complication can often be avoided by a procedure designed to restore the arterial pathway. Arteriorrhaphy whenever possible is always preferable in the presence of a fistula involving the common or internal carotid artery. The following case demonstrates the suggested method of handling such patients.

CASE 4. L. M. entered Charity Hospital with an arteriovenous fistula of the right common carotid artery and internal jugular vein caused by a gunshot wound incurred 7 weeks prior to admission. Three weeks later a modified transvenous repair of the fistula was performed with reconstruction of the carotid artery and the ligation of the internal jugular vein above and below the fistula. Heparin was administered after operation and a hematoma developed rather promptly. This was evacuated and the

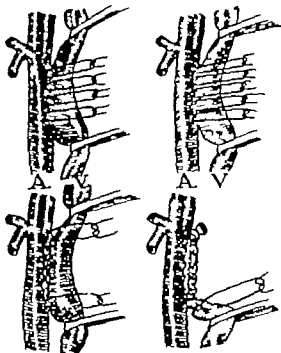


Fig. 3. Diagrammatic sketch of a modified transvenous arteriorrhaphy. In order to avoid tearing the internal jugular vein, complete liberation from surrounding scar tissue was not attempted. Instead large U mattress sutures were placed across the fistulous opening and tied. The vein was then interrupted above and below the fistula and the wall sutured to reinforce the closure of the fistula.

remainder of the postoperative course was uneventful. The patient was discharged fully recovered with no evidence of cerebral vascular deficiency. Figure 3 shows the lesion and the method of repair which was used.

Fistulas of other large vessels also merit a determined attempt at restoration of the arte-

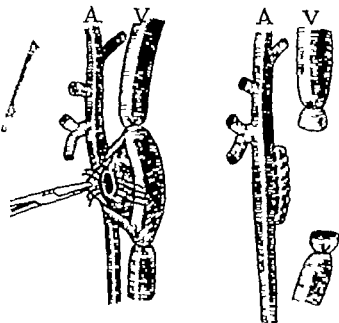


Fig. 4. Transvenous arteriorrhaphy with section of vein proximal and distal to fistula.





Fig. 9. Blackmore-Lord technique utilizing a venous graft and two vitallium tubes.

If the collateral circulation in this patient had been found inadequate an obliterative endoaneurysmorrhaphy could have been done in an effort to preserve as many accessory vessels as possible. To avoid suturing through an area of calcification a disc of calcified sac wall is excised around each opening. This will ordinarily leave enough fibrous tissue to permit closure of the openings in the usual manner. Figure 8 illustrates this modified technique.

**Collateral circulation.** The type of operation required in a given case must to a great extent depend on the adequacy of the collateral circulation. Collateral vascular channels will usually develop to a remarkable degree around an arteriovenous fistula if sufficient time is allowed to elapse. The time factor is all important. In those patients that present themselves to the surgeon quite early it is essential to postpone operation long enough to permit the establishment of good circulation in accessory vessels. However there are two important complications which require early operative intervention despite a doubtful collateral circulation. These are (a) progressive edema and hemorrhage in the tissues around the fistula, producing pressure sufficient to cut off the collateral circulation and threaten the development of gangrene and (b) early cardiac decompensation.

In the presence of a rapidly enlarging hematoma with compression of the collaterals, the usual operation is quadruple ligation with excision. This procedure will stop the bleeding, remove the fistula, evacuate the clot, and relieve the tension. The surgeon can only hope that the collaterals present at the time of operation will be sufficient to prevent ischemia or

gangrene. Restorative procedures or obliterative procedures as a rule cannot be done in such instances.

However it must be remembered that ligation of the main artery in the face of poor collateral circulation is not satisfactory. One case aptly demonstrates the complications that may occur when quadruple ligation and excision is performed before adequate collateral circulation has been established.

**CASE 10.** G Y was admitted to Charity Hospital suffering from a gunshot wound of the left thigh just below the inguinal ligament. An arteriovenous fistula of the common femoral vessels developed subsequently. Left lumbar sympathectomy was performed 3 weeks after admission, and operation for removal of the fistula was performed 2 weeks later. During operation the femoral artery was found to be involved by considerable scar tissue and was opened accidentally, resulting in a decalson to perform a quadruple ligation. Postoperatively despite sympathectomy the patient's foot was cold and pulseless, and the leg became indurated, swollen, and painful. The patient had to stop smoking and required prolonged treatment with elastic bandages, bed rest, and elevation of the limb for months after operation. Apparently the 5 week waiting period between injury and operation was too short to permit formation of sufficient collateral circulation.

On the other hand, when early cardiac decompensation occurs before adequate collaterals develop the surgeon is faced with an entirely different aspect of the problem. He must then direct his efforts toward eliminating the unprecedented load on the heart.

### General Factors

**Cardiac status.** Impaired cardiac status may manifest itself either as early or late decompensation. Early failure as a result of arteriovenous fistula is relatively uncommon. This is probably due to the fact that larger arteriovenous communications, which immediately overload the heart, often require emergency operative intervention to prevent fatal hemorrhage. Despite the fact that there is not time for collaterals to develop ligation and excision is the usual method used in the treatment of most of these cases. An obliterative endoaneurysmorrhaphy would not be feasible because a false aneurysmal sac requires some time to develop. Furthermore owing to the marked inflammatory reaction in and around the vessels, incident to the trauma, sutures

may not hold at this stage, with the result that arterial repair would be technically difficult and hazardous. The technique using vitalium tubes with a venous graft gives the promise of being a useful operation under such circumstances (Fig. 9). Blakemore and Lord have reported considerable success with their elective cases. Unfortunately, recent papers by Rose, Hess and Welch, and DeBakey and Simeone show that poor results were obtained when the nonsuture technique was used for war casualties with arterial injuries. More experience is necessary before the influence of this method can be accurately evaluated.

The development of cardiac symptoms late in the course of this condition is a frequent occurrence and has offered a fruitful field for many investigations. Those patients who show signs of decompensation with cardiac enlargement should be prepared for operation with utmost care. As a routine measure, repeated compression of the fistula preoperatively is advocated to permit adjustment of the heart to the circulatory changes which will occur after operation.

There will be occasional patients who have advanced cardiac disability as a result of a long standing fistula. Price recorded 5 such cases in 1937. Operation was considered impossible in 3 of these patients and only an incomplete procedure could be done in the remaining 2. When myocardial damage is severe a major operation is ill advised. Under such circumstances ligation of the proximal artery and vein or the proximal vein alone may prove beneficial as a preliminary step. These are relatively simple procedures which can be performed under local anesthesia and by reducing the amount of blood pouring back to the heart, may produce temporary relief. If sufficient improvement then takes place the patient will be able to withstand a second operation eliminating the fistula.

Fortunately, the cardiac changes in most instances are moderate and reversible. With careful preparation any one of the three main types of operative procedures can be used depending on the other factors. In the final analysis the cardiac status of a patient will greatly influence the choice of operation because the primary concern of the surgeon is to produce

relief for the decompensated heart. Cure of the fistula then may become a matter of secondary importance.

*Generalized arteriosclerosis* This causes degenerative changes not only in the vessels involved by the fistula but also in the collateral vessels. Repair of a calcified, arteriosclerotic artery is contraindicated because of postoperative complications such as secondary hemorrhage, thrombosis, and further degeneration of the arterial wall, with subsequent formation of an aneurysm. Quadruple ligation is preferred in such cases despite the risk of poor collateral circulation.

*Occupation of the individual* Patients who lead a sedentary life and who are rarely called upon to exercise the involved limb strenuously may do well with quadruple ligation. But as Blakemore and others have pointed out strenuous exercise such as that which is experienced by a dancer or by a soldier will require an arterial pathway that is functioning normally.

#### CONCLUSIONS AND SUMMARY

- 1 Postoperative deficiencies in circulation frequently follow the use of quadruple ligation and excision in the treatment of arteriovenous fistula.

- 2 Recent reports indicate that restoration of the main arterial pathway is the primary objective and should be accomplished whenever possible.

- 3 There are a large number of variable factors which influence the choice of operation for arteriovenous fistula.

- 4 Some factors contraindicate any procedure which interrupts the arterial blood flow. Others contraindicate restoration of the arterial lumen.

- 5 The importance of certain factors both local and general, have been discussed and their relationship to the choice of operation has been considered, with appropriate cases used as examples.

- 6 There is no single operative procedure of choice for all cases of arteriovenous fistula.

- 7 The surgeon must be prepared to use any one of the standard procedures or even an improvised technique in order to overcome individual problems which may be found at operation.

## METHODS

Thirty nine unselected cases of various types of surgical infections from the surgical services of three hospitals were used in this study. All of the cases were not followed through to their clinical end results, emphasis being placed on the changes occurring in the bacterial flora of the wound when treated with the urethane sulfanilamide mixture. Some cases were abandoned because of inability to maintain sterility, or to abolish the gram negative portion of the bacterial flora; these have been included as failures. The criterion for a response to treatment was the absence or presence of a change in the types and numbers of bacteria in the wound. It was impossible to exercise adequate surgical control in some of the cases.

A thorough history of each case was obtained including the duration of the infection prior surgery and the duration and type of previous chemotherapy. In addition to a careful physical examination a detailed description of the wound was recorded and the patient's age, dietary history, red blood count, hemoglobin and serum protein level were used to classify the patient's physical status. Each infection was classified as acute or chronic. Follow up notes were made, including the type, length of time, and complications of therapy rendered during this study and an assessment of the adequacy of concurrent surgical treatment.

At the time of the initial dressing a nurse was instructed in the proper procedure. Lack of optimal dressing conditions, unco-operative patients, and shifts in nursing personnel occasionally raised doubt as to the faithfulness of dressings, so that an opinion as to adequacy of urethane treatment was recorded for each case (Table I).

Cultures, taken at the time of the initial dressing and every 2 days thereafter were planted on heart infusion-blood-agar plates and in heart infusion blood broth and incubated for 24 to 48 hours. Colony types were identified on the basis of specific diagnostic tests, and an exact bacteriologic diagnosis made in each case. A careful record was kept of the relative numbers of gram negative and gram positive bacteria in each culture, and the time of disappearance of each was noted.

Most of the patients were treated with a mixture of 10 per cent urethane and 1 per cent sulfanilamide. This was prepared by dissolving 10 grams of ethyl carbamate and 1 gram of sulfanilamide in a small quantity of hot water and adding enough water to make 100 cubic centimeters. The solution was then sterilized by passing it through a Mandler filter. A few patients were treated with 10 per cent or 20 per cent urethane without sulfanilamide.

An attempt was made to keep the infected wound in contact with the urethane sulfanilamide solution constantly. This was accomplished by wetting the dressing every 4 hours. All wounds were dressed once a day with careful aseptic technique. Cultures were taken and sterile gauze placed within the infected cavity so as to cover all of the crevices. When applying the chemotherapeutic solutions, the dressings were removed only to the inner layer and the drug applied with a sterile syringe in a sufficient quantity to moisten them well. Sterile gauze was then applied covered with a sterile towel, bandaged, and then covered with waxed paper or oiled silk to prevent evaporation. In cases with sinuses or cavities which could not be saucerized or dependently drained a perforated catheter or Dakin's tube was inserted, with sterile gauze loosely packed around it. Injections were made through the catheter every 4 hours and the gauze and catheter changed once daily. Whenever wounds were so located as to be frequently contaminated such as a decubitus ulcer or adjacent to a colostomy the dressings were changed and saturated with urethane sulfanilamide every time contamination with fecal material occurred.

## RESULTS

*The effect of urethane sulfanilamide mixture on the gram negative bacteria in infected wounds*  
Thirty nine patients were studied and their wound cultures revealed a wide variety of gram positive and gram negative organisms. *Staphylococcus aureus*, *Staphylococcus albus*, and *Streptococcus pyogenes* were by far the most common gram positive bacteria present. Twenty-six of the wounds showed mixed infections yielding both gram positive and gram negative micro-organisms. Fifteen of these re-

vealed the presence of *Pseudomonas pyocyanea*, 12 *Proteus vulgaris*, 8 *Escherichia coli* and 3 *Aerobacter aerogenes*. One wound each harbored *Bacillus morgani*, *Klebsiella pneumoniae* and *Eberthella typhi*. In 6 of the wounds *Proteus vulgaris* and *Pseudomonas pyocyanea* were found together. Only 1 case yielded a pure culture of gram negative bacteria. In 20 (Cases 1 to 20) of the 26 mixed infections the gram negative members of the wound flora were eradicated with urethane sulfanilamide mixture. *Proteus vulgaris* and *Pseudomonas pyocyanea* were found to be most susceptible to the action of the drug mixture, these organisms frequently disappearing from the wounds within 48 to 96 hours. Some of the cases (Cases 4, 5, 13, 16, and 19) showed a slower response but were still classified as good results because elimination of the bacteria was accomplished in spite of such obstacles as fecal contamination, inadequate drainage, etc. The response observed in these wounds appeared to be significantly better than that following the use of other known topical chemotherapeutic agents. Although the wounds in 8 of the individuals (Cases 4, 5, 7, 8, 9, 10, 11, and 20) had a relatively shallow surface affording good contact with the solution others (Cases 15 and 17) presented situations in which good results were obtained in spite of conditions that were highly unfavorable.

In 7 patients classed as failures, no effect was produced on the gram negative constituents of the wound flora (Cases 21-27). All were in poor general condition, and had either a constant source of wound contamination, inadequate débridement or insufficient drainage. In addition 4 of the patients received inadequate treatment with urethane sulfanilamide solution. The infection was classed as chronic in 18 of the patients whose wounds contained gram negative bacteria and as acute in 9 patients. Six of the 7 failures and 12 of the 20 successfully treated infections were classed as chronic; thus, it would seem that the chronicity of the infection as indicated by the duration of the disease and the presence of thick walled granulations and scar tissue was not important in determining the ability of the drugs to eliminate gram negative bacteria from wounds.

Six patients were treated with a solution containing urethane alone (Cases 6, 7, 12, 15, 16, and 21), of these, 5 showed a good response to treatment, with elimination of the gram negative organisms. These results make it seem doubtful that the antibacterial effect of ethyl carbamate is enhanced by sulfanilamide. In 1 patient (Case 4) who had infected ulcers of both lower extremities, a mixture of 10 per cent urethane and 1 per cent sulfanilamide was applied to the lesions on one leg, and a 10 per cent urethane solution alone to those on the other. There was no demonstrable difference in the results. It appeared, therefore, that the urethane was the component in the mixture most active in killing gram negative bacteria, and that the sulfanilamide exerted little, if any additional effect.

*The effect of urethane sulfanilamide mixture on the gram positive bacteria in infected wounds.* Gram positive bacteria were present in the wounds of 38 patients. Twenty-six of these showed mixed infections while in 12 only gram positive bacteria were present.

In contrast to the excellent results obtained against gram negative bacteria, urethane sulfanilamide mixture was much less effective against gram positive organisms. Eradication of the gram positive organisms occurred in 12 wounds (Cases 4, 9, 16, 18, 28, 29, 30, 31, 32, 33, 34, and 35), and no effect was demonstrable in 24. In 2 cases (Cases 3, 4) treatment served to eradicate *Streptococcus pyogenes* from the wound but had no effect on *Staphylococcus aureus*, while in several other instances the streptococcus was unaffected by the drug. When good results were obtained, the time required for elimination of the bacteria appeared to be considerably longer than that necessary for gram negative organisms. The possibility exists that a similar effect on the gram positive organisms might have been produced by the meticulous use of saline solution, especially in those cases with shallow wounds. Although these bacteria showed only slight susceptibility to urethane, it may have some value in the treatment of infections by decreasing their pathogenicity. In 1 instance, *Staphylococcus aureus* was noted to change from coagulase positive to coagulase negative and become less actively hemolytic during treatment.

TABLE L—SUMMARY

Case No.	Age Sex	Diagnosis	Duration of infection	Description of wound	Acute or chronic	General status	Previous chemotherapy	Previous surgery	Treatment		
									Type	Time days	Complications
14	34 M	Infected post-operative suppurative wound, scars to kidney bed	months	Multiple slugs trapped scar to kidney bed. Decontaminated by Iridolol	Chronic	Good	?	Nephrectomy	10% ureth. 1% sulf.	30	None
15	30 M	Infected suppurative wound, scars to kidney bed	3 months	Multiple slugs to kidney bed from ureters, discharging suppurative wound	Chronic	Poor	?	Nephrectomy	10% ureth.	43	None and vomiting
16	37 F	Osteochondritis of hip, inlet seal. Decubitus ulcer	days	Decubitus ulcer over sacrum on dense abscess of buttocks	Chronic	Poor	Urea sulf. (this case not sent)	Hip manipulation	10% ureth.	31	None and vomiting
17	47 F	Multiple abscess of arm and shoulder	3 years	Multiple deep abscess tracts about shoulder girdle	Chronic	Fair	Sulfonamide crystalline penicillin	Multiple excision of abscess tracts	10% ureth. 1% sulf.	64	None
18	31 M	Chronic cystitis, right	14 years	Draining cavity right	Chronic	Good	Sulfonamide	Rob section	10% ureth. 1% sulf.		None and vomiting
19	31 M	Cancer of caecum Extensive wound infection	weeks	Wound opened widely down to fascia	Acute	Good	Urea solution for weeks	Right colectomy	10% ureth. 1% sulf.	8	None
20	41 M	Arteriovenous ulcer 1 base of great toe, right	days	Ulcer with draining mass at base of toe	Acute	Fair	None	None	10% ureth. 1% sulf.	4	None
21	64 F	Diabetes mellitus. Sloughing ulcer of foot, postoperative	month	Transverse sloughing undermining postoperative ulcer of dorsum of foot and lower leg	Chronic	Very poor	Sulfonamide	Amputation of toe	10% ureth.	10	Embolus
22	Elderly F	NO I malignancy. Decubitus ulcer		Intertriginous (old undecubitus ulcer, with sloughs and sloughing fascia necrotic on	Chronic	Poor	?	None	10% ureth. 1% sulf.	5	None
23	38 M	Carcinoma of sigmoid with perforation. Left groin abscess draining spontaneously		Large, granulating wound left groin with sloughs, discharging thick pus Induration in caecal region Crepitan to neck	Chronic	Poor		Cecostomy and transverse colectomy both functioning	10% ureth. 1% sulf.	8	None
24	51 M	Ulcerative colitis with abscess chest. Perirectal abscess	3 months	Perirectal cavity 8x3x6 cm draining perineal external	Chronic	Poor	None	Decectomy Drainage of rectal abscess	10% ureth. 1% sulf.	3	None
25	63 F	Hodgkin's disease. Post-radiation slough in neck	4 months	Fowl necrotic sloughing crater in neck extending into neck-stemum. Multiple abscess. No dependent drainage	Chronic	Very poor	Sulfonamide Zinc peroxide Ascorbic-acids Urea crystals	Biopsy of neck lymph node	10% ureth. 1% sulf.	10	None and vomiting
26	27	Chronic cystitis	30 months	Tube strapped into small sinus in chest	Chronic	Fair	?	Thoracotomy elsewhere	10% ureth. 1% sulf.	14	Resolving Cyst removed

OF CASES—Continued

Cultures of wounds		Adequate surgical treatment	Adequate urethane treatment	Clinical result	Bacteriological result	Remarks
Before treatment	After treatment					
<i>Proteus vulgaris</i> <i>Staphylococcus aureus</i> <i>Ps. pyocyanea</i> Diphtheroids	Absent Present Absent Absent	Yes wide open drainage	Yes	Excellent (cure)	Excellent gram negative Poor gram positive	<i>Proteus</i> and <i>Ps. pyocyanea</i> rare after 90 hours' good (after 16 days). Excellent result demonstrating the use of chemotherapy in conjunction with adequate surgery
<i>K. pneumoniae</i> <i>Staphylococcus aureus</i> <i>Staphylococcus albus</i> Diphtheroids <i>Ps. pyocyanea</i> <i>Proteus vulgaris</i>	Absent Present Absent Present Absent Absent Streptococcus pyogenes	N	Yes	Wound improved clinically	Good gram negative Poor gram positive	Good gram negative result in spite of inadequate drainage <i>Proteus</i> absent in 23 days. <i>Ps. pyocyanea</i> rare colony after 3 days
<i>Ps. pyocyanea</i> Nonhemolytic streptococcus Nonhemolytic staphylococcus aureus Diphtheroids	Absent Absent Absent Absent	Yes	Yes	Excellent. Ulcer sterilized. Grafted—100% take	Excellent gram negative Excellent gram positive	<i>Ps. pyocyanea</i> gone after 3 days. Easily contaminated area
Hemolytic <i>Staphylococcus aureus</i> Each coli	Present Absent	N	No	Poor	Excellent gram negative Poor gram positive	Disappearance of coli 48 hours after treatment
<i>Ps. pyocyanea</i> <i>Staphylococcus albus</i>	Absent Present	N	Yes	Good	Excellent gram negative Excellent gram positive	<i>Ps. pyocyanea</i> gone 48 hours after treatment started. N recurrence
Each coli	Absent	Yes	Yes	Excellent	Excellent gram negative	Wound sterile after 5 days of treatment. Wound edges pulled together with adhesive tape. Complete healing
<i>Ps. pyocyanea</i> Streptococcus pyogenes	Absent Present	No	N	Poor	Excellent gram negative Poor gram positive	Leg amputated on 4th day <i>Ps. pyocyanea</i> gone after 48 hours of treatment
<i>Staphylococcus aureus</i> <i>Proteus vulgaris</i> Diphtheroids	Present Present Present Each coli Streptococcus pyogenes	N	Yes	Patient died	Poor gram negative Poor gram positive	Hopless case. No adequate surgical drainage
<i>Proteus algaris</i> <i>Ps. pyocyanea</i> Each coli <i>Staphylococcus aureus</i> Diphtheroids	Present Present Present Present Present	N	Yes		Poor gram negative Poor gram positive	Abandoned because of lack of surgical control (ulcer needed debridement) and constant fecal contamination. Not fair test
<i>Cl. welchii</i> Each coli <i>Ps. pyocyanea</i>	Present Present Present Streptococcus aureus	No	Yes		Poor gram negative Poor gram positive	Not fair test. Abandoned due to constant fecal contamination
Gram negative bacilli—type undetermined	Present	N	N	Eventually good	Poor gram negative Poor gram positive	Abandoned because of fecal contamination. Not fair test
<i>Proteus vulgaris</i> <i>Ps. pyocyanea</i> Streptococcus pyogenes	Present Present Present Streptococcus	No	N	Poor	Poor gram negative Poor gram positive	Unfaithful treatment. N dependent drainage. Multiple abscesses
<i>Staphylococcus aureus</i> <i>Ps. pyocyanea</i> Streptococcus pyogenes	Present Present Present	N	N		Poor gram negative Poor gram positive	Adequate treatment impossible because of vomiting. This probably not due to urethane because it only occurred during irrigations

Of the 12 wounds in which elimination of gram positive bacteria was produced the infections in 7 were classified as chronic and in 5 as acute. Nine of the patients were in fair or good general condition, and the clinical status of 3 was poor. Five of the patients in whom good results were obtained had had previous sulfonamide therapy and all except 1 were subsequently treated with a mixture of 10 per cent urethane and 1 per cent sulfanilamide.

Analysis of the 26 failures to eliminate gram positive bacteria from wounds by the use of urethane sulfanilamide solution showed that in 13 there were such obvious reasons as inadequate drainage, constant fecal contamination, etc.

It should be stressed that of the 26 cases of mixed infections in which treatment failed to eradicate the gram positive bacteria, 15 (Cases 1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 17 and 20) showed complete elimination of the gram negative organisms while in none of the 7 gram negative failures were the gram positive organisms in the same wound eradicated. These cases show the highly selective action of urethane dependent on the staining reaction of bacteria.

**Complications.** Careful observation failed to reveal a hypnotic effect in any of the 39 patients treated by the topical application of urethane. One patient was given 10 grams of urethane orally in 24 hours without untoward reaction. Nine of the topically treated individuals suffered from nausea and vomiting 2 from nausea alone and 1 from retching. These symptoms were at times severe enough to cause moderate discomfort and were sufficiently alarming to warrant discontinuation of the drug in 1 instance (Case 26). In this patient psychogenic factors were thought to play a large part. The nausea usually began after 3 or 4 days of treatment, reached a peak on the fifth or sixth day and then decreased, to continue moderately thereafter. The 12 patients who showed these symptoms were treated for an average of 19 days, the shortest being 9 days and the longest 43 days. Seven of those who had gastrointestinal symptoms had previously received some type of sulfonamide. In the remaining 5 patients no information concerning the previous use of these

drugs was available. That the nausea and vomiting were not due to sulfonamide sensitivity was borne out by the fact that they occurred in 3 individuals who were treated with urethane solution alone. The wounds in 10 of the 12 patients who had gastrointestinal disturbances were relatively large, and it was our impression that the symptoms occurred more frequently when large surface areas of normal surrounding skin were kept constantly moist with urethane solution. This suggested that the drug was absorbed through normal skin, and other observations tended to bear out this theory. One patient, not included in this study who had severe pyoderma over the entire thorax and trunk and was treated with a large amount of urethane suffered very severe nausea and vomiting. During the latter part of the investigation, therefore, the normal skin was covered with vaseline gauze up to the wound edge in order to prevent absorption. With this type of management no other instances of nausea or vomiting were seen.

#### SUMMARY AND DISCUSSION

Meleney (16) has called attention to the difficulty of appraising the value of drugs used for the treatment of surgical infections and has enumerated many factors which must be taken into consideration in evaluating their efficiency. In certain acute surgical infections, a series of unselected alternate patients with relatively few variables can be treated under standard conditions, and the value of a chemotherapeutic agent assessed quite correctly. In the cases reported here in which most of the wounds were chronic, occurred in patients with a wide variety of underlying conditions, and included some which had been previously treated by various methods, it is difficult to assess the value of an antibacterial agent because of the lack of adequate controls. It is necessary, therefore, to use the patient's previous response to other types of therapy as a control and to stress the importance of changes in the bacterial flora. In order to conclude that ethyl carbamate is of value, the results obtained must be significantly better than those expected after other types of treatment.

As can be seen from the data presented, urethane has a selective action against gram

negative organisms. These results are in accord with those previously described in *in vitro* studies. The reason for this selectivity is not known but it would appear to be of great value in the treatment of wounds with mixed infections since, with the exception of streptomycin, there are few agents which are highly active against gram negative organisms.

Most of the patients in this study were treated with a combination of sulfanilamide and urethane. Several cases given carbamate alone appeared to show as good a response as those receiving a combination of the drugs, and it is our impression that the addition of sulfanilamide may not be necessary. *In vitro* studies of ethyl carbamate separately and in combination with sulfonamide yielded the same results, although a slight synergistic effect could be demonstrated when the two drugs were combined. It has been shown by Weinstein that penicillin plus urethane will inhibit greatly the growth of mixtures of gram positive and gram negative bacteria in the test tube. These data suggest the possibility of using a mixture of urethane and penicillin in the treatment of wounds. With such a combination the gram positive organisms should be killed by the penicillin and the gram negative organisms by the carbamate. An agent potentially bactericidal for the gram negative group should prevent or limit their production of substances such as penicillinase (1) which inhibit the action of penicillin and should thus render the latter more efficacious.

Urethane showed no deleterious effect on tissue healing since large wounds were found to heal promptly after being sterilized. Skin grafts took successfully when postoperative dressings were kept continuously saturated with urethane (Cases 4, 9, 11 and 8). Epithelialization was observed to progress at a normal rate in the constant presence of 10 per cent urethane solution.

The complications seen in patients receiving urethane have already been described. Nettleship, Henshaw and Meyer have called attention to the carcinogenic effect of ethyl carbamate in mice. These investigators increased the incidence of lung tumors in C<sub>3</sub>H female mice<sup>1</sup>

from less than 5 per cent to more than 75 per cent by minimal anesthetizing intraperitoneal injections of urethane, by a dose of 1 milliliter of a 10 per cent aqueous solution per 100 grams of body weight. Haddow and Sexton (5) on the other hand have shown that urethane has a growth inhibiting effect on animal tumors, and Paterson, Haddow, Thomas, and Watkinson (19) have recently reported beneficial effects from the use of urethane in myeloid and lymphoid leucemia, carcinoma of the breast, lymphosarcoma, Hodgkin's disease and other malignant lesions.

In some of the cases reported in the present study, the quantity of urethane used probably exceeded the level used by Nettleship and co-workers, but it was employed as a topical agent and was not administered parenterally. Although some was undoubtedly absorbed through the skin or wound it does not appear likely that the amount was as great per unit of body weight as that given intraperitoneally to mice by Nettleship and his co-workers. There would appear to be little to fear regarding the carcinogenic effect of urethane in man. The fact that the incidence of tumors in a known tumor susceptible strain of mice is increased by the administration of some substance does not mean that such a result would follow the use of the same material in man. For example, the administration of estrogenic substances is known to enhance the occurrence of breast tumors in mice, yet these agents have been used very extensively in women.

Although urethane has been shown to be very effective against gram negative organisms and to allow normal wound healing it must be remembered that the use of this or any other drug does not replace the application of sound surgical principles. Experience in World War II (2, 12, 28) has demonstrated that the presence or absence of bacteria is not important in choosing the proper time for suture of soft tissue wounds, failure having followed the closure of clinically dirty wounds which were sterile and success having resulted after suture of wounds massively contaminated with staphylococci and streptococci. It is not reasonable to expect the eradication of bacteria to result from the topical application of a chemotherapeutic agent to wounds in which the

<sup>1</sup>An inbred strain of mice with a high incidence of mammary cancer.



TABLE I

Our lab. No.	Obtained from	Origin	Per cent concentration	Plunge*	Condition at room temperature
A	Wilson & Co	Pigskin	8	Medium and high (50-100)	Liquid
B	Wilson & Co.	Pigskin	8	Low (30-40)	Liquid
C	Wilson & Co	Pigskin		High & low (8-17)	Liquid
D	Wilson & Co	Pigskin		High (18-27)	Liquid
E	Atlantic	Pigskin	7	Medium (30)	Liquid
F	Atlantic	Pigskin	7	Medium (30)	Liquid
G	Knox	Bone	6	High (3)	Solid

\*The "plunge" of gelatin is an expression of its gel strength and is determined by the weight required to make a stylus penetrate a given depth at 4°C.

plunge gelatin i. e. slightly degraded or markedly degraded material have not been well established. This study was undertaken therefore from the viewpoint of comparing the efficacy of different concentrations of gelatin and of gelatins of varying degrees of hydrolysis.

In Table I are listed the variety of gelatins tested and some of the pertinent information obtained.

We attempted to use animals with a medium factor of probability of survival (1 700-3,000) and with medium carbon dioxide (20-30 volumes per cent) value except when 2 per cent gelatin and saline were employed. With the latter two materials we purposely chose animals with a high factor of probability of survival and a high carbon dioxide value because it became clear very early that these substances were relatively ineffective.

**Methods.** The experimental procedure and methods used were those described previously (1) with one exception after the hemorrhage, the blood was quickly centrifuged the supernatant plasma removed and at the reinfusion, a volume of test material equal to the removed plasma was injected followed by the packed red blood cells. There could not be complete substitution of the test material for the plasma, for about 6 per cent of the latter was retained around the packed red blood cells and reinfused with them. This was constant however for the varying substances tested. Blood pressures were recorded continually from a

carotid artery. One femoral artery was used for bleeding and for withdrawal of blood samples for analysis. All surgical procedures were performed on dogs under local anesthesia (procaine).

## RESULTS

**Antishock properties and survival.** The efficacy of the gelatin was based on the period of survival of the animal. In the tables, D E signifies death occurring during the experiment. D N indicates longer survival but death during the night following the experiment and I S means indefinite survival, in which group we placed all animals alive 48 hours after the experiment. Rarely did an animal fail to survive indefinitely if it was still alive 24 hours after the experiment. Table II presents a summary of all experiments. The data previously obtained (1) when whole blood was reinfused are included for comparison at the bottom of the table. The results presented in this table lead to several clear-cut conclusions.

1. Confirming the previously expressed results, most animals with a carbon dioxide value less than 20 volumes per cent and a factor of probability of survival under 1 700 will not survive regardless of the reinfusing fluid, even when whole blood presumably the best, is used.

2. Animals with a carbon dioxide value above 30 volumes per cent and a factor of probability of survival above 3,000 have a good prospect of survival if the reinfusing agent has definite restorative properties.

3. On the basis of our criteria, saline has the least value in saving animals.

4. Two per cent gelatin is only little better than saline.

5. Four per cent gelatin has definite value, is strikingly better than saline but is somewhat inferior to gelatin of higher concentrations.

6. Gelatin of 6 to 8 per cent concentration is a very effective agent. The relative merits of the different concentrations and plunges are not so clearcut. Statistical analysis of the results, by the chi square test, discloses that there is no overall difference between blood and gelatin and, in general all the higher concentration gelatins are equivalent. Statistical

TABLE II.—SUMMARY OF AVERAGE VALUES AND RESULTS

Average CO <sub>2</sub> volume per cent	Average B P mm. Hg.	Average F P S.	No. of dogs	Survival*						Average hours survival of dogs that died
				D E.		D N		I. S.		
				No.	Per cent	No.	Per cent	No.	Per cent	
				Gelatin A (3%)						
8.2-10.0	78	99	8	5	6	3	38		7.0	
20-24.0	74	683	8	4	50	4	50	0		20
5-20.0	77	3	8	0		4	50	4	50	9.6
30-40	100	1370	7			3	43	4	57	13.0
				Gelatin B (8%)						
6.2-9.0	6	118	3	3	100				5	
24.2-29.0	77	2096	5			3	60		40	8
30-30.0	83	303	10	1		5	30	4	40	.8
				Gelatin C (4%)						
5-9.0	70	97	5	4	80	1	20		2.8	
20-24.0	80	177	7	7	86	1	14			4.
5-20.0	70	900	9	3	33			4	43	4.6
30-40.	7	568	4		5		5		50	6.3
				Gelatin D (2%)						
5-20.0	96	903	5	5	100	0	0	0	2.4	
30-40.3	99	1406	8	6	74		13	1	3	6.3
				Gelatin D (1%)						
9.6-14.0	50	560			100				1.0	
20-24.0	66	1483	5	3	60	1	20	1	20	6.2
5-20.0	98	268	5				20	4	80	3.0
33-30.0	8	418	3		0			3	100	
				Gelatin E (1%)						
7.6-9.0	63	900	4	3	75		1		0	
5-20.0	70	920	3		0	4	80	1	20	13.0
30-40.3	97	2486	3					3	100	
				Gelatin G (6%)						
17.8-7.0	8	1463			100				5	
20-24.0	8	774	3	3	100					3.5
5-23	94	26	7			4	57	3	43	13
				Saline						
22.0-23.3	98	2273			100			0		
5-20.0	94	535	4	4	100					3.7
31-41.0	9	4566	4	4	100					1.8
				Whole blood						
1.3-19.0	83	2237		10	100	0				
20-24.0	78	16.8	10	5	30		20	3	20	6
5-20.0	76	0.4	9		3	3	23	4	45	8
30-42.6	8	818	1		8	3	1	8	67	0.7

F P S.—Factor of probability of survival.

\*D. E. signifies death occurring during the experiment; D N during the night; and I. S. indicates survival.



low plasma protein content delays recovery particularly if there is a complicating infection. In such cases, the plasma proteins should be restored as rapidly as possible to normal levels by plasma or whole blood administration and proper nutrition.

Gelatin is an effective agent in combating shock due to plasma loss and should be a valuable addition in our therapy if the gelatin is used with due regard to its properties and limitations.

#### SUMMARY

The efficacy of gelatin solutions in the treatment of hemorrhagic shock was tested.

Various brands of gelatin gelatins with different degrees of hydrolysis and various concentrations of gelatin solutions were tried in our experiments.

Our method of repeated graded hemorrhages and reinfusion of the blood 30 minutes after each hemorrhage was used as control. In the assays of the gelatin solutions the plasma of the withdrawn blood was replaced by a gelatin solution.

The factor of probability of survival and the critical carbon dioxide value were used to predict the chance of survival of the individual animal. Prolongation of the periods of survival served as criterion of the efficacy of the gelatin solutions.

Gelatin solutions of 2 per cent concentration do not prolong life of the shocked animal appreciably and therein resemble physiologic saline solution.

The best results were obtained with gelatin solutions of 6 and 8 per cent concentration. The effects of these solutions with the packed cells were as good statistically as reinfusion of whole blood.

The degree of hydrolysis of the gelatins in the range tested by us did not seem to be an important factor in the efficacy of the gelatin as plasma substitute.

Gelatin solutions must be pyrogen free and should be liquid at room temperature.

In the dog, gelatin is excreted rapidly in the urine with the exception of 6 per cent bone gelatin which left the circulation at a slower rate than the skin gelatins.

Gelatin solutions dilute the blood and lower hemoglobin and protein values. In some cases

plasma and red cells must be given later in the treatment.

Following our experience in the dog, we do not hesitate to recommend gelatin solution for use in patients. Gelatin cannot replace whole blood, nor is it a substitute for plasma, but has value as an inexpensive easily available agent to combat shock due to plasma loss. Our experience with the use of gelatin solution in the patient has been favorable.

#### REFERENCES

1. ARIMOTO, F., NICHOLLS, H., LEVINSON, S. O. and JANOTA, MARTHA. *Am. J. Physiol.* 1945 143 198.
2. BRUNSWICHTWIG, A., CORBIN, N. and JOHNSTON, C. D. *Ann. Surg.* 1943, 118 1038.
3. BRUNSWICHTWIG, A., and NICHOLLS, S. *Surgery* 1944 16 923.
4. BRUNSWICHTWIG, A., NICHOLLS, S., and BIGGLOW, R. *Surg. Gyn. Obst.* 1946, 82 25.
5. BRUNSWICHTWIG, A., SCOTT, V. B., CORBIN, N., and MOE, R. *Proc. Soc. Exp. Biol., N.Y.* 1943, 52 46.
6. ELY, J. O. and AMOULO, A. W. *J. Franklin Inst.* 1943 235 197.
7. EVANS, E. L., and RAFAEL, H. S. *Ann. Surg.* 1945 121 478.
8. FLETCHER, A. G., HARDY, J. D., RIEGEL, C., and KOOP, C. E. *J. Clin. Invest.* 1945 24 405.
9. GORDON, H., HOGUE, L. J. and LAWSON, H. *Am. J. M. Sc.* 1942, 204 4.
10. GRODINS, F. S. *Federation Proc.* 1943 2 17.
11. HOGAN, J. J. *J. Am. M. Ass.* 1915 64 721.
12. HOLT, J. P. and KNOEFEL, P. K. *J. Clin. Invest.* 1944, 23 657.
13. HOPPS, H. C. *Illinois M. J.* 1944 86 815.
14. HUEPPE, W. C. *Am. J. Path.* 1943 18 895.
15. IVY, A. C., GREENGLASS, H., STEIN, I. F., GRODINS, F. S. and DUTTON, D. F. *Surg. Gyn. Obst.* 1943 76 85.
16. JACOBSON, S. D. and SMYTH, C. J. *Arch. Int. M.* 1944, 74 254.
17. JANOTA, MARTHA, NICHOLLS, H., WESTON, R. E., WEISSEMAN, V. and LEVINSON, S. O. *Exp. M. Surg.* 1943 1 198.
18. a) JANOTA, MARTHA, ARIMOTO, F., NICHOLLS, H., and LEVINSON, S. O. In writing.  
b) NICHOLLS, H., LEVINSON, S. O., JANOTA, M. and ARIMOTO, F. *Surg. Gyn. Obst.* 1947 84 499.
19. KLEINBERG, W., REMINGTON, J. W., EVERSOLE, W. J., OVERMAN, R. R. and SWINGOLD, W. W. *Am. J. Physiol.* 1943, 140 197.
20. KNOEFEL, P. K., and LEIDMAN, G. J. *Pharm. Exp. Ther.* 1945 83 185.
21. KOOP, C. E., and BULLITT, L. *Am. J. M. Sc.* 1945, 209 28.
22. KOOP, C. E., FLETCHER, A. G., RIEGEL, E., and LOCKWOOD, J. S. *Surgery* 1944, 15 839.
23. KROLL, D. D., POPPER, H., STEINMANN, F., and VOLK, B. W. *Am. J. M. Sc.* 1944, 208 141.
24. LAWSON, H. and REHM, W. S. *Am. J. Physiol.* 1943 140 431.
25. *Ibid.* 1945 144 217.
26. LITTLE, J. M., and DAMKRON, J. T. *Am. J. Physiol.* 1944, 140 636.
27. LITTLE, J. M., and WELLS, H. S. *Am. J. Physiol.* 1943 138 495.

evidence of previous breast disease recorded in the case histories, although it seemed inconceivable that caked breasts, should not have occurred in some cases. There was no history of trauma in the entire series.

**Duration** The duration of this condition before the patients sought treatment was difficult to determine with accuracy. A few admitted having a lump in the breast for months but the great majority insisted that it had been present for only 2 weeks or less in 14 for 3 to 7 days, in 7 for 8 to 16 days, in 6 for 3 to 4 weeks, in 4 for 3 months, and in 1 for 3 years. The older women were more or less reticent regarding their breast tumors this was especially true of negro women who had a great fear of operations. However the patients were questioned very carefully on this particular point and their answers were at variance with the operative findings. It is difficult to picture a mass the size of a tennis ball, with a dense fibrous wall an inch or more thick surrounding a central pus pocket containing a dram of pus, developing in 2 weeks or less.

Approximately one third of the patients noticed that the tumor mass had enlarged rapidly in the last few days before admission to the hospital. We believe these lesions to be long standing and will elaborate this phase further under the pathological discussion.

**Symptoms** The symptoms were varied: lump in breast in 30 swelling of breast in 3 pain at onset in 11 late pain in 5 no pain in 6 heavy sensation in 3 squeezing sensation in 1 burning in 1 discomfort in 1 tenderness in 6 pain in nipple in 1 itching of nipple in 1 discharge from nipple in 2 tumor enlarging rapidly in 9 fever (early) in 5 swelling in axilla in 1. Of these the most important were the lump in the breast, the various interpretations of pain or discomfort, the early fever and the recent rapid enlargement of the mass.

**Physical findings** The tumor was described as hard in 19 indurated in 3 lobulated in 1 rough in outline in 1 firm in 9 nonfluctuant in 1 circumscribed in 3 nodular in 1 irregular in 2 regular in 3 stony in 1 adherent to skin in 11 not adherent to skin in 7 not adherent to underlying tissues in 5 movable in 4. The overlying skin was orange peel in 4 red in

1 and increased temperature was noted in 2. Five patients had retraction of the nipple and in 1 instance ulceration was present. The breast was tender in 8 but in 10 tenderness was recorded as being absent. The axillary glands were palpable in 9, not palpable in 5 hard in 3 and adherent to the skin in 1.

We are all familiar with the cardinal signs of moderately advanced breast cancer the hard lump fixed in the breast tissue, flattening or dimpling of the overlying skin when squeezed gently adherence of the tumor to the skin and underlying tissues, retraction of the nipple poor transillumination of the breast, the orange peel skin and enlarged, hard axillary lymph nodes. Circumscribed chronic suppurative mastitis may present any or all of these characteristics.

In this series of cases, the leucocyte count and the polymorphonuclear percentage were within normal limits in all but a few cases, and in no instance was an increase in eosinophils noted. Temperature in the 100 degrees F group was observed in 25 per cent of the cases and there was only 1 instance of 101 degrees F or more.

**Diagnosis** The differential diagnosis of breast lesions is of the greatest importance. To overlook a malignancy is a serious mistake. With circumscribed chronic suppurative mastitis the problem of diagnosis is reversed but no less important. The performance of a radical mastectomy where less extensive surgical treatment will suffice is also a grave error. Patients with circumscribed chronic suppurative mastitis are often seen in that stage of the disease which most closely simulates cancer and hence differentiation of these two diseases is difficult and requires careful evaluation of all available information.

The duration of the symptoms is important in spite of the fact that the operative findings point to a lesion of long standing. The history of 2 weeks or less duration with recent rapid enlargement of the tumor mass should be of maximum importance in the differentiation as this is unlike the progress of a malignant tumor.

Pain at the onset always points toward an inflammatory lesion although this may vary with the individual and in some instances be entirely absent. It should also be remembered

that pain may be present in malignant tumors that have attained this stage of development.

The symptom of early fever is less reliable and by the time the patient enters the hospital will have subsided.

Tenderness on palpation is of about the same value as pain. It will vary with the individual and may be absent in half the cases. It, too, can be present in a malignant tumor that has reached these proportions.

Increased surface temperature or redness over the lesion is rare but, if present, points very strongly toward inflammation.

After careful evaluation of the symptoms and physical findings there will remain about one-third of the cases in which surgical exploration is necessary for diagnosis.

Preoperative biopsy for breast tumors including aspirations, punch biopsies, and those procedures which remove only small bits of tissue we consider entirely inadequate. Positive findings in borderline cases may be inconclusive and negative reports simply show there is no evidence of malignancy in the tissue submitted. In this institution frozen sections are rarely done except under special circumstances. After several unfortunate experiences the procedure was discarded as unreliable for breast tumors and a rapid 24 or 48 hour paraffin method substituted. We have made it a rule to send all of the tumor to the pathologist for biopsy whenever possible even should it include the entire breast. To do less is unfair to the patient and the pathologist.

The preoperative diagnoses in this series were chronic mastitis 5, chronic cystic mastitis 1, abscess 7, tumor type undetermined 8, carcinoma, 7, carcinoma with axillary metastases 4.

#### PATHOLOGY

Although minor variations may be present, both the gross and microscopic pathologic features of this lesion are distinctive. The tumor varies considerably in size. When palpated through the skin such terms as size of a large walnut, hen's egg, plum, lime and orange were employed. In actual measurement the tumors varied from the smallest, 2.0 centimeters in diameter to the largest 11.0 by 9.0 by 5.0 centimeters. The shape is ovoid rather than round. The

tumors cannot be peeled away from the surrounding breast parenchyma without great difficulty as no actual cleavage planes are present. Sharp dissection is necessary either at the operating room table or at the pathological examining board.

The essential characteristics of the lesion are best seen if the tumor is hemisected. There will be found a central abscess filled with gray yellowish gray, or greenish pus. This purulent center is always small in relation to the mass often it measures only 0.5 centimeter in diameter even in the largest tumors. Occasionally the abscess measures 5.0 centimeters in its greatest dimension but this is distinctly unusual. An average abscess measures 1.0 to 1.5 centimeters in diameter. This pus is rather thick and does not flow easily. When the pus is removed a shaggy gray or grayish green lining is observed. In a few specimens two or three small abscesses of a similar nature are found instead of one central abscess. Occasionally the larger abscess communicates by narrow channels with smaller satellite abscesses.

The bulk of the tumor is composed of dense, firm white tissue surrounding the abscess. This can be cut with moderate resistance and a slightly gritty sensation. Frequently the tissue is so hard as to be grossly indistinguishable carcinoma. The wall of the abscess measures from 1.0 to 5.0 centimeters in thickness. For this reason if the tumor is cut tangentially or if the section misses the abscess, only firm white tissue strongly resembling carcinoma is found. The tumor blends gradually into the adjacent parenchyma which is rubbery and rolls under the cutting knife. One side of the tumor may be close enough to the skin to be adherent to it and it is in these cases that wrinkling of the skin is prominent.

The axillary lymph nodes are enlarged some measuring as much as 3.0 centimeters in their greatest dimension. They are discrete and firm and on sectioning appear uniformly gray or somewhat mottled but no hard white areas indicative of metastases are seen.

Microscopically the abscess is filled with polymorphonuclear leucocytes, generally in a fair state of preservation. Occasionally many fat filled macrophages and a few lymphocytes



# A COMPARISON OF SUTURE AND NONSUTURE METHODS FOR THE ANASTOMOSIS OF VEINS

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THE introduction of an improved method of blood vessel anastomosis by Blakemore and Lord (3) in 1942 put a new and practical tool into the hands of the vascular surgeon. This method made use of the principle that two vessel ends can be successfully joined over a tube of inert metal (vitallium) provided the inside of the tube be lined with intima, thus it reaffirmed the long known axiom (8) that intimal integrity and continuity are the essence of permanent blood vessel patency. The advantages of the new nonsuture method were asserted to be chiefly (1) the technical ease and speed with which the anastomosis could be performed, especially under battle conditions where the immediate re-establishing of blood supply was essential to the life of a part, and (2) the fact that a gap could be bridged.

This nonsuture anastomosis was in fact first devised as a means of bridging arterial defects (3, 4) a segment of prepared vein was used to line the gap between the divided ends of an artery. However the method has since been applied by Blakemore (2) and others to vascular problems in which there is no defect to be bridged i.e. to cases amenable to the old direct suture method of anastomosis (5, 6). Notable among such cases has been the portal caval anastomosis for the relief of portal hypertension (2). Such a procedure may consist in (1) an end-to-end anastomosis between the proximal ends of the divided splenic and left renal veins following removal of the left kidney and spleen or it may mean (2) the anastomosis of the divided distal end of the portal vein to the side of the inferior vena cava.

The question therefore arises whether the newer nonsuture method is preferable to anastomosis by suture. In cases in which either procedure is feasible, is the nonsuture anas-

tomosis better than the old direct suture method? And what are the advantages and disadvantages of each procedure? The results of the few reported cases in which the vitallium tube has been used are promising. The advantages of technical ease claimed for this procedure are undisputed. But current developments and the recently observed potentialities of blood vessel surgery demand a more thorough comparison of the two methods and their merits.

The primary consideration in all blood vessel surgery—far from being any refinement of technique *per se*—is, of course, the functional efficiency of the vessel as a conductor of blood. Compared to this all other factors are secondary and contributory in their importance. Unless a given procedure produces results at least comparable to those of other methods, no technical advantage justifies its use. A valid analysis and comparison of two such different methods would have to be on a functional basis. Anastomoses would have to be performed by each method under similar conditions and on the same vessels in a number of experimental animals, and delayed observations made of the functional patency of all these anastomoses. The purpose of this report is to present a summary of such observations.

## PROCEDURE AND TECHNIQUE

The renal splenic vein anastomosis was considered singularly suited to this comparative study since it would eliminate certain external and mechanical factors which might introduce an inconstant error. From a physiological standpoint, the pressure gradient between the portal and caval systems in normal dogs is small, 30 to 50 millimeters of water (1). This means that the sheer mechanical pressure effect of flowing blood in keeping the anastomosis open is reduced to a desirable minimum.

In these experiments dogs weighing between 15 and 25 kilograms were used. They were

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TABLE I.—RESULTS END-TO-SIDE SUTURE ANASTOMOSIS

Dog	Day after operation	Function	Microscopic
	(Dead)	Patent	N section.
	16 (Dead)	Thrombosed	No section.
3	75 (Sacrificed)	Patent	No thrombus
4	74 (Sacrificed)	Patent	Slight intimal thickening.
	5 (Sacrificed)	Patent	5 mm. thrombus along splenic vein.
5	5 (Sacrificed)	Patent	Slight intimal thickening
16	27 (Sacrificed)	Patent	No thrombus.
8	5 (Sacrificed)	Patent	N thrombus.
9	28 (Sacrificed)	Patent	No thrombus.
20	70 (Sacrificed)	Patent	No thrombus

anesthetized with intratracheal ether. In order to avoid errors of technical variation the types of anastomoses were performed alternately and by the same operating team. At intervals of 12 to 75 days following operation autopsies were made on the dogs. The anastomoses were examined grossly for functional patency and thrombosis, and microscopically for intimal changes and the presence and type of thrombi.

Three series of operations were performed. No anticoagulant was used in any of these experiments.

In the first series the proximal end of the divided splenic vein was anastomosed into the side of the intact left renal vein. The anastomosis was done by the classic method of Carrel and Guthrie (5, 6). There were 10 dogs in this series.

In the second series in which 11 dogs were used the spleen and left kidney were removed and a suture anastomosis was performed between the proximal ends of the splenic and left renal veins. With fine silk and straight needles, three stay sutures were placed to insure proper alignment and a continuous running suture was employed with care to approximate intimal surfaces by everting the edges of the veins.

In the third series, after splenectomy and left nephrectomy the ends of the renal and splenic veins were anastomosed over a vitallium tube by the method described in detail by Blakemore (2, 3, 4). The end of the splenic

vein was brought through the tube and everted over its edge, being secured here by silk ligatures placed behind tying ridges on the outside of the tube. The end of the renal vein was then very carefully brought over the outside of the vein lined tube and secured tightly by two silk ligatures, one behind the tying ridge and one just behind the edge of the tube. Twelve anastomoses were done in this series.

## RESULTS

There were no operative or early postoperative deaths among the 33 dogs in the three groups of experiments.

In the first series (Table I) of the 10 end-to-side suture anastomoses, one was completely thrombosed after 16 days. Nine were functionally patent after periods of 12 to 74 days of these, 1 showed a microscopic thrombus extending 5 millimeters along the lumen of the splenic vein, 2 showed negligible intimal thickening at the suture site and 5 were absolutely clear microscopically. No sections were made of the remaining 2. The silk suture material was unabsorbed even after 75 days, but the foreign body reaction was not remarkable. The over all patency was 90 per cent.

Of the 11 end-to-end suture anastomoses, (Table II) 3 were completely obstructed by organized thrombi at 46, 55 and 51 days. Eight were functionally open after 13 to 55 days. 4 of these showed microscopic thrombosis which was functionally negligible; there was slight intimal thickening in 1; in the remaining 3 the anastomoses were clear. There was 72.7 per cent patency.

Of the 12 anastomoses performed by the non-suture technique only 2 were patent (Table III). Both of these were in animals sacrificed 14 days after operation. The remaining 10 were completely thrombosed after periods varying from 14 to 52 days. In all cases the thrombi were found to obliterate the vessel lumina throughout the entire length of the vitallium cannulas. There was microscopic evidence that the thrombotic process began in the renal end of the cannula and progressed down the splenic vein since in most cases the fresher part of the thrombus was at the splenic end of the anastomosis. There was some recanalization but this was of no functional

# SUTURE AND NONSUTURE METHODS FOR VEIN ANASTOMOSIS TABLE II.—RESULTS END-TO-END SUTURE ANASTOMOSIS

Dog No.	Days after operation	Function	Microscopic
6	27 (Sacrificed)	Patent	No thrombus. Silk suture line at one point.
8	33 (Sacrificed)	Patent	Small organized thrombotic tag at suture line
4	7 (Sacrificed)	Patent	Small organized thrombus at apical vein.
16	3 (Died)	Patent	Small organized thrombus at suture line
17	33 (Sacrificed)	Patent	No thrombus
30	26 (Sacrificed)	Patent	One mm thrombotic tag at suture site
30	26 (Sacrificed)	Patent	N thrombus
30	31 (Sacrificed)	Thrombosed	Slight intimal thickening.
33	31 (Sacrificed)	Thrombosed	Organized thrombus filling entire lumen
34	26 (Sacrificed)	Thrombosed	No section
			Organized thrombus filling entire lumen

TABLE III.—RESULTS NONSUTURE VITALLIUM CANNULA ANASTOMOSIS

Dog No.	Days after operation	Function	Microscopic
5	7 (Sacrificed)	Thrombosed	Organized thrombus completely filling lumen
7	4 (Sacrificed)	Thrombosed	Fresh thrombus filling lumen inside tube
5	8 (Sacrificed)	Thrombosed	Old thrombus filling entire tube
7	33 (Sacrificed)	Thrombosed	Old thrombus filling entire lumen
15	4 (Sacrificed)	Patent	No thrombus
9	34 (Sacrificed)	Thrombosed	Old thrombus filling entire lumen
	27 (Sacrificed)	Thrombosed	Old thrombus filling entire lumen
3	26 (Sacrificed)	Thrombosed	Old thrombus filling entire lumen
7	27 (Sacrificed)	Thrombosed	Old thrombus filling entire lumen
30	14 (Sacrificed)	Patent	Old thrombus filling entire lumen
3	5 (Sacrificed)	Thrombosed	Fresh thrombus present in each end of tube
0	33 (Sacrificed)	Thrombosed	N section.
			Old thrombus filling entire lumen.

importance. In this group there was 17.2 per cent patency

## COMMENT

The results of these experiments indicate that in vein anastomosis, through which the blood flow is relatively small e.g. splenic renal shunt, the suture method judged by functional patency is superior to the nonsuture method.

The fact that the nonsuture technique has met with greater success in arterial anastomosis than in this series may be attributed partly to the mechanical effect of the pressure of the arterial blood flow in maintaining patency. This factor should also contribute to comparably better results in direct suture arterial anastomoses.

In this connection work by Murray and Janes, at Toronto has shown that arterial anastomosis over metal bands leads to necrosis of the vessel wall with resulting hemorrhage in many cases. Suture anastomoses did not show this in any of their cases.

In addition to its demonstrated functional inferiority in this particular vein anastomosis, the nonsuture method has two important drawbacks pertinent to arterial as well as venal surgery. (1) It leaves a large foreign body in the tissues. (2) The metal tube is not expansile

and hence the anastomosis cannot increase size subsequently.

Regardless of the technique of anastomosis used in this portal caval shunt, the end-to-end anastomosis would seem preferable to the end-to-end anastomosis because (1) it preserves the left kidney and (2) it provides a greater flow of blood—from the left kidney—past the anastomosis a factor which should be helpful in preventing thrombosis.

There is no implication here that the direct suture rivals the nonsuture method for bridging defects of arteries and veins. It is also apparent that the suturing of vessel ends is inferior to the vitallium tube when there is any appreciable tension on the anastomosis. In these important respects, the method of Blakemore is a major contribution. We conclude however that for cases in which a suture anastomosis can be performed without undue tension this procedure is preferable to the nonsuture method and remains the technique of choice.

## SUMMARY

1. Experiments were performed on dogs to determine the relative merits of two accepted methods of blood vessel anastomosis: the di-

rect suture method of Carrel and Guthrie and the nonsuture method of Blakemore.

2 Anastomoses were performed (a) by suture between the proximal end of the divided splenic vein and the side of the renal vein (b) by suture between the proximal end of the splenic vein and the proximal end of the renal vein and (c) by the nonsuture vitallium tube method, between the proximal end of the splenic vein and the proximal end of the renal vein

3 Delayed observations showed a higher percentage of functioning patent anastomoses in the suture groups (90% and 72 7%) than in the nonsuture group (17 2%)

4. It is concluded that in blood vessel anastomoses where there is no tension on the suture line and no defect to be bridged the

suture method of anastomosis is superior to the nonsuture method. In other cases the nonsuture technique of Blakemore is probably better

#### REFERENCES

1. BEST and TAYLOR. *The Physiological Basis of Medical Practice*. 3d ed. Baltimore, Maryland. Williams & Wilkins Co., 1943.
2. BLAKEMORE, ARTHUR H., and LORD, JERE W. *Ann. Surg.*, 1945, 121 435-453.
3. BLAKEMORE, ARTHUR H., LORD, JERE W. and STEFKO PAUL L. *Surgery* 1945 13 485-508.
4. Idem. *Ann. Surg.*, 1943, 117 481-407
5. CARREL, ALBERT. *Lyon mtd.*, 1902, 93 859-864.
6. MARKOWITZ, JACOB. *Textbook of Experimental Surgery*. Baltimore, Maryland: William Wood & Company 935
7. MURRAY GORDON, and JAMES, J. N. *Surgery* 1945, 15 670-633
8. WARREN, JOHN C. *Healing of Arteries*. Baltimore, Maryland. William Wood & Co., 1884.

# ORIGIN AND DEVELOPMENT OF THE ERECT POSTURE

CLARENCE A SPLITHOFF M.D. Oakland California

MAN with childlike innocence has always considered his erect posture a God given blessing. Milton in *Paradise Lost* said that in the Garden of Eden there were

Of living creatures new to sight and strange,  
all kind  
But

Two of far nobler shape, erect and tall,  
Godlike erect, with native honor clad,  
In naked majesty seemed lords of all,  
And worthy seemed."

Man's erect spine has been one of his greatest assets yet to all intents and purposes also one of his greatest liabilities. Because of it the forelimbs have been divorced of their former function of locomotion and developed into organs of prehension. This fact has enabled man to become master of his domain. Despite this apparent superiority man's low back is a weak spot, a so called 'Achilles' heel. Since man is the only living creature endowed with unconditional erect posture it may be well to examine this inheritance to shed new light on the problem created by his ability to walk erect.

The pelvis and hind limbs appeared first as keels or ridges supported by basal rods operated by extensions of the segmental muscles of the body wall. Later they became paddle like and finally were bent downward and strengthened to support the body on land, and to cooperate with the pectoral limbs in pushing the body forward (2).

The pelvis arose in close association with other bodily functions those of digestion and excretion and also of reproduction in the discharge of eggs or living young in the female and of sperm in the male (Fig. 1). The pelvis thus arose around the cloaca and served as a base or platform for certain groups of muscles those running forward along the lower surface of the abdomen those running backward along the under and outer sides of the tail and a cone shaped mass of muscles based on the pelvis

and converging outward and downward to form the thigh muscles.

The ilium at first grew upward between the muscles of the back in front and the tail muscles behind. In so doing it passed to the sides of the ribs being at first entirely free, later becoming tied to them by connective tissue and ligaments and still later by bony connection.

Although we are not sure of the date when human posture evolved we are quite certain that it became adjusted through a series of changes from arboreal to terrestrial existence.

(3) These changes can be readily observed by a comparative study not only of livingbrates but of fossil material beginning with the Devonian lobe fin Eusthenopteron (Fig. 2 a) a prehistoric fish. In this animal which existed about 350 million years ago formed the earliest evidence of a pelvic girdl consisting of a pair of bony rods on either side of the cloaca. It supported the pelvic fins which were moved by simple opposing groups made up of folds of the outer myomere.

Further development occurred after the fin fish came out on land. The iliac blades upward becoming attached to the sacral ribs and thus to the vertebral column. This found in the earliest amphibians about 300 million years ago in the carboniferous age of which Eogyrinus (Fig. 2 b) is an example.

In the ancient amphibians such as Eryops megacephalus (Fig. 2 c) the pelvis was shaped like a body was slung by muscular straps attached to the pelvis much as the cables of a suspension bridge. The iliac blades were attached to the spine by ligamentous attachment to the sacral ribs. The limbs were widely spread apart and walking was cumbersome. The Cynognathus (Fig. 3 d) from the upper Triassic of South Africa, about 175 million years ago represented an in between stage of the reptile and the mammal. The limbs were adapted for running and there were many features of the skull backbone and limbs that approached those of mammals. The iliac blade



Fig. 1 The basic invention of the pelvis or bony foundation for the hind limbs. Underside of pelvic region of primitive shark, showing pelvic fins on either side of cloaca, which are keel-like folds supported by skeletal rods. (Reproduced from *Scientific American*, Oct. 1930 after W. K. Gregory) C cloaca, B basal rods.

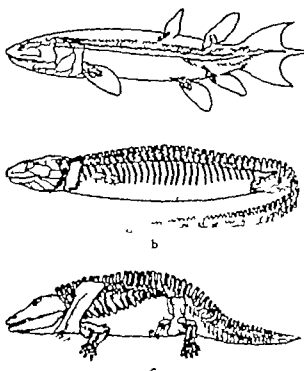


Fig. 2 Man's quadrupedal ancestors, comparison of a, Devonian lobe-fish (*Eusthenopteron fordsi*) b, Carboniferous amphibian (*Eogyrinus*) c, Permian amphibian (*Eryops megacephalus*). (Reproduced from *Proceedings of the American Philosophical Society* Vol. 67 1923, after W. K. Gregory)

was wider and was more firmly attached on a broader base to the spine

As a representative of the next stage in development, the opossum (Fig. 3 e) may be studied (5). It retains, in the main, the leading characteristics of the skeleton of the older fossil animals. The iliac blade is elongated and inclined forward. The limbs contain five-toed grasping hands and feet, by which it made its way about in the trees. In these early mammals when the knees were drawn forward the ilium also grew forward almost parallel with the backbone to which it was now attached by means of the sacral vertebrae and their ligaments, the sacral ribs having become short and wide and fusing with the transverse processes of the sacral vertebrae.

The order of primates to which man belongs made its appearance early in Eocene times, about 60 million years ago in the form of an arboreal monkey-like animal *Notharctus* (Fig. 4). Adaptation to tree climbing was quite well

advanced which is obvious from certain features of the skeleton such as the grasping type of construction of the hind feet. It is highly significant that all of the known foot and limb bones of fossil lemurs, monkeys and apes are unquestionably of arboreal type. Hence one must infer that the origin of the order of primates as a whole was arboreal. This fact is of importance in the question of man's origin and brings us to a consideration of the relationship between man and ape.

It is not certain when the separation of man from the primitive anthropoid stock occurred; however, it must have been during the Miocene epoch somewhat over 20 million years ago. No fossil showing the transformation has been found and only by deductive and inductive inference have we been able to reach any conclusion. There is, however, some difference of opinion regarding man's origin. Professor Osborn states, "I personally had abandoned the anthropoid ape theory and I advanced the

# SPLITHOFF ORIGIN AND DEVELOPMENT OF ERECT POSTURE

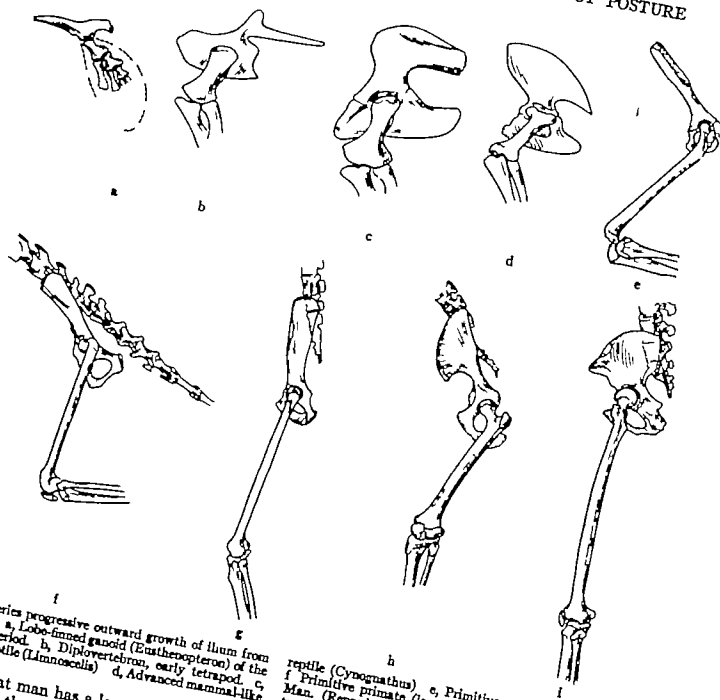


Fig. 3. Series progressive outward growth of ilium from fish to man. a, Lobe-finned ganoid (*Eusthenopteron*) of the Devonian period. b, Diplovertebron, early tetrapod. c, Primitive reptile (*Limnoscelus*) d, Advanced mammal-like

reptile (*Cynognathus*) e, Primitive mammal (opossum) f, Primitive primate (*lemur*) g, Gibbon. h, Gorilla. i, Man. (Reproduced by Courtesy American Museum of Natural History after W. K. Gregory.)

opinion that man has a long line of dawn ancestors and that the other theory rests upon a large amount of evidence which proves the kinship of anthropoid apes to man but does not prove the ancestry of man through an anthropoid ape type. He further quotes Sir Arthur Keith who is of the opposite opinion stating that all the evidence now at our disposal supports the conclusion that man has arisen from an anthropoid ape not higher in the zoologic scale than a chimpanzee (?)

Man and ape possess certain characteristics in common, such as a high mentality, a prehensile hand, an erect or semierect posture, etc. However there are certain skeletal and developmental differences which I propose to examine to obtain a clearer understanding of the evolution of the erect posture.

The gibbon, an East Asiatic tree living descendant of the first family of tailless or man-like apes is the only ape normally walking on its hind legs when on the ground. The skull

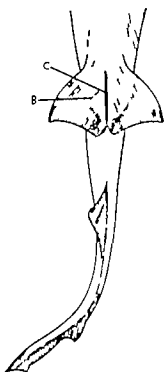
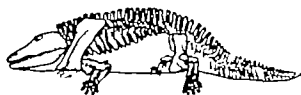


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b



c

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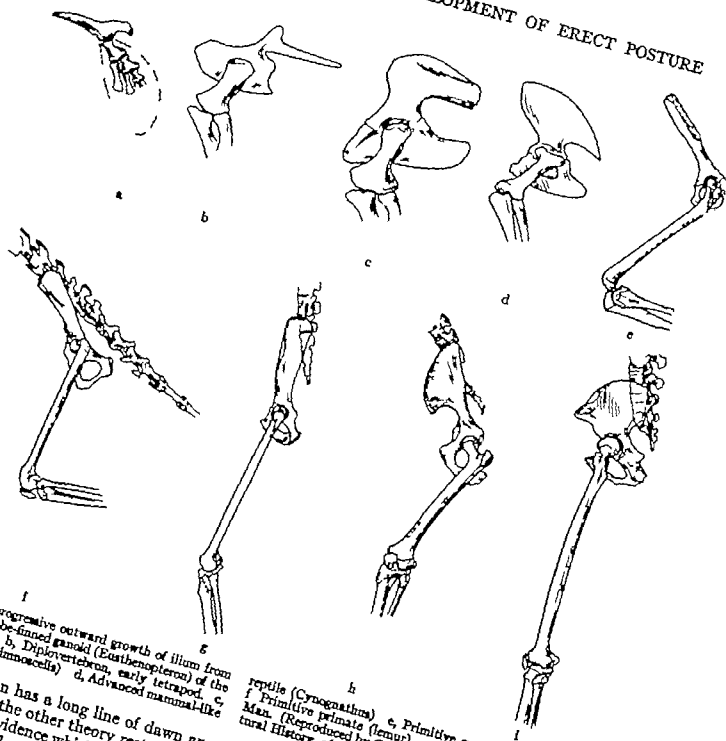


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Man and ape possess certain characteristics in common such as a high mentality, a prehensile hand, an erect or semierect posture, etc. However there are certain skeletal and developmental differences which I propose to examine to obtain a clearer understanding of the evolution of the erect posture. The gibbon, an East Asiatic tree living descendant of the first family of tailless or like apes is the only ape normally walking only on its hind legs when on the ground. The



eton begins to be almost human (Fig. 3 g) however the arms are excessively long because of its brachiating habits. Its pelvis begins to show incipient widening of the iliac blade as compared with the lemur (Fig. 3 f) one of a group of monkeys (Lemuroidea) which exist entirely in trees. In the lemur the ilium is narrow and is adapted for running and leaping. At first in the mammals the upper part of the ilium was triangular in cross section, its three surfaces being occupied respectively by the muscles of the upper side of the backbone, by the iliacus muscles in front and by the gluteal muscles on the outer side. When the primates began to sit upright, resting themselves on their folded legs and on the lower ends of the pelvis the iliac muscles served to check them from falling forward. Thus with increased size of these two muscles the blade of the ilium began to grow outward in a transverse plane the chief successive steps in this broadening process being recorded in the lemurs, monkeys, apes, and man (Fig. 3 f, g, h, and i).

Since the gibbon has been endowed by nature with the ability to walk upright it may be well to pause at this point and learn how this came about. The body of the primitive quadruped is slung between two suspension towers, which are the pelvic and pectoral girdles. The gibbon has succeeded in turning this suspension bridge up at right angles to its original horizontal position and in balancing it on the rear tower represented by the pelvic girdle. Thus nature has worked out in this animal the basic invention for upright or bipedal progression. This step can be seen in the viscera which approach the human type in a number of ways, and in the details of construction of its pelvis.

The gibbon learned to run on its hind legs by first learning the habit of sitting upright, and secondly by the habit of brachiating or climbing with the arms raised above the head and the body suspended beneath the branches. The habit of sitting upright conditioned the first steps in the remodeling of the pelvis, especially the flattening of the ilium in the transverse plane. The habit of brachiating conditioned the extension to and upon the ilium of certain muscles of the loins and abdomen, thereby being better able to support the vis-

cera, pelvis, and hind limbs when the body was suspended by the arms. In addition to climbing the gibbon makes enormous leaps from one branch to another and in so doing has developed great extension backward of the thigh muscles so that they may be nearly parallel with the backbone. Thus he is able to walk when on the ground.

Further widening of the iliac crest together with an expansion of the iliac and gluteal muscles is seen in the gorilla (Fig. 5 c). This is further conditioned by the habit of sitting and walking upright on the ground. The gorilla, because of its great weight must of necessity be principally terrestrial, however it may take to the trees under certain conditions.

There is such a striking resemblance between the anthropoids and ourselves in external form and in their attitudes, also in their internal structure, particularly when studied in captivity that we are apt to overlook the radical distinction in their mode of locomotion. In man, his whole weight is poised on a very narrow pedestal in direct opposition to the erect posture. If he declined at all from it he would be forced to the earth, but for the preponderance in the back and the legs of the extensors over the flexors. The position of the ape in nature is just the reverse. He hangs and moves about among the trees by means of his long and powerful arms. He is thus sustained not from below but from above where by his weight would soon bring him to earth, except for the immense power of his flexor arm muscles.

Various investigators have reported their studies of dissected material, and seem to be in general agreement that the muscle pattern of apes and man is similar the main difference being in function and thus also in comparative size. For instance the gluteal muscles in quadrumanes are small and weak. Thus we assume that it is for this reason that the apes are unable to stand erect or stand on one leg as we do whereas the real distinction is in the position of these muscles thus accomplishing a different function mainly that of leaping. Man, however does not leap well, and consequently by a priori reasoning we might assume that his glutei are small. This we know is not true. Again certain animals such as the horse cannot

# SPLITHOIF ORIGIN AND DEVELOPMENT OF ERECT POSTURE

stand erect The secret of the functional difference is the position of the focal point of action In man the external surface of the short broad ilium looks outward like the acetabulum The fibers of the gluteus medius converge from a broad origin to the great trochanter the whole arrangement acts to prevent the body from sinking to one side when supported by the opposite leg It also assists the gluteus maximus and the psoas in preserving the balance forward and backward required in ordinary progression (8)

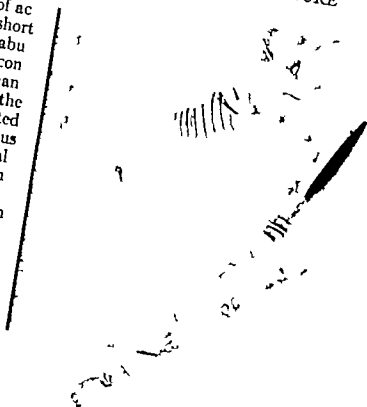
In apes the external surface of the ilium looks upward or backward while the acetabulum still looks outward as in man Thus the acetabulum is at right angles with the ilium which is long and narrow so that the fibers of the gluteus run nearly parallel to each other and the muscle is inserted at the end and not as in man down the outer side of the trochanter Thus the leverage arm acts to greater advantage in man aiding pelvic balance in walking and in the erect posture The glutei semitendinosus and biceps support the trunk behind and the gracilis and sartorius antagonize them in front In man the glutei and long flexors of the leg have two sets of function according to whether or not they take their fixed point of function from above or below This means that they may be used either for moving the legs by themselves or for acting powerfully upon the trunk as in locomotion The human pelvis is likewise fitted in many other ways to act as a bony anchor for the muscles that tie in the abdominal viscera, and as a base for the powerful thigh and back muscles that hold the body erect

Sir Arthur Keith has divided the evolution of the erect posture into three phases the first the hylobatid or gibbon type represented by the fossil remains found in Pliocene and Miocene deposits of Europe parts of which very closely resemble the modern gibbon He therefore assumes that they have come through unchanged or troglodyte stage of which the chimpanzee is the most generalized surviving member whose upper and lower limbs are developed to a more or less equal degree The gorilla also in this group however shows specialized development of the lower limbs. The third or plantigrade

stage is represented by changes principally to the lower limbs The knees thigh extended and lengthened the pelvis modified and the muscles and bones as human form We cannot fix the exact geological date and no fossil showing the transition has been found It is assumed that geological date is in Miocene or Oligocene about 20 to 35 million years ago (Fossil man has contributed little to knowledge of when human posture evolved We know that his posture was crouching character similar to the apes. Marcellin Boule in describing the so-called Neanderthal skeleton from La Chapelle Aux Saints states the vertebral column was short and massive. The first vertebrae are much more like those of a chimpanzee than those of a man The spinous processes are long lying at right angles to the axis of the vertebral column instead of inclining backward and they are not bifurcated at the end.

These peculiarities seem to indicate in the cervical region of the vertebral column a

Fig. 4. Reconstructed skeleton of *Notharctus*, found in the primates. A North American of Eocene times. (Courtesy after W. K. Gregory)





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Fig. 4. Reconstructed skeleton of *Notharctus*, founder of the primates. A North American of Eocene times. (Reproduced by Courtesy of American Museum of Natural History after W. K. Gregory.)

grade stage is represented by changes confined principally to the lower limbs. The knees and thigh extended and lengthened the pelvis was modified and the muscles and bones assumed human form. We cannot fix the exact geological date and no fossil showing the transformation has been found. It is assumed that the geological date is in Miocene or Oligocene times about 20 to 35 million years ago (6). Fossil man has contributed little to our knowledge of when human posture evolved. We know that his posture was crouching in character similar to the apes. Marcellin Boule in describing the so-called Neanderthal skeleton from La Chapelle Aux Saints states that the vertebral column was short and massive. The first vertebrae are much more like those of a chimpanzee than those of a man. Their spinous processes are long lying at right angles to the axis of the vertebral column, instead of inclining backward and they are not bifurcated at the end.

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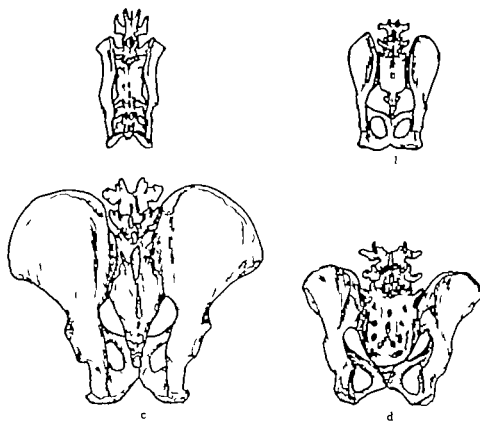


Fig 5 Progressive widening of the pelvis and sacrum in Primates. a, Lemur b, Gibbon, incipient widening of iliac blade c, Gorilla d, Man (Reproduced by Courtesy American Museum of Natural History after W. K. Gregory)

etc absence of curves or a slight curve in direction opposite to that in modern man negating the dorsal curve as occurs in an ape, such as chimpanzee.

The vertebrae of the other regions are not so preserved. It would seem as if the lumbar curve were less pronounced than in the major part of modern men. The portions of the sacrum which we possess point to narrow sacral foramina slightly arched and deeply set beneath the iliac bone. These are Simian characteristics. (1)

Thus Marcellin Boule gives account of the erect crouching posture of one of the most primitive of prehistoric men. It may be concluded therefore that if Neanderthal man still retained a moderate crouching posture and Simian characteristics of his skeleton 25,000 years ago that human posture as we know it today has finally evolved in that span of time; however it is possible that erect forerunners of *Homo sapiens* (e.g.

Pittdown man) may date back to upper Pliocene times around one million years ago (4). We may conclude further that the low back area together with the sacrum and pelvis remain in a state of flux because it is this portion of the skeleton which has undergone the greatest change in the synthesis of erect posture. The human skeleton as we know it today may be the best adaptation for the purpose to which it is being put, however it is axiomatic that nature develops by trial and error and that future millenia will produce a structure better adapted to the stresses and strain which the erect posture entails.

#### CONCLUSION

Human posture is shown to have evolved through a series of progressive changes beginning with the prehistoric Devonian fish, 350 million years ago. Changes occurred which allowed the ancient amphibians some 50 million years later to become land dwellers. Because

of poor adaptation to terrestrial locomotion their efforts were probably limited simply to obtaining food with little attempt made to move for any distance

Walking continued to be cumbersome in the ancient reptiles whose limbs were widely spread apart and not yet well adapted for land use. However progress was made by evolutionary changes and there evolved a creature actually able to run on land. From this *Cynognathus* which existed 175 million years ago has evolved the more highly developed *Notharctus* an arboreal monkey like mammal.

The *Notharctus* was one of a great group of primitive primates and as such may be considered a representative progenitor of the order to which man belongs. The ability to climb trees was possessed by this animal and later by other lemurs, monkeys and apes. The only ape able to walk upright on the ground is the gibbon an East Asiatic tree living descendant of the first family of man like apes. The skeleton of this ape begins to appear almost human in type. Nature first endowed this ape with the ability to walk by up-ending one tower of the suspension bridge to which the shoulder and pelvic girdle together with the spine may be compared and balance it on its rear tower represented by the pelvic girdle. The ability to walk upright was evolved from the habit of sitting upright and by the habit of brachiating or swinging from limb to limb.

The ability to walk has been perfected in the human through modification of the entire skeleton but principally the pelvis and lumbo-sacral spine. It is true that certain apes can walk upright however this gait may not be natural for them because the pelvis is not mech-

anically suited for such progression. The muscle pattern of ape and man is similar yet there is a difference in function and in comparative size and a difference in the focal point of action of the gluteal muscles which is the secret of human ability to walk. In the ape the external iliac surface points backward at right angles to the acetabulum rather than externally or outward as in the human.

Thus human posture was evolved by progression from water onto land then into the trees and to the ground again and as this progress was made the skeleton was conditioned to the habits of the animal or the uses to which it would be put. Since man is the culmination of nature's efforts over many millions of years it may be inferred that the erect or orthograde posture is the ideal means of terrestrial progression and that no further change will occur. However in the words of Professor William K. Gregory evolution bears no evidence of a beginning and no prospect of an end thus we may hope that a more perfect creature is yet to evolve.

## REFERENCES

1. BOULE, M. *Fossil Men* P. 214. London: Oliver and Boyd.
2. GREGORY W. K. Basic patterns in evolution III. *Scientific American* 1930 August: 286.
3. Idem. *Proc. Am. Phil. Soc.*, 1928, 67: 363.
4. Idem. Personal communication.
5. GREGORY W. K. and ROUSSEAU M. Introduction to human anatomy. No. 86. *Guide Bulletin Am. Museum Natural History* 1942.
6. KATZ, SIR ARTHUR. Man's posture, its evolution and disorders. *Brit. M. J.* 1923, 1: 451.
7. OSBORN H. F. The influence of habit in the evolution of man and the great apes. *Bull. N. York Acad. M.* 1928, 4: 216-230.
8. WILDER, B. G. Contributions to comparative myology of the chimpanzee. *Boston J. Nat. Hist.* 1861: 7: 353-384.

## MALIGNANT LYMPHOMA

### The Value of Radical Surgery in Selected Cases

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**S**URGERY as a therapeutic measure in malignant lymphoma has been generally abandoned and has been replaced by radiation therapy because the disease is regarded as essentially systemic. Recently, however, Call expressed the belief that radical surgery has a definite place in the treatment of malignant lymphoma. In his series of 45 patients with the disease sufficiently localized to permit radical surgical excision, 19 survived two to three times longer than identical cases treated by radiation. From the Memorial Hospital, New York, Sugarbaker and Craver reported a 5-year survival rate in 24 per cent of patients with malignant lymphoma subjected to early surgical treatment.

During the past twenty years I have not infrequently noticed that sufferers from malignant lymphoma lived 5 years and longer after surgical removal of a single tumor and belied the gloomy outlook which I had predicted from the microscopic section. This discrepancy between occasional long survival period after operation and the discouraging viewpoint of most surgeons regarding malignant lymphoma prompted me to review all primary lymphoid malignant tumors which have passed through the Pathological Department of St. Francis Hospital, from January, 1926, to December, 1945. 34 cases of malignant lymphoma were examined in our laboratory. While histologic slides were available for personal study from all these cases, only 110 cases were used for this analysis because they had complete clinical records and had been followed up for a sufficient length of time to be of value. The material included in this survey comprised 5 autopsies and 105 surgical specimens from a total of 110 patients.

Records were complete to the day of death for 65 patients and 45 patients are still alive for period of 5 years or longer after the histologic diagnosis of malignant lymphoma had been established.

#### CLASSIFICATION OF MALIGNANT LYMPHOMA

In cases of lymphoid tumors the difficulty in distinguishing between an inflammatory and a neoplastic tumor and the uncertainty of correlating histologic structure and clinical course is familiar to every pathologist. Many surgeons and pathologists call all lymphoid malignant growths simply lymphosarcoma and they point out the possible transformation of one process to another. They believe that these processes are not only genetically related but that fundamentally they are merely phases of the same disease. I wing on the other hand in its on a rigid application of simple histologic principles in the classification of lymphoid tumors, even at the risk of carrying the anatomical distinctions too far.)

During recent years three attempts have been made to classify lymphoid tumors. I too accepted the principles of the Lymphatic Tumor Registry and distinguished between reactions and tumors of lymphocytic and of reticulum cell origin, those with and without leucemia. Murray and Broders described four grades of lymphosarcoma based on the degree of cell differentiation. They employed similar criteria as used in grading of epithelial malignant growths and believed that the histologic grade in primary lymphosarcoma bears a definite relation to the time of survival following operation.)

In 1934 Callan and Malory proposed a classification not regarding anatomical distribution of the lesion and blood manifestations. From their analysis of 545 cases they concluded that nothing in the histologic character of an individual lesion will permit a reliable predic-

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Fig 1. Inoperable neck tumor in 56 year old male. Biopsy by incision into a tumor which is firmly fixed to surrounding structures is not advisable. Aspiration biopsy revealed typical lymphoblastoma. Initial response to roentgen treatment good. In our material, one out of three noninflammatory neck tumors was a malignant lymphoma.

as to the distribution of the process in other parts of the body nor can it be determined whether leucemia is present or not by histologic examination of a lesion.

The same authors found a great constancy of the reacting cell types in biopsies of the same case taken at different times: in only 23 per cent did the lesion become less differentiated in appearance. As to the possibility of histologic distinction of the different types in routine biopsy material they could apply their method easily in 94 per cent. Gall and Mallory's classification which is fundamentally cytologic has the advantage of conforming with the accepted usages of oncology and it has more than academic value in the field of malignant lymphoma, since a reasonable degree of correlation could be demonstrated with the clinical course of the disease.

The cell types making up the various subgroups of malignant lymphoma correspond to the different stages of cell development as found in normal lymph nodes. A knowledge of the normal cytology of lymphoid tissue is therefore necessary. According to Maximow the supporting stroma in lymphoid tissue consists of a framework of argyrophilic fibers intimately connected with an undifferentiated cell syncytium mesenchymal in nature. These undifferentiated reticular cells are large, stellate or spindle shaped and have an abundant



Fig 2. Localized reticulocytoma of mandible in 5 year old girl. Total removal of lower jaw without radiation resulted in cure. No evidence of disease today 10 years after operation.

cytoplasm and a pale oval nucleus. They are not phagocytic in character and possess unrestricted potentialities for differentiation. The lymphatic sinuses of the lymph nodes are lined with specially differentiated reticular cells which have been termed by Siegmund (1925) littoral cells. These cells are phagocytic and are entirely different from the endothelial cells lining ordinary blood and lymph vessels. From these fixed littoral cells clasmotocytes and the monocytes of the circulating blood are derived; these cell types are not only closely related, but are indistinguishable from each other. Their outstanding characteristic is their phagocytic property. In the germinal center of lymph follicles, lymphocytes are formed from the reticular cells. The immediate descendants of the reticular cells appear as lymphoblasts. The latter are the mother cells of the mature small lymphocyte. In this line of differentiation the phagocytic properties are lost and the resulting cells no longer store vital dyes. Further differentiation is restricted though lymphocytes may give rise to plasma cells as a result of unknown stimuli.

True mesenchymal reticulum is found in the malpighian corpuscles of the spleen, in bone marrow and as undifferentiated cells of the connective tissue as well as in lymph nodes. In these locations also the reticular cells possess the ability to differentiate into the various described cell types.

Adhering to Gall and Mallory's general outline but substituting some of their unfamiliar terms with those used by the Lymphatic Tu





Fig. 3. Axillary lymphocytoma consisting of 5 nodes in 8 year old male. Removal of all tumors and postoperative radiation 8 years ago. Patient is living and well 1 present.

mor Registry (Callender) I divided my material of primary lymphoid tumors into 8 groups. The number of cases encountered in this survey of 130 malignant lymphomas were as follows:

	Cases
Reticulocytoma	6
1. Giant cell reticulocytoma	5
2. Monocytoma	3
3. Hodgkin's disease	26
4. Lymphoblastoma	44
5. Lymphocytoma	34
6. Follicular lymphoma	
7. Plasmacytoma	
Total	30

In our experience most malignant lymphomas fall into four groups, namely reticulocytoma, Hodgkin's disease, lymphoblastoma, and lymphocytoma. The percentage of the other four groups we found varies between 0.8 and 3 per cent.

Tumors composed of highly undifferentiated reticular cells are called stem cell lymphoma by Gall and Mallory while we prefer the term of the Registry reticulocytoma. Tumors made up of more mature phagocytic cells corresponding to littoral cells, clasmatocytes, and monocytes are designated as clasmatocytic lymphoma by Gall and Mallory but as monocytoma by us. The group of tumors called Hodgkin's sarcoma by Gall and Mallory is apparently the same which Foot calls pleomorphic lymphosarcoma and for which we



Fig. 4. Breast with large lymphoblastoma in 3 year old female. Metastases to axillary and abdominal nodes at time of admission. In spite of intensive radiation therapy death occurred 3 months after admission.

propose the term giant cell reticulocytoma. While there are authentic cases reported in which Hodgkin's diseases after a comparatively benign course becomes transformed into a rapidly progressive tumor in our material the cases of giant cell reticulocytoma have shown their characteristic clinical and morphologic behavior from the onset.

The justification of subdividing the malignant lymphomas into 8 distinct groups rests on the constancy of the cell type in an individual case. Sixteen patients of our series had biopsies on two or more occasions or specimens were available from both biopsy and subsequent necropsy. Of our 30 autopsy cases microscopic sections of all involved organs were studied. In about 82 per cent the original histologic structure was maintained while in only 18 per cent the lesion became less differentiated. This degree of dedifferentiation must be expected in any group of malignant tumors followed over a longer period of time. The occasional transition from one form to another supports the view that these tumors are essentially of common origin but does not invalidate the practical application of Gall and Mallory's classification.

#### CLINICAL OBSERVATIONS

**Incidence.** In comparison with other types of cancer malignant lymphoma is not common. Between January 1925 and December 1945 699 lymphoid tumors were submitted to our laboratory for histologic diagnosis of



Fig. 5. Mediastinal lymphoblastoma compressing trachea and both main bronchi. Sudden death by suffocation. X ray therapy may prevent sudden death in these incompressible tumors however life expectancy of different tumor types is seldom prolonged by radiation



Fig. 6. Intrapulmonary malignant lymphoma. Surgical removal of entire lobe eradicated the tumor as shown by autopsy

which 234 proved to be malignant lymphomas. They represented less than 5 per cent of all cancers examined during the 21 year period. The average number of malignant lymphomas seen in our laboratory during an average year is therefore less than twelve. Our material came from 57 surgeons and the largest number of lymphoid tumors submitted by a single surgeon was 18 while 53 physicians had only one case each.

**Age.** As the age of onset we have listed the age at which the first relevant symptom was noted. For the entire group the average age was 44.7 years, about 10 years lower than that for the epithelial types of cancer (53.8 years). The average age was 5 years higher in females (45.5 years) than in males (40.8 years). In general malignant lymphoma is rare before the age of 20 years and after the age of 70. Our youngest patient was 4 months old (lymphoblastoma) and our oldest 84 years (monocytoma).

While in Gall and Mallory's series Hodgkin's disease had a tendency to appear nearly a decade earlier than any other form of lymphoma, in our material the age of patients with Hodgkin's disease was only slightly lower than in the entire series, namely 42.3 years. The most common period of life when malignant lymphoma became evident was the fourth and fifth decades. Two types, lymphoblastoma and lymphocytoma, occurred in the first two decades with significant frequency, 14 and 10 per cent respectively. Below the age of 40 there were 23 per cent of reticulocytomas and 25 per cent of follicular lymphomas.

**Sex.** It is generally stated in the literature that malignant lymphomas show a predilection for the male sex. Gall and Mallory found a definite predominance of men over women (2.2 to 1). Sugarbaker and Craver reported



Fig. 7. Resection of stomach with primary Hodgkin disease. 60 year old male. Complete removal of disease. No other foci found at autopsy.



Fig. 9. Surgical specimen of giant reticulocytoma of cecum in 67 year old female, no postoperative radiation. Clinical cure since operation 6 years ago.

the same characteristic sex distribution namely a ratio of about 7 to 3. In our own material on the other hand the frequency was found to be almost equal namely 3 males to 2 females.

**Primary site.** Cutler states that in cases in which clinical examination discloses cervical lymph nodes invaded by lymphosarcoma the presence of a primary lesion in the pharynx or nasopharynx should be suspected and Coutard advises that these areas should be irradiated even when a primary focus cannot be demonstrated. In our material, which includes complete autopsy studies in 30 cases, an extranodal primary focus of the disease

could be demonstrated in only one third of all cases. In 26 cases the primary focus could be reasonably assumed to arise in one of the cranial structures with the tonsils and nasopharynx as the most common sites. In 19 cases the disease arose apparently in the gastrointestinal tract (stomach 5, ileum 4, appendix, 2, rectum 8 cases). In the remaining 6 cases primary sites were widely scattered i.e. in bone, thymus, lung, ovary and skin.

Two thirds of the entire series never had what could be supposed to represent an extranodal primary focus. In these the first and only subsequent evidence of disease was confined to lymph nodes until widespread dissemination took place. Our own experience therefore conforms with that of Sugarbaker and Craver that malignant lymphoma is a disease which in the majority of cases begins, and runs its early course in the lymph nodes alone.

The site of the first lymph node involvement is of interest. In 40 per cent of the cases the lymph nodes of the neck were first involved, the axillary nodes in 9 per cent, the inguinal glands in 13 per cent, and the abdominal nodes in 4 per cent. Mediastinal nodes were enlarged in 8 per cent. In less than 2 per cent of the patients the disease appeared to involve almost the entire node system simultaneously.



Fig. 8. Lymphocytoma of jejunum in 53 year old female. Resection as not followed by radiation. No recurrence or other manifestations of disease in following 7 years.

TABLE I.—FIVE YEAR SURVIVALS AFTER RADICAL SURGERY WITHOUT RADIATION

No.	Age	Sex	Location	Histologic type	Follow-up
1		M	Tonsil	Reticulocytoma	Living and well, 80 yrs.
2	5	F	Jaw	Reticulocytoma	Living and well, 10 yrs.
3	67	F	Cecum	Giant cell reticulocytoma	Living and well, 6 yrs.
4	60	M	Inguinal	Hodgkin's disease	Living and well, 9 yrs.
5	33	F	J. junctra	Lymphocytoma	Living and well, 7 yrs.
6		M	Neck	Lymphocytoma	Living and well, 12 yrs.
7	0	F	Appendix	Lymphocytoma	Living and well, 5 yrs.
8		F	Skin (breast)	Lymphocytoma	Living and well, 7 yrs.
9		F	Anal	Lymphocytoma	Living and well, 6 yrs.
10	26	F	Supraclavicular	Lymphocytoma	Living, diseased, 9 yrs.
11	40	M	Neck	Lymphocytoma	Living and well, 15 yrs.
12	34	F	Appendix	Lymphocytoma	Living and well, 5 yrs.
13	27	M	Skin (shoulder)	Hodgkin's disease	Living and well, 13 yrs.
14		M	Anal	Lymphocytoma	Living and well, 11 yrs.
15		F	Groin	Lymphocytoma	Living and well, 8 yrs.
16	28	M	Axilla	Lymphocytoma	Living and well, 8 yrs.
17	34	M	Tonsil	Lymphoblastoma	Living and well, 7 yrs.
18		F	Neck	Lymphoblastoma	Living and well, 7 yrs.
19	61	M	Ovary	Plasmacytoma	Living and well, 6 yrs.
20		F	Uterus	Lymphocytoma	Living and well, 6 yrs.
21	61	F	Anal	Lymphocytoma	Living and well 5 yrs.
22	37	M	Neck	Hodgkin's disease	Living and well, 14 yrs.
23		F	Tonsil	Lymphoblastoma	Living and well, 12 yrs.
24	14	F	Thigh	Lymphoblastoma	Living and well, 7 yrs.
25		M	Inguinal	Lymphocytoma	Died, coronary 5 yrs.
26	30	F	Neck	Hodgkin's disease	Died of disease, 10 yrs.
27	21	M	Neck	Lymphoblastoma	Died, 7 yrs.
28	35	M	Neck	Lymphoblastoma	Died, 4 yrs. 11 mos.
29		M	Neck	Follicular lymphoma	Died, 5 yrs. 8 mos.
30	25	M	Neck	Lymphocytoma	Living and well, 8 yrs.

In addition to the primary sites of involvement, numerous organs may subsequently become involved either as a result of lymphatic or hematogenous metastasis or by direct extension. The spleen was palpable in 23 per cent of our cases, liver enlargement was recorded in 6 per cent. Roentgenologic evidence of infiltration of lungs and pleura was present in 21 cases. Metastatic involvement of the skin occurred in 16 per cent and of the bones in 12 per cent.

Evidence of presumably secondary foci in the gastrointestinal tract was obtained in 27 cases. The rapidity with which lymphoma advances is readily understood when one con-

siders that the average duration of life from onset of the disease until death was only 26 7 months.

*Systemic symptoms* Chill, fever, weight loss and weakness rarely appeared before the disease had become far advanced. The general mildness of the symptoms early in the disease is evidenced by the fact that the average interval between first symptoms and hospital admission was 10 3 months. Temperature of 101 degrees and higher occurred at some time during the course of the disease in 40 per cent of the lymphocytomas and 42 per cent of the lymphoblastomas. In 55 per cent of Hodgkin's disease intermittent fever was recorded. This

type of fever was also frequent in giant cell reticulocytoma

**Blood findings** In contradistinction to Hodgkin's disease in whom anemia usually develops early (11%) the other types of lymphoma maintained good hemoglobin values for some time. On admission 61 per cent of our patients showed hemoglobin readings above 80 per cent and only 36 per cent of the cases had less than 70 per cent hemoglobin. As a result of advancing disease very definite blood changes took place. Only 32 per cent of the patients at this time had hemoglobin values higher than 70 per cent. In 16 per cent of the higher series the red cell blood count was less than three million. Profound anemia was recorded most often in lymphoblastic and lymphocytic types (15 and 11% respectively) associated with leucemia.

A leucocytosis exceeding 12,000 per cubic millimeter on admission was found in 13 per cent of the lymphocytoma cases and in 10 per cent of lymphoblastomas. The same count was noticed in 11 per cent of Hodgkin's disease. Leucopenia with white cells numbering less than 5,000 cells per cubic millimeter was noted in about 20 per cent of lymphoblastoma and lymphocytoma and half as often in Hodgkin's disease. Monocytes in excess of 10 per cent were recorded in all cases of monocytoma and in some cases of Hodgkin's disease. In the latter eosinophilia was not a prominent feature. Atypical cells, either unidentified or blast forms appeared in the peripheral blood of 15 per cent of the cases of lymphoblastoma and 13 per cent of those with lymphocytoma. In the other subgroups these abnormal cells were infrequent.

Blood pictures characteristic of leucemia occurred at some time during the course of the disease in 26 per cent of the cases with lymphocytoma and in 15 per cent of those with lymphoblastoma. They were absent in reticulocytoma and infrequent in the remaining types. Individual patients showed true leucemia at intervals, then subleukemic or aleukemic blood pictures. Of the patients with positive blood findings 13.2 per cent were nonleukemic when first observed, but developed leucemia later in the course. 17 per cent were leukemic at the initial observation but

showed normal blood pictures prior to death and 11 per cent were leukemic at the beginning and at the end of the disease, but were nonleukemic in the interval. In only one half of the leukemic patients was the blood picture entirely constant throughout the course of the disease. Of the patients in whom a leukemic or subleukemic picture was superimposed none survived the 5 year period following biopsy. The duration of disease in these cases varied between 6 weeks and 4 years, its average being 15.1 months against 26.7 months for the entire series.

#### DURATION OF DISEASE

The duration of the disease depends to a surprising degree on the cytologic character of the underlying lesion. Four types of malignant lymphoma, namely lymphoblastoma, reticulocytoma, giant cell reticulocytoma and monocytoma offer a relatively poor prognosis with an average duration from 3.3 to 11.8 months. lymphocytoma and Hodgkin's disease run a comparatively slower course with averages of 16 and 38 months, while follicular lymphoma and plasmocytoma offer a much better outlook lasting in the average 4.8 and 4.3 years respectively. For the entire series of lymphoma the average duration was 26.7 months. In even the most malignant types occasional instances of unusually long survival are met. These are least frequent in lymphoblastoma, monocytoma, and giant cell reticulocytoma. While only one giant cell reticulocytoma, 3 reticulocytomas, and 7 lymphoblastomas survived longer than 5 years, there were 17 lymphocytomas who did not show any sign of the disease 5 years and longer following operation.

The group prognosis is altered definitely by the presence of blood findings characteristic of leucemia. Patients with leucemia have a life expectancy of about 1 year less than those without leukemic manifestations. A less important factor in our series was the age of the patients at the onset of the disease only in lymphoblastoma and Hodgkin's disease was the life expectancy shorter in the few cases which occurred before the age of 10 years.

Of all 130 patients, 32 or 24.6 per cent, have survived 5 years or longer. Ten per cent

of our patients survived eight years or more. Twenty three or 17.2 per cent, of the entire series are apparently cured. 7 died more than 5 years after treatment was begun and 2 are living with active disease still present. The longest duration recorded in our series was 20 years the patient still being alive after removal of a reticulocytoma involving a tonsil.

#### TREATMENT

In general malignant lymphoma is extremely radiosensitive, and it is not surprising to observe a bulky tumor mass regress to half its size after a few days of treatment and completely disappear within a week (Sugarbaker and Craver). In occasional cases in which large masses are situated in vital locations inaccessible to surgical intervention—for instance intrathoracic tumors—radiation may be life saving and may avert sudden death. On the other hand most observers (Minot and Isaac, Sugarbaker and Craver) agree that roentgen therapy does not seem to prolong the average duration of life.

Failure to respond initially to x ray therapy was rare in our cases of Hodgkin's disease, follicular lymphoma, and lymphocytoma, while more than one half of the reticulocytomas and 40 per cent of the lymphoblastomas failed to show any evidence of improvement following irradiation.

Only 2 of 40 patients survived the 5 year period following irradiation alone after the diagnosis had been made by biopsy. One patient had a lymphoblastoma, the other a lymphocytoma.

Since x ray treatment has become the standard treatment for malignant lymphoma once the diagnosis has been established a comparison of patients treated in this manner with those who have been treated solely with surgery is extremely difficult.

The pessimistic view that surgery as a therapeutic measure in malignant lymphoma is contraindicated presumably on the basis that the disease is essentially systemic is contrary to our experience. First it is noteworthy that 10 per cent of our autopsy cases certainly were not systemic in character but showed single localized lesions accessible for surgical excision. Second the long survivals in our

series following operation suggest that in certain cases of malignant lymphoma with localized lesion patients may be treated more successfully by surgical procedure than by any other means.

Surgical therapy was initially employed in 67 cases with the intention of effecting a cure and often in ignorance of the true nature of the tumor. Of the 63 patients who survived the operation 21 received no other form of therapy, while 42 received postoperative external radiation regardless of the absence of clinical symptoms.

Of the 21 patients who underwent surgical operations and who did not receive radiation therapy 12 survived 5 years or longer and none shows at present any evidence of disease. In this group the following types of malignant lymphoma were represented: 2 reticulocytomas, 1 giant cell reticulocytoma, 1 Hodgkin's disease, and 9 lymphocytomas.

In 40 instances, radical removal of a single focus of disease was followed by adequate radiation. Eighteen of the 40 patients survived and 9 are at present without clinical evidence of the disease. There were 6 lymphoblastomas, 7 lymphocytomas, 1 follicular lymphoma, 1 plasmacytoma, and 2 Hodgkin's diseases in this second group.

From these observations it must be concluded as long as malignant lymphoma is confined to an accessible single mass that there is an excellent chance for obtaining a cure by complete removal of the primary focus.

#### CONCLUSIONS

1. A comparative clinical pathologic study of 130 cases of malignant lymphoma is reported.

2. Following Gall and Mallory's cytologic classification 8 types of malignant lymphoma were distinguished corresponding to different degrees of differentiation of their component cells.

3. There was a close correlation between the histology and life expectancy of the different subgroups.

4. The average duration of disease was found to be 26.7 months for the entire series. It varied in the different histologic types between 3 months and 4.8 years.

5 Due to its striking initial effect on lymphoma, radiation therapy may occasionally save a life when the tumor is located in a vital part of the body inaccessible for surgery but it will seldom prolong the life expectancy inherent to the histologic type of lymphoma.

6 Early surgical removal of a primary focus of disease offers the best chance of cure in malignant lymphoma. In our entire series 24.6 per cent of the patients survived 5 years or longer regardless of postoperative radiation. In 21 patients with a single primary focus radical surgery alone was used and 12 of the 21 patients survived from 5 to 20 years.

## REFERENCES

1. CALLENDER, G. R. *Am. J. Path.*, 1934, 10: 445.
2. COURTARD, quoted by Cutler and Buschke, pp. 684.
3. CUTLER, M. and BUSCHKE, F. *Cancer Its Diagnosis and Treatment*. P. 684. Philadelphia, W. B. Saunders Co., 1938.
4. EWING, J. *Neoplastic Diseases*, 4th ed., p. 386. Philadelphia, W. B. Saunders Co., 1940.
5. FOOT, M. Q. *N. Y. State J. M.*, 1942, 42: 2230.
6. GALL, E. A., and MALLORY T. B. *Am. J. Path.* 1942, 8: 351.
7. GALL, E. A. *Ann. Surg.* 1943, 118: 1064.
8. MACLEOD, A. A. *Textbook of Histology*. P. 60. Philadelphia, W. B. Saunders Co., 1930.
9. MEYER, G. R., and ISAAC, R. *J. Am. M. Ass.* 1936, 86: 85 and 1965.
10. MURRAY, N. A., and BROOKS, A. C. *Am. J. Clin. Path.*, 1943, 13: 104.
11. SOGARMAN, E. D. and CRAVER, L. F. *J. Am. M. Ass.*, 1946, 115: 17 and 112.

# DIGESTION OF LIVING TISSUE BY THE HYPERACID STOMACH

## An Experimental Study

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**I**N a recent publication we showed that living autogenous organs and tissues of all sorts are completely digested in from 1 to 6 weeks when they are deeply implanted in the canine stomach. Those experiments were carried out on dogs with normal gastric secretions. In the present investigation we have repeated the experiments using the same technique of implantation, but we have given these animals daily postoperative injections of histamine in order to study the effects of hyperacidity upon the process of autodigestion.

Sixty-six healthy adult dogs were used. Under pentobarbital sodium anesthesia with aseptic technique, various organs and tissues of the body were implanted through large windows, usually in the anterior wall of the stomach. Care was taken not to compromise the circulation of the implants. Beginning 24 hours after operation each animal received daily intramuscular injections of histamine dihydrochloride. The histamine was mixed with beeswax and mineral oil after the technique of Hay, Varco, Code, and Wangenstein. Uniform daily doses of 30 milligrams of histamine base were administered irrespective of the weight of the dogs.

The animals were observed closely following operation. Food ("purina dog chow") and water were allowed *ad libitum*. Periodic measurements were made of weight, temperature, hematocrit, hemoglobin, blood cell counts and plasma proteins. At suitable intervals the implants were explored surgically or the animals were sacrificed and examined blocks being cut for microscopic study. These examinations were usually made 24 hours after the last in-

jection of histamine. At the time of implantation before the animals had received histamine, and subsequently whenever the stomach was opened at operation or autopsy, samples of fasting gastric contents were secured for analysis. The dogs used in these experiments averaged 19.3 units of free acid and 55.1 units of combined acid before histamine was injected after histamine the samples averaged 91.4 units of free acid and 33.1 units of combined acid.

### EXPERIMENTS

1 *Digestion of living omentum* The corrosive effect of hyperacid gastric juice upon the omentum was pronounced. Characteristic fibrosis and granulation tissue response occurred but were ineffectual barriers to the digestive process. Omental patches covering large gastric windows had irregular necrotic craters after 2 weeks, and one such patch perforated on the twentieth day with resultant general peritonitis. Large tongues of omentum implanted deeply in the lumen of the stomach were more rapidly digested in these dogs than were similar preparations in normal animals.

2 *Digestion of living intestine* Implants of intact jejunum, appendix, and cecum were quickly digested by the hyperacid stomach. Two out of 6 animals died within 24 hours of hemorrhage from the rapidly eroding intestinal wall. Perforation of the implant usually occurred in less than 1 day, and much of the implant had disappeared entirely by the eighth or tenth day. Histologic changes were observed similar to those previously reported for normal dogs, but the process of inflammation, necrosis, and digestion appeared to be far more acute in the present series.

3 *Digestion of living organs* An implanted lobe of liver showed partial erosion after 3 days and digestion nearly to the level of the gastric wall within a week. In normal dogs complete

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digestion of the hepatic implant was not obtained until the end of the fourth week.

The gall bladder was implanted in 3 hyperacid dogs. After 24 hours (that is, 24 hours after histamine was started) the gall bladder wall had perforated and was partly digested after 3 days the implanted portion had almost entirely disappeared leaving a large ragged fistula between the stomach and the remainder of the gall bladder.

The tail of the pancreas was implanted in 2 dogs. In both instances complete digestion of the implant occurred within 3 days.

The lower pole of the spleen was successfully implanted in 3 animals. This organ was likewise digested rapidly by the hyperacid stomach partial digestion occurring in 2 days and complete digestion to the level of the stomach wall after 3 days. A similar degree of digestion was not observed in normal animals before the nineteenth postoperative day.

The superior pole of the left kidney was satisfactorily implanted in 3 dogs. All of the implants showed relatively rapid digestion as compared with digestion of similar implants in normal dogs. One animal, sacrificed on the nineteenth day showed loss of the entire upper pole with exposure of the calyces to gastric juice.

4. *Digestion of living connective tissue.* Cartilaginous ends of ribs were fully digested away after 3 days of hyperacidity (4 days after implantation).

Pedicle skin flaps from the anterior abdominal wall likewise suffered relatively rapid digestion as did free skin grafts growing on intra abdominal serosal surfaces.

When large gastric windows were sewed to the parietal peritoneum of the anterior abdominal wall progressive erosion of the tissues occurred. These ulcerations eventually extended through muscle and fascia forming abscesses. One dog died on the fourth postoperative day with a large abscess beneath the anterior rectus fascia. Another dog died on the sixth postoperative day with a subcutaneous abscess which extended to the axilla.

5. *Digestion of living gastric tissue.* Artificial ulcers<sup>1</sup> were produced in the stomach by cutting away round or oval areas of mucosa. The defects exposed the outer layers of the

stomach wall to the digestive action of the strongly acid gastric juice. These lesions all showed progressive erosion of both mucosal margins and ulcer base. One dog died of perforation and peritonitis 3 days after operation and 2 days after the histamine was started. Another dog which was sacrificed on the seventh postoperative day was about to perforate.

Pedicle flaps of gastric wall turned into the lumen of the stomach, as described in our previous article, were digested in 3 to 6 days. When these flaps were denuded of mucosa at the time of implantation complete digestion occurred in less than 3 days.

#### OBSERVATIONS

Daily injections alone of 30 milligrams of histamine base will cause spontaneous ulcerations in the previously healthy stomach and duodenum. Hay and his associates found that of 12 dogs so injected 8 developed duodenal, and 3 developed gastric, ulcers. These animals received an average of 24 doses of histamine although 1 dog had a large gastric ulcer and a nearly fatal hemorrhage after only 4 injections. Another died after 7 injections of multiple perforated duodenal ulcers. Other investigators have obtained similar results. Crandall in this laboratory injected 10 dogs (4 normal dogs, 4 with Finney pyloroplasties and 2 with gastroduodenostomies) and obtained ulcers—gastric, duodenal, or both—in all of them. The duration of histamine therapy in this control series was from 8 to 44 days. It was not determined how soon the ulcers developed but one of the dogs died on the eighth day as a result of a perforated duodenal ulcer and peritonitis.

In our larger series, where the animals had operative implants and subsequent injections of histamine there were only 5 instances of independent ulcer formation at a distance from the implant. This relatively small incidence of ulcer production is explained by the short duration of the experiments. Our dogs died or were sacrificed, on the average, 4.9 days after histamine therapy was instituted. Duodenal ulcers were observed in 4 dogs which had received histamine 5, 5, 4, and 3 days, respectively and 1 dog which had received histamine

injections for only 3 days showed both gastric and duodenal ulcers. None of them had perforated. On the other hand 2 dogs which had received histamine for 19 days showed no evidence of spontaneous ulceration.

Pronounced deterioration of health was noted in about two-thirds of our animals. Loss of appetite was a constant feature. Weight loss for the entire group averaged 2.77 per cent of the original body weight per day. Hair lost its gloss and was shed freely. Vomiting was conspicuous in 5 cases.

Most of the animals developed a moderate degree of anemia. Hematocrit determinations for the entire series fell from an average of 47.9 to 38.0, hemoglobin from 17.2 grams to 13.7 grams, and red cell counts from 6,330,000 to 4,824,000. Total plasma proteins showed relatively little change; however, the preoperative average being 6.36 grams as compared with a final average of 6.18 grams. Gross bleeding from the implant was a common finding, 9 of the animals were seen at autopsy to have had large, perhaps fatal hemorrhages into the gastrointestinal tract.

In our previous report on digestion of living tissue by the normal stomach it was observed that "a number of our animals appeared toxic; some were quite ill; in fact, during the period of necrosis and digestion of the implants but these animals recovered full health after the necrotic tissue had disappeared. This phenomenon was observed particularly after implantation of intestines, gall bladder and solid organs." This "toxicity" appeared to be even more pronounced in the present series. Elevation of temperature was frequently seen. The white blood cell count rose from an average of 10,020 to 19,015.

Histologic examination of the margins of implants showed that proliferation of gastric epithelium was feeble or absent, and in some instances there was progressive autodigestion of the gastric wall and extension of the area of erosion. This picture was in striking contrast to that which was seen in the normal stomach where vigorous epithelial proliferation across the base of the implant was the general rule.

#### SUMMARY AND CONCLUSIONS

An experimental study has been carried out in which living autogenous organs and tissues of various sorts were implanted in the stomachs of dogs. Following implantation the animals received daily injections of histamine in beeswax in order to produce a high degree of hyperacidity. Results of these experiments have been compared with those of a similar series of implantations in stomachs not stimulated by histamine injections.

The implants were all digested. The rate of digestion by the hyperacid stomach greatly exceeded that shown by the normal stomach. Tissue reactions to the corrosive process were also more violent.

Only a small proportion of the animals receiving histamine developed spontaneous ulcers at a distance from the implant, presumably because the experiments were too acute. In a control series 10 dogs which received more prolonged histamine therapy all developed gastric or duodenal ulcers.

Most of the dogs receiving histamine showed deterioration of general health.

Some of the implants bled grossly during the process of digestion and virtually all of the animals with implants developed at least a moderate degree of anemia.

Evidences of toxicity were pronounced during the period of digestion of the implants.

No living tissue, not even gastric epithelium itself, appeared to be immune to digestion by the hyperacid stomach. Fibrosis and granulation tissue occurred in some of the implants, but seemed to be ineffectual barriers to the corrosive action of very acid chyme.

This investigation supports the results of our previous study and justifies the general conclusion that living organs and tissues of all sorts are susceptible to gastric digestion, and that hyperacidity increases the rate of that digestion.

#### REFERENCES

1. CRANDALL, R. G. Unpublished data.
2. HAY, L. J., VARCO, R. L., CODE, C. F. and WAMGEN, STEVEN O. H. *Surg. Gyn. Obst.*, 1948, 75, 170-182.
3. PRICE, P. B. and LEE, T. F. *Surg. Gyn. Obst.*, 1946, 83, 61-72.

# ADOLESCENT PRIMIGRAVIDA

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**L**ABOR at either extreme of the woman's reproductive life is considered by many physicians to be fraught with additional hazards. That this is true in the elderly primigravida has been stated by numerous authors. The young primigravida however receives little attention in our present day texts. Greenhill (2) in the eighth revision of Dr DeLee's text devotes the following paragraph to its consideration. "Labor in young primipara shows little variation from the usual. Eclampsia, premature delivery, atonia uteri, and breech presentation are slightly more frequent and there is a slight increase in perineal lacerations and fetal mortality. Labor is shorter somewhat easier and there is less hemorrhage. The pelvis is larger than one would expect. If this be true, there is no cause for alarm when an adolescent mother presents herself for prenatal care. Labor should be conducted with the same precaution and alertness as is customary but meddlesome midwifery under the guise of assistance, precipitated by the belief that catastrophe awaits the young mother is to be avoided. That we might aid the accoucheur in maintaining his equanimity while practicing that greatest of virtues necessary for the successful management of childbirth namely watchful expectancy this study was undertaken."

## MATERIAL

At St. Vincent's Infant and Maternity Hospital, a unit of the Department of Obstetrics and Gynecology of Loyola University Clinics the percentage of adolescent primigravida is high due to the number of unwed mothers cared for. This circumstance afforded an excellent opportunity to assemble 200 consecutive cases of primigravida 17 years of age or under (Table I).

From the department of Obstetrics and Gynecology Loyola University School of Medicine

Read at the Twenty-fourth Annual Fall Clinical Conference of the Kansas City Southwest Clinical Society, Kansas City, Missouri, October 7 & 8, 1946.

TABLE I — AGE INCIDENCE

Age group years	No. cases
12	3
13	3
14	6
15	27
16	66
17	95
Total	200

The majority of these patients report to the prenatal clinic early in their pregnancy and during the last 2 lunar months are sequestered in the institution their prenatal care must, therefore be considered adequate. The deliveries are managed by the resident obstetrician under the supervision of the authors. It is our custom to perform mesiolateral episiotomy in all cases and the second stage of labor is terminated by elective outlet for cesarean operation. Pudendal block or caudal anesthesia was employed in all cases. The third stage of labor is managed by administering intravenous ergotrate with the delivery of the anterior shoulder.

## TWELVE YEAR OLD GROUP

Although precocious pregnancy reports appear in the literature they are too rare to merit consideration at this time. The youngest patients in our group as shown in Table II were 12 years of age.

Harris in 10,000 cases at Johns Hopkins, had only 2 cases of pregnancy in patients of this age. Williams had 3 cases of pregnancy in 12 year old patients. This infrequency occurred in spite of the fact that their clinic was in an area populated heavily with negroes who presumably mature at an earlier age. All of our patients were white. The average length of labor for our 3 patients was 13 hours, 33 minutes for the first stage 62 minutes for the second stage, and 7 minutes for the third stage. There were no complications, morbidities, nor morbidities among these 12 year old mothers.

# SCHMITZ, TOWNE ADOLESCENT PRIMIGRAVIDA

TABLE II.—DURATION OF LABOR  
Twelve year old group (3 cases)

Case No.	First stage		Second stage		Third stage
	hrs.	min.	min.	min.	
1	9	30	36		min.
2	13	30	60		4
3	17		07		8
Average	13	33	63		7

There were no complications or mortalities among these 1 year old patients.

The average length of labor for the first stage was 6 hours and 7 minutes for the second stage 1 hour and 5 minutes. The third

THIRTEEN YEAR OLD GROUP  
In Table III are listed 3 patients in the 13 year age group

TABLE III.—DURATION OF LABOR  
Thirteen year old group (3 cases)

Case No.	First stage		Second stage		Third stage	
	hr	min.	hr	min	hr	min.
1	3		4			5
2	6	1	5			5
Average	6	7	5			7

In this series 1 infant expired 12 hours after delivery which was complicated by prolapse of the umbilical cord.

stage averaged 52 minutes. In 1 case the cord prolapsed and in spite of the fact that the infant was resuscitated it died 12 hours later of respiratory complications. In the patient having a 2 hour 7 minute third stage a manual removal of the placenta was done.

FOURTEEN YEAR OLD GROUP

In the 14 year age group (see Table IV) there were 6 patients with an average length of labor of 31 hours and 50 minutes for the first stage 42 minutes for the second stage and 7 minutes for the third stage. The average time of the first stage was increased because of 1 case of prolonged labor. The first stage in this instance lasted 66 hours the infant terminated spontaneously with the birth of a living infant. The episiotomy however became infected. There was 1 stillbirth of a

TABLE IV.—DURATION OF LABOR  
Fourteen year old group (6 cases)

Case No.	First stage		Second stage		Third stage
	h	min.	hr	min.	
1	66	30	1	1	min.
2	7			30	6
3	18	30		30	5
4	4			5	5
5	7	30		5	5
Average	31	50		42	7

In this series there was 1 stillbirth of monstrosity and 1 case of prolonged labor following the case of episiotomy.

FIFTEEN YEAR OLD GROUP  
In the 15 year age group of 27 cases the individual length of labor is not listed but Table V gives the average length for each stage

TABLE V.—DURATION OF LABOR  
Fifteen year old group (27 cases)

Total No. cases	Average length first stage	Average length second stage	Average length third stage
27	hr 3 min	45 min	16 min.

## COMPLICATIONS

- Prolonged labor 2 cases
- Neonatal death (Congenital heart defect 8th postnatal day) 2 cases
- Morbidities 1 case
- Retained placenta postpartum hemorrhage 2 cases
- 1 case

The average for the first stage was 13 minutes for the second stage 46 minutes and for the third stage 16 minutes. There were 2 cases of prolonged labor each with a first stage of 28 hours. One necessitated a for cephs rotation because of a transverse arrest the other terminated spontaneously. The 1 morbid case in this group was due to an upper respiratory infection the other was unclassified. There was 1 neonatal death the infant succumbing on the eighth postpartum day because of a congenital heart defect. One patient had a retained placenta which was removed manually after 3 hours and 43 minutes. The blood loss amounted to 950 cubic centimeters.

SIXTEEN YEAR OLD GROUP

Labor in the 66 patients in the 16 year age group averaged 13 hours 26 minutes for the

✈

✈

birth The third stillbirth resulted from pro-  
lapse of the cord The 1 cesarean section in  
our entire group was due to cephalopelvic dis-  
proportion The mother had a 12 hour test of  
labor and as a result developed an endometritis  
and is listed as a morbid case. The 5 other  
morbidities were due to mastitis upper re-  
spiratory infection right lower lobe pneu-  
monia, cystitis and 1 not classified. There  
was 1 set of twins in this group and in 1 case  
a midforceps application for transverse arrest.

## COMPLICATIONS OF LABOR

Prolonged labor cases	
First stage (average)	18 or 9 per cent
Second stage (average)	36 hours 41 minutes
Third stage (average)	1 hour 36 minutes
Delivery	9 minutes
Spontaneous or outlet forceps	196
Midforceps	1
Midforcep rotations	1
Occiput posterior positions	1
Transverse arrest	1
Cesarean section for dispropor- tion	3 or 2 per cent incidence
Routine L.M.L. episiotomies in all cases.	1 or 0.05 per cent
One case of infected episiotomy.	
All were cephalic presentations.	

## DISCUSSION

Although there are not sufficient cases in  
each group to provide accurate statistical  
data, a summary of all the cases provides us  
with definite information relative to labor in  
the adolescent primigravida. The length of  
labor in all cases was somewhat shorter than  
what we consider normal for primipara.  
Spiller in studying 1400 consecutive primi-  
paras delivered by the vaginal route agrees  
with DeLee, Nathanson Dauhman Miller  
and others that the younger the mother the  
shorter the labor Our study confirms this  
belief The incidence of prolonged labor in  
this group was 9 per cent which is higher than  
our incidence of 2.5 per cent for all cases All  
delivered spontaneously however and with-  
out fetal mortality Uterine inertia was not  
encountered and in no instance was it found  
necessary to employ drugs to stimulate uterine  
contraction If allowance were made for in-  
effectual pains early in labor this incidence  
would be lowered considerably

Labor was terminated spontaneously by  
elective outlet forceps in 196 cases or 98 per  
cent Forceps interference was necessary in  
but 4 instances and 3 of these were for pur-  
poses of rotation This incidence of 2 per cent  
is within our average incidence and lower than  
other reports for a similar series. The 1 case  
in which abdominal delivery was necessary  
makes the incidence of cesarean section 0.5 per  
cent. This figure is below our incidence of 2  
per cent for all cases In the entire group few  
pelvic abnormalities were present and no dif-  
ficulty was encountered because of lack of  
development of the individual. Posner and  
Pulver in studying 100 girls between the ages  
of 12 and 15 at the Harlem Hospital found

deformed pelves in 17.25 per cent and their  
operative incidence of 12.8 per cent. Our in-  
cidence was but 2 per cent which compares  
with an incidence of 1.4 per cent reported  
by Bromberg and Brzezinski in their study of  
136 primiparas of 14 to 16 years of age Our  
percentage of morbid cases were 6 per cent in  
contrast to Posner and Pulver's incidence of  
22.6 per cent. Our total number of morbid  
cases consisted of 13 cases 1 case of infected  
episiotomy, 3 of upper respiratory infection  
1 of temperature cause unknown 4 of endo-  
metritis 2 of mastitis 1 of pneumonia, and  
1 of cystitis. We therefore cannot agree with  
their statement that This is a disquieting  
factor and shows less fitness for pregnancy in  
the young group

The antepartum complications totaled 15  
or 7 per cent and postpartum complications  
9 or 4 per cent. These figures are within our  
average for the entire obstetric service. Com-  
plications of labor consisted of 8 cases of pre-  
eclampsia, 2 of prolapsed cord, 2 of abruptio  
placenta 1 of placenta previa lateralis 8 of  
postpartum hemorrhage 1 of postpartum  
eclampsia (convulsions) 1 of eclampsia 1 of  
cephalopelvic disproportion a total of 24  
cases or 12 per cent.

The uncorrected infant mortality was 4.5  
per cent of these 2 or 1 per cent were neo-  
natal deaths. The 1 infant expired 12 hours  
after delivery complicated by a prolapsed  
cord. The second succumbed on the 8th post-  
partum day of a congenital heart defect. The  
7 stillbirths an incidence of 3.5 per cent were



# RESULTS OF TREATMENT OF EPIDERMOID CARCINOMA OF THE ANUS AND RECTUM

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STATISTICAL studies of cases of carcinoma of the rectum have not always given separate consideration to the group with epidermoid carcinoma of the anal canal. It is obvious to anyone who has had experience with these cases that the clinical course and response to treatment of the epidermoid carcinoma group differ in many respects from those of the adenocarcinoma cases. Although these differences have been generally recognized there has not always been a uniform opinion about what they entail. With this fact in mind a study of epidermoid carcinoma of the rectum arising in the anal canal has been made from the case records of the Palmer Memorial and Massachusetts General Hospitals.

Epidermoid carcinoma of the anus is a relatively rare type of rectal carcinoma (1). This fact is borne out by the observation that of 802 consecutive cases of carcinoma of the rectum seen at the Palmer Memorial Hospital only 38 (4.7 per cent) were of the epidermoid variety.

It is well known that in general carcinoma of the rectum occurs in the ratio of approximately 3 men to 1 woman. Of the 77 patients who comprise this group of cases of epidermoid carcinoma, there were only 24 men as compared with 53 women. There is no satisfactory explanation for the fact that this type of tumor is apparently so much more common among women than among men.

## CHARACTERISTICS OF THE TUMOR

When it comes to a consideration of the type of treatment to be used, and especially as an aid to the understanding of the course of the disease and the end results of treatment, a knowledge of the gross condition and histological characteristics of the growth is of value.

From the Surgical Services of the Palmer Memorial and Massachusetts General Hospitals, Boston.

**Size (Table I)** Information concerning the size of the tumor is available in 65 of the cases. In 28 cases the growth was classified as small. In this group were put all those which were confined to the anus itself without evidence of invasion of adjacent tissues and those which were not large enough to encircle the lumen or to extend much into the rectum above. In 37 cases the growth was called large. This group included all annular tumors all those which had invaded the surrounding tissues (perineal fat, skin of the buttock or perineum and vagina) or those which had extended into the upper rectum.

**Invasiveness** In 58 cases the presence or absence of invasion of adjacent tissues (vagina or perineal fat) is known. In all there were 36 cases in which the growth had invaded the vagina or perineal tissues.

These observations make it apparent that only about 39.4 per cent of the cases could be considered favorable insofar as the local extent of the disease is concerned (Table I).

**Histological grading** In all but 6 cases these tumors were studied from the standpoint of the degree of malignancy based upon the appearance of the tissue under the microscope. Only 7 were called grade 1. In 26 cases the tumor was classified as grade 2 and in 38 cases it was considered to be grade 3.

**Groin involvement** There were definite metastases to the lymph nodes of one or both groins of 18 patients at the time of the first examination. In 33 the groins were apparently not involved. In the remainder either the groins were not described or the examiner was uncertain about his observations (Table II).

## METHODS OF TREATMENT

Of the 77 patients who were observed, 5 were not treated because of (1) the extremely advanced stage of the disease (2) the excessive age of the patient or (3) the refusal of the patient to accept the treatment which was ad-





Chart Types of treatment used in 77 cases of epidermoid carcinoma of the anus and rectum.

vised Of the remaining 72 patients 53 were operated upon and 19 were treated by irradiation (Chart 1)

**Surgical cases** Of those who were operated upon, 3 with far advanced disease were given a colostomy because of intolerable obstruction 2 had a small localized growth removed by local excision, and 48 patients were given the benefit of radical extirpation of the disease by either the combined abdominoperineal or the colostomy and posterior excision methods.

It is important to observe at this point that in only 13 of the cases in which radical surgery was employed was the growth a small one confined to the anus. In 33 the growth was large and in 23 of these it had already invaded the vagina or perirectal fat (Table III) In other words, in the majority of the cases in which surgery was employed the growth had progressed well beyond the early stages of development. This fact should be kept in mind when comparing the results with those obtained by the use of radium.

The histological grading of the tumors in these 48 cases was grade 1—2 cases grade 2—17 grade 3—28 undetermined—1 case. From these figures it is apparent that the majority were grade 2 or grade 3 and that more than half were grade 3

Combined abdominoperineal excision of the rectum was used in 28 cases. In 24 the opera-

TABLE II.—GROIN INVOLVEMENT  
(AT FIRST EXAMINATION)

	Radiation treatment group	Surgically treated group	Total
Involved	7	1	18
Not involved	8	25	33
Not stated	4	7	

tion was performed in one stage and in 4 it was considered to be necessary to use the two stage technique (Jones method) In the remaining 20 cases a colostomy and posterior excision of the rectum was performed in 5 in one stage and in 15 in two stages. It was possible to use the colostomy and posterior excision in such a relatively large number of cases because of the fact that the growth was low in all. It was chosen frequently because of the fact that the abdominal stage of this operation is much simpler and less upsetting to the patient than that of the combined abdominoperineal excision. This made it possible to operate successfully upon a few of the aged or otherwise relatively poor risk patients. The combined abdominoperineal method was chosen in the better risk cases or because the wide extension of the tumor made it seem that the posterior approach would be inadequate.

**Irradiation treatment cases** Irradiation by means of roentgen rays radium alone, or both combined was used in 19 cases. Of these 7 patients were treated by deep roentgen ray only. The remaining 12 patients were given radium. In 3 of the latter supplementary roentgen ray treatment was used. The method of treatment varied from case to case, but in the majority of the radium treated cases interstitial irradiation with platinum needles or with gold radon seeds was used. The roentgen ray treatment was usually used only with palliation as an object and was usually not given in doses of larger than 1500 to 2500 roentgen units. Two patients only were treated heavily with doses of 5400 roentgen units and 7500 roentgen units respectively. In all 3 cases in which both forms of irradiation were used, the treatment was begun with radium and x ray was used to treat recurrent disease or metastases to the groins.

**Choice of treatment** The choice between operative and irradiation treatment was made on the basis of the merits of each case. In gen-

TABLE I.—GROSS CHARACTERISTICS  
OF THE TUMOR (72 TREATED CASES)

	Radiation treatment group	Surgically treated group	Total
<b>Size</b>			
Small	6		25
Large	1	7	37
Not stated	2	5	7
<b>Local Invasiveness</b>			
Positive		26	36
Negative	4	8	32
Not stated	5	9	14

TABLE III.—GROSS CHARACTERISTICS OF THE TUMOR IN THE PATIENTS SUBJECTED TO RADICAL OPERATION

	Colostomy and posterior excision	Combined abdominoperineal excision	Total
Small	5	8	13
Large but not invading adjacent tissues	4	6	10
Large, invading vagina or adjacent tissues	10		
Not stated	0	13	23
Total	19	29	48

eral radical excision was used in any case in which the patient was a reasonable risk for surgery and also in all those with a growth too large or too inaccessible for radium unless it was inoperable when roentgen ray treatment was given. In a few cases however the decision in favor of the use of radium was undoubtedly made because of the clinician's preference for this method in a low fairly accessible epidermoid carcinoma of the anal canal. In the last analysis, the judgment and experience of the individual surgeon in charge were what determined the decision in each case.

## RESULTS OF TREATMENT

Chart 2 shows the results of treatment in this group. Of the 77 cases of epidermoid carcinoma of the anal canal and rectum which constitute the basis of this study the end result is known in 75 cases. Taken as a whole, the results are discouraging especially when compared with those obtained in the adenocarcinoma group. In a very carefully followed series of cases of carcinoma of the rectum, in Jones reported every patient seen by him, Dr D F he had seen to be alive and apparently well at the end of 5 years. In the group of epidermoid carcinomas reported here only 13 patients living 5 years or more free from disease representing a possible 5 year cure rate of approximately 17.3 per cent of the entire group. Whether or not this relatively poor result is related in any way to the fact that in the epidermoid group an appreciable number of patients were treated by irradiation methods instead of by radical surgery is not certain. But this conclusion is in part substantiated by this report. It is probable that if a larger proportion of pa-

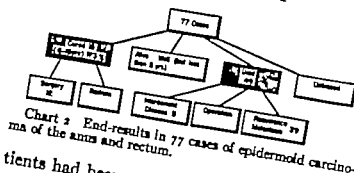


Chart 2. End-results in 77 cases of epidermoid carcinoma of the anus and rectum.

tients had been operated upon a higher percentage of cures would have been obtained.

**Surgical treatment.** The 3 patients who were treated by colostomy alone died of their disease but 1 survived almost 2 years.

Both of the patients who were treated by local excision of a small lesion died of local recurrence and distant metastases one after 2 years and the other 3 years after operation.

In Dr Jones' report based upon all his cases including epidermoid and adenocarcinoma types radical operation resulted in 55 per cent of 5 year cures (2). In the present series of epidermoid carcinoma of the anus and rectum of the 48 patients operated upon radically (including both abdominoperineal and colostomy and posterior excision techniques) 12 patients lived 5 years or more without disease. If we exclude 3 patients whose operations were performed less than 5 years ago and 2 who are untraced, a 5 year cure rate of the operative cases of 28.8 per cent is observed. This should be compared with the 17.3 per cent for the group as a whole. This result might be improved if the abdominoperineal excision were used in all of the cases instead of the colostomy and posterior excision which never results in the removal of as much of the area of lymphatic spread as the former procedure and which in Dr Jones' experience with carcinoma of the rectum as a whole resulted in only 37.7 per cent of 5 year cures as compared with 55 per cent in the combined abdominoperineal excision group.

Chart 3 summarizes the results of radical operative excision in the 46 cases in which the end result is known. Twelve are classified as cured. The survival period in this group varies from 6 to 16 years. In 6 of these cases the growth was large and locally invasive. In the remaining 6 cases the tumor was small, but in 2 of these there was definite evidence of invasion of adjacent tissues. In 9 of the 12 cases

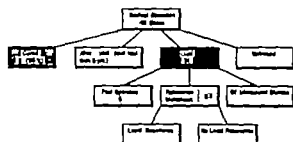


Chart 3. Results of radical surgery in 48 cases of epidermoid carcinoma of the anus and rectum.

the tumor was classified as grade 3 malignancy histologically. Eight were operated upon by the abdominoperineal method (one stage) and 4 by the colostomy and posterior excision technique (two stage). It is interesting that all those patients who were operated upon by the colostomy and posterior excision technique survived an unusually long period of time (8, 14, 15 and 16 years respectively).

Three patients are alive and apparently well less than 5 years after operation. These are not yet classified as cured.

The remaining 31 patients are dead. Among this group there were 5 operative deaths. Two of these were caused by acute small intestinal obstruction. Both occurred before the invention of the Miller Abbott tube. In each case an enterostomy performed for the relief of the obstruction was unsuccessful. Today with the prompt use of a Miller Abbott tube these deaths might be prevented. One patient died of pyelonephritis, another of pulmonary edema, and the fifth patient succumbed to postoperative pneumonia.

Of the remaining 23 deaths, all of which occurred in less than 5 years following radical surgical removal, there were 14 patients in whom there was a definite local recurrence of the growth, but there were 9 in whom death occurred from metastases without any sign of a local recurrence of the disease. In other words, as a result of surgery there was good local palliation—that is freedom from recurrence in 21

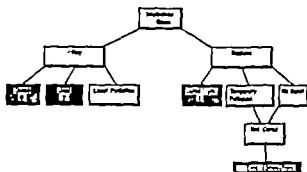


Chart 4. Results of irradiation treatment in epidermoid carcinoma of the anus and rectum.

cases. Twelve of these were cured and 9 died of distant metastases without local recurrence of the disease. This fact should be kept in mind when comparing the results of surgery with those of irradiation treatment.

The location of distant metastases in the 23 patients who died of recurrent or metastatic disease following radical extirpation of the growth is summarized in Table IV. As one would expect, there was a high incidence of metastases to the groins in this group of cases because of the lymphatic communications which exist between the anus and the inguinal nodes (16 of 23 cases).

**Irradiation treatment.** Some form of irradiation treatment was used in 19 cases (Chart 4). It would be interesting and valuable to be able to say just why this method was chosen in each of these cases, but from the records this cannot always be done with certainty. An attempt was made to obtain this information from the surgeons in charge, but after the passage of several years it is often difficult to recall just what the reasoning was. Obviously some of the cases had reached the stage of local inoperability and the choice in favor of irradiation was made merely in the hope of producing some degree of palliation. This was true of the majority of the x-ray treated group, 3 of whom already had groin metastases when they were first seen. In many cases it was because the surgeon believed that as a result of either advanced age or poor general condition the patient would not survive a radical operation. Some of these patients if seen today would undoubtedly be operated upon because of the improvements in anesthesia and general preoperative and postoperative care which have

TABLE IV.—DISTRIBUTION OF METASTASES IN 23 CASES IN WHICH THE LOCATION IS KNOWN

Inguinal nodes	6
Mesenteric nodes	5
Liver	
Spleen	
Lungs	

increased the operability of all types of rectal or colon carcinoma. Some of these patients however were treated with radium in the belief which seems to be held by certain surgeons, that these tumors like epitheliomas of the skin, respond favorably to the effects of irradiation. The truth of this belief remains to be proved by those who subscribe to it. A study of this group of cases tends to lead one to believe that it is erroneous. Chart 4 summarizes the results.

Of the 7 patients who were given x ray treatment alone 3 were inoperable because of metastases to the groins. In each of these cases the growth was a large one but the remaining 4 might have been operated upon with better prospect of palliation if not of cure. All 7 died. None lived more than a year. Two showed a slight temporary regression in the size of the tumor. In none was there any significant relief from pain and tenesmus. As a method of palliation, therefore in these 7 cases x ray treatment was a failure. Those treated with the 400 000 kilovolt apparatus appeared to be no better off than those treated with the 200 000 kilovolt machine.

The details of the treatment and the dosages used varied from case to case but consisted in every instance in the use of platinum needles or gold seeds implanted into the tumor or around its periphery. Of the 12 patients treated, platinum needles were used in 7 gold seeds in 5. In 2 of the patients in whom platinum needles were used seeds were implanted as well. The results on the whole were disappointing. In many of the cases the growth was not large. In 7 of the cases the growth was small and confined at first to the anus itself. In only 3 was it obviously large and in only 1 of these was it invading adjacent structures. In 2 there was no record. The histological grade of these tumors was grade 1—1 case grade 2—6 cases grade 3—4 cases no grading—1 case.

If these tumors as some believe may be expected to respond favorably to irradiation treatment the fact that so many of this group were small and not yet invading the surrounding structures should have assisted in obtaining good results. But on the contrary the results were poor. There was only 1 cure. This

patient is alive and well at the end of 11 years after interstitial radiation with platinum needles. Her growth was a small one. The lesion healed slowly, however, and there was a severe local reaction with much pain and tenesmus lasting several months.

In 6 patients in this group there was reasonably good palliation. In these 6 patients there was a temporary complete disappearance of the growth for from 2 months to 4 years. Two of these patients may have been cured of their anal carcinoma, but the end result could not be known because both died of some other disease. One died 4 years later of a carcinoma of the breast. The other died after 2 years of gangrene of the foot. In both cases the growth was small and both were treated with gold seeds alone.

In 5 cases there was no regression. In all of these the pain and tenesmus induced by the radium treatment in addition to the discomfort already present made them most uncomfortable.

Of the 11 patients who received radium treatment and were not cured, all are now dead (2 of intercurrent disease as stated). The survival period in this group varied from 3 months to 5 years. These results are most disappointing.

#### COMPARISON BETWEEN THE RESULTS OF THE TWO PRINCIPAL METHODS OF TREATMENT CARRIED OUT

Although there were relatively more small and locally favorable tumors in the irradiation treated group than in the surgical group the results both as to cure and good palliation were notably superior in the latter. Radical surgery produced cures in 12 of 48 cases (25 per cent) whereas in the irradiated group only 1 in 19 was cured (5.2 per cent). In the majority of the surgically cured patients the growth was large and invasive. In the 1 radium cure case the tumor was small and not invasive. Leaving aside the question of cure, the degree and duration of relief from local symptoms is important. Here again the results of radical surgery are better. In 21 surgically treated cases there was no local recurrence. Thus 41.6 per cent of the patients operated upon experienced complete relief from the local discomfort.

fort produced by the growth. In only 6 of the irradiation treated cases was there even temporary disappearance of the growth and relief from pain. In 1 of these there was a cure. Two died of other causes but in 3 there was a recurrence of the disease. There was therefore if we exclude the recurrent cases a degree of palliation in the irradiation treated cases comparable to that obtained by surgery in only 15.8 per cent of the group.

One must conclude therefore, that irradiation treatment is not as satisfactory as radical surgical excision either as a method of cure or as an attempt to secure relief from the distressing local symptoms of epidermoid carcinoma of the anus and rectum.

#### REFERENCES

- Butz, L. A., and Brewster, J. C. M. *J. Lancet*, 1933, 53: 565.  
57  
Jones, D. F. *Canad. M. Ass. J.* 1933, 28: 471-480.

# MANAGEMENT OF JAW FRACTURES

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THE treatment of jaw fractures and associated facial injuries, together with severe burns and miscellaneous problems of plastic surgery arising in the Canadian Army Overseas in the late war, was centralized in the plastic surgery division of Basingstoke Neurological and Plastic Surgery Hospital, Royal Canadian Army Medical Corps. This plastic surgery service was organized and commanded originally by Lieutenant Colonel Stuart D Gordon. The association of neurosurgery and plastic surgery in one hospital was very valuable because craniocerebral injuries so often were associated with wounds of the face and jaws, and in numerous cases the plastic surgeon was able to provide full thick scalp coverage in loss of skull and overlying scalp after debridement by the neurosurgeon.<sup>1</sup>

In all, around 3,000 patients were treated by the plastic surgery service or between 5 and 6 per cent of Canadian casualties.<sup>2</sup> Of this number as might be expected, by far the majority followed the evacuation of wounded from Italy in the late months of 1943 up to D' Day and with marked increase after that the work being maintained at a high volume until 'VE' Day.

Our experience was varied. In the early period it was concerned with training accidents with wounds essentially of civilian character and casualties the result of enemy bombing of civilians. To these were added definitive surgery in late cases of patients arriving from Italy these patients were treated as long as possible before repatriation. Following D' Day until hospitals were established on the Continent there was a period when patients came to us relatively untreated though with surprisingly little delay. Subsequently, most of the patients with facial in-

juries received their primary treatment at the hands of one or other of two British maxillo-facial surgical units under the command respectively, of Major Hynes and Major Fitzgibbon, to whose excellent work we are indebted.

As mentioned previously our experience covered all phases in the treatment of the jaw wound, whether they resulted from simple trauma or from missile injury. Statistics quoted represent individual patients, not individual fractures of either mandible or maxilla. Of the whole series detailed analysis has been made of all those patients admitted between January 1, 1944 and July 15, 1945 with the exception of those who died or those who required bone grafts. The figures shown in the tables suffice to exemplify typical features of treatment and complications.

TABLE I.—PATIENTS WITH JAW WOUNDS  
JANUARY 1944 TO JULY 1945

Mandibular fractures—All types	No. cases
Maxillary fractures	369
Mandibular fractures—gunshot wounds	356
Mandibular fractures—simple trauma	256
	113

## MANDIBULAR FRACTURES

*Simple trauma* For purposes of treatment the jaw is arbitrarily considered in four parts: condyle or ascending ramus including the neck, the angle coronoid compound from base of condyle to the last molar tooth, the ramus or horizontal ramus and the symphysis.

If reduction is accurate and fixation adequate these fractures heal well and are united in 6 weeks. Union is estimated by clinical criteria—no spring or pain at the fracture site on manipulation or mastication long before it can be confirmed radiologically. If infection occurs union is delayed for an average of 12 weeks. It is in this type of fracture that nonunion most often occurs. Fractures of the

<sup>1</sup>There were 18 cases of this type.  
<sup>2</sup>Based on report of Canadian casualties dated December 28, 1945.

ramus and symphysis are always compound into the mouth, and reduction and fixation are urgent if infection is to be avoided. In our analysis, a delay of 4 days between fracture and reduction, gave marked increase in infection. Surprisingly a firm tooth in the fracture line appeared to have little influence on the incidence of infection, in fact the evidence pointed the opposite way possibly because an alveolar gap may have been created in an effort to remove the tooth. Certainly if it represented a single tooth in the posterior fragment, its utility in maintaining reduction was such that it was retained if at all possible. It may be that in older patients in civilian practice showing a less ideal mouth hygiene than existed among our soldiers a tooth in the fracture line would be less well tolerated with less danger of carrying away alveolus in its removal.<sup>1</sup>

TABLE II.—METHODS OF FIXATION OF MANDIBULAR FRACTURES

	No. cases
Interdental and intermaxillary wiring	14
Cast cap splints	88
Interosseous wiring	40
External pin fixation	7
Circumferential wiring	
External angle wire to plaster of Paris head cap or to bar on cast cap splint	4

**Fixation.** In methods of fixation our practice differed widely from that of our British confreres who treated the majority of patients with cast cap splints. Perhaps their predilection for splints is due to the loss of teeth and irregular spacing of remaining teeth so frequently found in their patients, even in the age group encountered in the Army. We used cast cap splints in the same relatively edentulous type of patient, but in our soldiers the loss of teeth almost always coincided with their injury. One cannot speak too highly of the fine state of mouth hygiene preserved by the Canadian Dental Corps in the units of our Army.

We of the plastic surgery service were especially fortunate in the caliber of the officers attached to us by the Canadian Dental Corps, in the early days of the unit Major (later Lt.

Col.) G. Franklin and later Lieutenant Colonel V. Jekill. Major A. T. Roger, M. B. E., and Major G. MacDonald, M. B. E. The latter two were most intimately concerned with the work in the operating room and the wards. Each patient was seen by surgeon and dental officer in consultation and the method of treatment determined. In many cases, this was carried out by the dental officer until fixation was removed and the patient was again seen in consultation for final appraisal before discharge. In all cases the dental officers assisted in the routine postoperative care in the wards. Patients with complications from the beginning or in whom complications developed were operated on by the surgeon with the assistance of dentist to provide fixation. In this way our usual aggregation of 50 or 60 patients with fractured jaws was under the closest observation with a minimum of overlapping. Fracture of the mandible of civilian type due to simple trauma is usually of ramus (including symphysis) or angle coronoid and the opposite condyle. A condyle fracture alone, even in the presence of luxation of the head is treated by fixation in good occlusion for 2 weeks to prevent shortening on the side of fracture. Early mobilization is necessary to avoid trismus which is prone to occur in such case after prolonged fixation of the jaws.

Angle coronoid fracture is not likely to be compound but the posterior fragment is prone to upward and inward displacement with consequent malocclusion. Reduction may be retained by a bite block and intermaxillary fixation but is usually disappointing both in reduction and fixation. Open reduction and interosseous wiring is most satisfactory combined with interdental and intermaxillary (I.D. and I.M.) wires. Pins may be used in this type of fracture if preferred. Angle coronoid fractures unite freely but upward displacement of the posterior fragment must be guarded against, for if present it seriously interferes with fitting of a denture and sometimes with occlusion and mastication.

Ramus fractures are always compound into the mouth. Treatment is urgent on this account, though not an emergency unless through bilateral ramus fracture the patient is unable to swallow. In such case it is im-

<sup>1</sup>From an analysis of 33 cases of fracture due to simple trauma in this series, 040 to May, 044.

portant that he be treated face downward until the jaw is fixed to prevent him drowning by aspiration of blood and saliva. As previously pointed out a tooth in the fracture line should be retained if it is alone or is one of two in the posterior fragment and is firm. If the ramus is edentulous or the posterior fragment is edentulous the fracture must be treated in the same way as an angle fracture. In most cases of ramus fracture, eyelet wires and intermaxillary wires or some suitable combination of arch wire, or arch bar and intermaxillary wires give satisfactory reduction and fixation. The fracture is tested for union in 5 to 6 weeks and should not be considered a case of nonunion for at least 3 months unless gross infection has occurred.

Nonunion of ramus and symphysis fractures may be due to failure of reduction and fixation but occasionally it is difficult to explain. The chief factor in nonunion is infection. Nonunion is to be expected in case of bone loss involving the whole depth of the mandible. It is not important in the condyle except in consideration of adjacent soft tissue damage leading to trismus. Movement must be started early in from 2 to 3 weeks to avoid such an occurrence. Due to whatever cause nonunion is treated along the lines adopted for fracture due to gunshot wounds with loss of bone though of course the reconstruction is far less formidable.

TABLE III.—GUNSHOT WOUNDS OF MANDIBLE

	No cases
Gunshot wounds with ramus fracture	154
Gunshot wounds with condyle fracture	37
Gunshot wounds with angle coronoid fracture	65
Mandibular fracture with bone loss	72
Mandibular fracture with soft tissue loss	20

*Gunshot wounds of mandible* Bone loss is a term used in this group to indicate loss of a section or sections the full depth of the jaw and thus to distinguish the case as a problem in treatment different from the fracture due to simple trauma. Where a portion of the alveolus is knocked off in association with a fracture through the body of the bone simple débridement of bone and soft tissue wound with closure of the latter to cover the bone and with the type of fixation used for a fracture due to simple trauma is the treatment. A free

graft to deepen the sulcus is commonly necessary before a dental prosthesis can be fitted. Similarly, if a piece of bone is fractured from the lower border of the ramus it usually retains enough soft tissue attachment to provide a blood supply and may be ignored. The troublesome case is that in which there is gross comminution of bone. A thorough débridement must be done that is scrupulous removal of all bone fragments with doubtful blood supply of tooth fragments and devitalized soft tissue and complete closure of the soft tissue wound. If there is not enough soft tissue available inside the mouth for resorption mucosa must be sewed to skin edge over the bone ends. It is quite easy to locate and remove bone fragments detached from soft tissue in the recent wound, but if they are allowed to remain the wound will suppurate and in the presence of the resultant edema granulation and scar tissue it may be impossible to locate them.

Fixation of the fracture with bone loss is best done with sectional cast cap splints if teeth are available. Impressions are made for these at the time of débridement and they are cemented in place 1 or 2 days later an anesthetic being unnecessary. This splint retains the normal relative position of the fragments and is the final fixation until union occurs after bone graft. In case there are not teeth available the alternative fixation is by external pins.

Fractures with any appreciable amount of bone loss require a bone graft for union if deformity is to be avoided. In case of nonunion of a fracture due to simple trauma or if bone loss is less than  $\frac{1}{2}$  inch the graft may be of medullary chips. The ends of the fracture fragments must be freshened and intervening scar tissue removed. Enough of the outer cortex adjacent to the fracture must be removed to get free contact between the chips and the host. The wound is not drained and a pressure bandage is applied for 48 hours to prevent any possibility of hematoma.

*Bone grafts in mandibular fractures* In larger defects, a combination of cortical bone and medullary chips is used. The graft is obtained from either iliac crest which is exposed and split longitudinally for a little more than



TABLE IV — BONE GRAFTS IN MANDIBULAR FRACTURES

	N cases
Gunshot wound bone defects iliac cortical block and medullary chips	70
Simple trauma cancellous graft	3
Total series 1940-1945	73

the estimated required length of graft. The inner half is removed for a depth of about 3/4 inch by checking with an osteotome, then with a narrow osteotome a considerable yield of medullary fragments may be obtained. If only medullary bone is required the cortical block is driven back into its place. If the cortical block is to be used as graft a moderate amount of medullary bone is left attached to it. The jaw fragments are now exposed and prepared as described previously the cortical block is suitably shaped and wired firmly to the fracture fragment at each end, cortical side out, and small medullary chips are packed around its ends and beneath it.

Penicillin and chemotherapy have markedly cut down the morbidity in these cases. Bone grafting can usually be done 3 to 4 weeks after the primary débridement and closure of soft tissues instead of in as many months. Practically all bone grafts were done in England as a routine measure in spite of pressure of other work, in view of the fact that the jaws had to be fixed in occlusion until union was procured and of possible delays in repatriation and in resumption of active treatment at home. In this way it was possible to avoid much discomfort and inconvenience to the patient. Actually firm clinical union was the rule in 6 weeks from operation and the majority of these patients were observed to this point. It is probably unwise to send a patient on a stormy Atlantic crossing with his jaws wired together.

Complications of bone graft were few. There was no case of osteomyelitis of ilium. An abscess occurred in the soft tissues outside the jaw in 5 cases, but in each case yielded to simple drainage and chemotherapy without loss of graft. We saw only 1 case of nonunion after bone grafting and 1 other case in a repatriated patient is known to us. A complete survey of these repatriated patients has been impossible to date.

TABLE V — FRACTURES OF THE MAXILLA

	No cases
Total maxillary fractures*	56
Maxillary sinus "clean-out" Caldwell-Luc	75
Maxillary sinus "blow-out"	9
Nonunion of mid third fracture†	1

\*Series of cases January 1944 to July 1945.

†Union secured with bone graft.

Trismus is rarely troublesome in mandibular fractures but is a feature in fractures and gunshot wounds of the condyle and coronoid. It is most common in what appear to be relatively simple through and through wounds of the middle of the face from bullets. Probably the mechanism is the same in both cases and is due to side to side adhesion of muscle and fascial planes. It can be avoided by early mobilization but, once established is very difficult to overcome. Forced mobilization under anesthesia only results in recurrence in aggravated form. Dental exercisers are disappointing the best results are from graduated bite blocks worn 24 hours daily until the opening is enough to admit solid food.

#### MAXILLARY FRACTURES

Fractures due to simple trauma range from fracture of a portion of the alveolus to complete separation of the maxilla from the skull the mid third fracture or floating maxilla so often seen in motor cycle accidents and frequently complicated by being comminuted through palate and alveolus. The alveolar fracture is easily treated by wiring the teeth in occlusion. The more severe type requires repair of the mucoperiosteum of the palate, if this bone is broken and in addition to interdental and intermaxillary wires, a plaster of Paris chin cradle and head cap connected by two lateral rods adjustable through universal joints. The problem of insufficient remaining teeth is met by wiring a Gunning splint to the alveolus. The simple alveolar fracture unites in 3 weeks the more severe fracture requires fixation for 4 to 6 weeks. Infection and nonunion are rare.

When a missile traverses through the cheek and maxillary sinus and lodges, perhaps, in the pterygoid fossa or the neck on the opposite side, it is usually quite easy to remove it by following the track or by making a counter incision in the neck. We felt that removal was

wise for fear of infection from the sinus and danger of secondary hemorrhage from the large vessels of the neck. Many bone fragments were driven into the maxillary sinus and débridement and closure of the wound were combined with a Caldwell Luc antrostomy when the antrum could be cleaned out and indirect drainage of the wound track provided by making a large window into the nose.

In cases in which the missile traversed the face and which we termed a "blow-out" because of the wide destruction of soft tissue of the cheek at the site of exit, careful débridement of the wound was done, free drainage into the nose provided from both maxillary sinuses though this was usually present from the nature of the wound and every effort made to close the cheek wound by undermining or by rotating a cheek flap. No attention was paid to lining in such case in the hope that it would regenerate from the antral mucosa and this appeared to be the case. Careful débridement of bone and devitalized soft tissue and avoidance of dead space are essential. In some cases, especially if a good deal of the zygoma was lost, dead space was obliterated by rotating a flap of temporal muscle. Penicillin and chemotherapy undoubtedly are of great assistance to the natural defensive forces against infection but are of no avail unless débridement is scrupulous and fluid collection is avoided. Hemorrhage often severe in this location is usually controllable with fibrin foam but in a few cases it was necessary to ligate the external carotid artery.

TABLE VI.—COMPLICATIONS OF FACIAL WOUNDS

Secondary hemorrhage	6
Osteomyelitis	15
Tracheal obstruction (tracheotomy)	34
Gastrostomy required	1
Eye enucleation or eversion	66
Eye trauma	80

#### COMPLICATIONS IN FACIAL WOUNDS

The relative rarity of secondary hemorrhage is remarkable. Intramuscular penicillin was started with the first treatment of our casualties and was continued in regular dosage throughout evacuation to base hospital. In no case did we find spreading infection on

arrival and to penicillin treatment and to careful débridement must be attributed the rarity of secondary hemorrhage. Tracheotomy was wisely done by the maxillofacial surgical unit in all cases in which there was any doubt of airway obstruction during evacuation. It was only occasionally required otherwise.

Operation in these cases is not an emergency measure unless because of hemorrhage respiratory obstruction or inability to swallow. In fact it should be deferred for a few hours for on arrival the patient is tired, cold and hungry. Clinical check is followed by immediate x ray examination in those cases in which high priority for operation is indicated. Removal of dirty, blood-caked clothing, a hot bath, hot nourishing fluids, and a sedative lead to a few hours of sleep and relief of "battle fatigue" and make the patient a much better operative risk. In case clinical examination of the chest, checked by radiological examination if necessary shows evidence of aspirated fluids these are removed through a bronchoscope before operation.

Credit to Major R. A. Gordon our anesthesiologist and his staff cannot be too high. Pre-operative resuscitation was under his supervision, and he was continually alert for post-operative pulmonary complications. He frequently had occasion to aspirate large amounts of blood and mucus saliva from the lungs before operation and in this way and in prompt bronchoscopic cure of collapse of the lung when it occurred after operation chest complications were avoided. Blood transfusion was done freely during operation for it was found more economical to keep the patient out of shock than to resuscitate him when shock had already taken place. These operations were frequently prolonged and often attended with a good deal of unavoidable hemorrhage.

There was only 1 death in our cases of jaw and facial wounds.

Private L. S. G41607 Shell wound enemy action. Wounds consisted of compound fracture of right humerus, both jaws, and chest received July 28, 1944. Treatment No. 5 maxillofacial surgical unit débridement of arm and plaster cast débridement of jaw and face and intermaxillary fixation were carried out. He was admitted to Basingsfold Neurological and Plastic Surgery Hospital August 5, 1944. Patient was

very ill but as x ray examination showed multiple bone and tooth fragments in the fractures of both jaws, and the previously sutured facial wounds were partially separated, exposing bone operation was carried out. Two bottles of blood were given during operation. Operation consisted of débridement of tooth and bone fragments from both jaws, interosseous wire to lower jaw débridement of soft tissues, and repair to cover exposed bone. His condition was not good enough to permit taking care of the arm fracture. Penicillin was given in 100,000 units daily sulfathiazole grams one every 4 hours for 5 doses intravenous glucose saline 5 per cent 3,000 cubic centimeters daily. Condition was improved until August 9 when he became confused mentally and lethargic. He vomited occasionally. Urinalysis was + plus albumen red blood cells and white blood cells, nonprotein nitrogen 436. Steady deterioration and uremia occurred resulting in death on August 16 1944 nonprotein nitrogen 450.

This man had 12 transfusions before he was admitted to our care. Necropsy showed his kidney tubules plugged with blood. It was a remarkable feat that our soldiers were supplied with blood so freely. Even at our level, only Type O blood was supplied. Transfusion accidents were very rare, and in our experience this was the only case in which there was a fatality.

## FEEDING ROUTINE FOR JAW CASES

- Types of diets. (a) Jaw fluids. (b) Jaw No. 1 (c) Jaw No. 2

**Methods of feeding.** Patients with gunshot wounds of mouth are fed a completely fluid diet of 1800 calories, plus a special tube feeding of 800 calories. Patients should be fed in a prone position in order to prevent regurgitation of the liquids. The patients are fed with a rubber tube on the end of a large glass syringe or a bulb syringe.

**Jaw fluid diet** consists of 1800 calories. If patient is able to purse the lips and does not have a paralyzed tongue, he may drink the fluids from a feeder. Otherwise patient has rubber tube inserted between the molars and the cheek and the liquid is poured slowly through the tube from a feeder. If opening is inadequate, fluids may be forced gently between the teeth by a bulb syringe.

**Jaw 1 diet** consists of 2600 calories. All the food is puréed and all beverages strained. This diet is fed to the patient all the time the splints are on. Patient carries the puréed food to the lower lip by spoon, and then sucking and pushing (by the finger) gets the food into the mouth.

**Jaw 2** consists of 2600 calories. Only the meat remains puréed, no raw salads are given. This diet is given when the patient has had the splints removed.

To all diets is added ascorbic acid, 100 milligrams, and vitamin D oil, 1/4 ounce daily.

The patient must be encouraged to eat the Jaw 1 diet at the earliest possible moment. This Jaw 1 diet

is better balanced, has more calories, and gives greater variety than the fluid diet. The Jaw fluid diet is used only for 24 to 48 hours except in the case of patients with gunshot wounds and special patients who may need fluid diet for a longer time because of particular injury.

It is always important that the food be presented to the patients in as attractive a manner as possible and that a wide variety of tastes to attract his palate be used.

## SUMMARY

An analysis of fractures of lower and upper jaws is submitted. These fractures were of two types, namely civilian type and those due to gunshot wounds. Types of fixation are indicated in their respective frequency of employment.

With careful débridement associated with penicillin and chemotherapy and by carefully planned closure of soft tissue wounds, it was possible to avoid much soft tissue deformity. Similarly in comminuted fracture of the mandible, treatment consisted of careful débridement of all planes of the wound especially aimed at removal of any bone fragment without soft tissue attachment or with doubt full blood supply obliteration of dead space, and complete closure of the overlying soft tissue without drainage. Following this procedure there was rarely any further sign of infection necessitating further débridement. Bone grafting was done within a month after primary closure in those cases in which it was indicated and was practically always successful with minimal complications.

Secondary hemorrhage was rare probably due to adequate surgery and avoidance of infection. Penicillin and chemotherapy are of great value in limiting infection but the great est factor is still careful surgery.

In civilian type fractures with nonunion or in fractures with a gap of less than 1/4 inch bone graft was of medullary chips alone from the iliac crest. In larger gaps, a block of cortical and medullary bone was wired firmly to both fragments of mandible, supplemented by medullary chips beneath it and around the ends.

Some practical suggestions regarding the care of wounds of this kind and regarding dietary requirements are included.

# SURGERY OF THE POSTERIOR INTEROSSEOUS BRANCH OF THE RADIAL NERVE

## Analysis of 58 Cases

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**L**ESIONS of the posterior interosseous branch of the radial nerve have been considered unamenable to surgical repair by many surgeons. Reluctance to attempt repair has been based on the belief first that gaps could not be overcome because of the straight course of the nerve second that widespread arborization prevented end-to-end suture and third that tendon transplantation provides an adequate substitution with a much shorter convalescence. Experience in the Neurosurgical Section at Percy Jones Hospital Center indicates that these objections are not valid.

The primary purpose of this paper is to present the data from 58 patients treated surgically. These data demonstrate that surgical repair may be accomplished satisfactorily in a high percentage of cases and that the results justify the attempt. It is our further purpose to discuss in some detail the diagnosis and surgical treatment employed.

### ANATOMY

The radial nerve after giving off motor branches to the extensor carpi longus and brachioradialis divides just distal to the elbow into its two terminal branches the superficial radial nerve and the deep or posterior interosseous branch. The latter nerve then passes deep to the extensor carpi longus and enters the fibers of the supinator muscle. Coursing obliquely around the head of the radius it emerges from the supinator fibers on the posterior aspect of the upper one-third of the forearm. Textbooks of anatomy depict immediate branching of the nerve as it leaves the supinator fibers. In our experience it often arborizes 1 or more inches below the supinator muscle.

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The nerve supplies the extensor communis digitorum, extensor carpi ulnaris, extensor pollicis longus and brevis and abductor pollicis longus. No significant sensory component is present in the nerve.

### DIAGNOSIS

Paralysis of the muscles which this nerve supplied produces a characteristic deformity of the hand (Fig. 1). Dorsiflexion of the wrist is preserved by the extensor carpi longus. Paralysis of the extensor communis digitorum renders extension of the proximal phalanges of the fingers impossible. Extension of the distal phalanges is preserved, since this movement is performed by the interossei and lumbricales. Paralysis of the extensors of the thumb prevents active extension of all joints of the thumb and paralysis of the long abductor prevents abduction of the thumb in the plane of the palm. The thumb in repose assumes a position of slight flexion being immediately ventral to the index finger. When forceful extension of all digits is attempted, apparent extension of the index finger may be accomplished in a passive manner by strong contraction of the adductor and the opponens pollicis.

### SURGICAL TECHNIQUE

Exposure of the deep branch of the radial nerve is secured through an incision (Fig. 2) overlying the fascial plane between the brachioradialis and biceps muscle on the lateral aspect of the distal portion of the upper arm extending lateral to the antecubital fossa and over the posterior aspect of the upper portion of the forearm between the brachioradialis and the extensor carpi radialis. The radial nerve is identified between the brachioradialis and the biceps tendon and dissected downward to the site of injury. Care must be taken to preserve

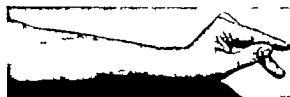


Fig. 2. Typical deformity on attempted extension of all digits in paralysis of posterior interosseous nerve



Fig. 3. Full recovery of all muscles 18 months after operation

the motor branches to the brachioradialis and extensor carpi longus. The nerve is then picked up immediately below the supinator fibers by separating the extensor carpi longus and extensor communis digitorum. The proximal neuroma and distal glioma are resected back to healthy fascicles. Gaps measuring up to 50 centimeters are easily overcome by freeing the nerve up to its parent trunk and flexing the elbow to 90 degrees. Anastomosis is accomplished with sutures of 003 tantalum or No 000000 black silk placed through the epineurium of the divided nerve ends. No stay suture has been employed except in cases in which tension on the suture line was thought to be unduly great. Tantalum foil

has not been used. The elbow is immobilized in the flexed position by means of circular plaster with the forearm in slight pronation the wrist in cock up and the fingers and thumb free. The plaster is removed in 4 to 5 weeks and immediate physiotherapy is begun without restriction upon the rapidity with which complete extension of the elbow is secured.

#### RESULTS

Of the 58 patients (Table I) subjected to surgical exploration of the deep branch of the radial nerve neurotomy was done in 39; in 2 cases it was necessary to repair the divided nerve by means of an autogenous graft obtained from the superficial radial nerve; the nerves in 14 cases required neurolysis only. In 3 cases, for reasons which will be described, it was impossible to secure repair of the nerve.

For appraisal of results the patients have been divided into two groups: group I, includes cases in which repair was performed prior to May 1945; group II, those cases in which repair has been carried out since that time. Though 2 of our patients have shown earliest signs of recovery during the seventh and eighth months, we have included for final evaluation all cases in which repair was effected 6 months or more prior to this report. Of the 37 cases comprising group I, neurolysis only was performed in 9, and to-end suture in 24; the use of an autogenous graft to overcome

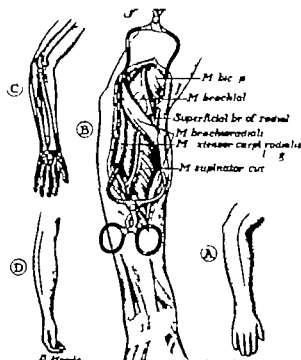


Fig. 4. Surgical exposure. A, Line of incision—forearm prone, elbow flexed; B, line of incision—elbow straight; C, diagram of course of nerve with arm in position A; D, incision open—nerve exposed.

TABLE I.—SURGICAL EXPLORATION OF POSTERIOR INTEROSSEOUS NERVE OCTOBER 1943 TO OCTOBER 1945

Type of repair	Group I 6 mos. or more postoperative	Group II Less than 6 mos. postoperative	Total cases
Neurotomy	24	15	39
Repair with graft			
Neurolysis	9	5	14
Irreparable			3

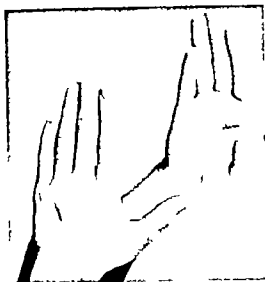


Fig. 4. Partial recovery demonstrating residual paralysis of extensor and long abductor of thumb 6 1/2 months after operation.



Fig. 5. Partial recovery demonstrating residual partial paralysis of extensor communis digitorum 7 months after operation.

gap in the nerve in 2 and complete failure to secure repair in 2 cases.

The deep branch of the radial nerve being purely motor lends itself to simple evaluation. We have divided our patients into those who have obtained what we call full recovery (Fig 3), in whom all the muscle groups supplied by the deep branch of the radial nerve function with at least 50 per cent of normal motor power; partial recovery (Fig 4), in whom recovery in some but not all, of the muscle groups supplied by the nerve has taken place, or in whom all muscle groups have recovered but one or more of them in a defective manner (Fig 5).

Evaluating the cases of neurorrhaphy observed longer than 6 months after operation (Table II) in the 26 patients so treated full recovery has been obtained in 19 or 72 per cent of the cases. Partial recovery has been noted in 3 cases and failure of any evidence of muscle return in 4 cases. Two of the patients with partial recovery were operated upon less than 8 months ago and further evidence of recovery in the muscles still paralyzed is anticipated. It should be noted that the 26 cases considered for evaluation of end result includes the 2 patients in whom graft was necessary to secure repair.

#### DISCUSSION

The data leave little doubt about the feasibility of repairing this nerve in a high percent

age of cases. Attempt to repair the divided nerve met with failure in 3 cases representing 6 per cent of the total group. One of these patients had been struck by fragments of a phosphorous shell and had in addition to the soft tissue damage caused by the metal fragments extensive phosphorous burns of the proximal third of the forearm. The area normally occupied by the deep branch of the radial nerve was replaced by such dense scar tissue that identification of the nerve was impossible. The remaining 2 cases of failure were in patients with extensive soft tissue damage and severe comminuted fractures of the upper end of the radius with generous callus formation. In these cases as in the first, scar tissue and callus replaced the area through which the deep radial nerve coursed.

The 4 patients in whom repair was secured, but in whom recovery has not taken place deserve special consideration. In 1 of these patients E. S. the original injury to the nerve was incurred 3 years prior to surgical exploration and was the result of a surgical accident during operative removal of the head of the radius in civilian life. Because of the long period of time which had elapsed prior to repair of the nerve only 4 months postoperative observation was allowed before tendon transplantation was undertaken for at that time electrical reactions indicated complete denervation. In the second patient, A. M., end to-end anas-

TABLE II.—RESULTS FOLLOWING NEURORRHAPHY OBSERVED 6 MONTHS OR MORE POST OPERATIVELY—TOTAL CASES 26

Degree of recovery	No. of cases	Per cent of cases
Full recovery	19	72
Partial recovery	3	12
Failure	4	16



# HISTOPATHOLOGY OF THE GASTRIC SEMISQUAMOUS EPITHELIAL LAYER

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HAVING described previously (1, 2) the semisquamous epithelial layer (Fig 1) which covers the normal gastric and intestinal mucosae we are now going to describe the different histopathological syndromes found by making a study of a fair number of resected specimens of stomach

## PATHOLOGY OF THE GASTRIC SEMI SQUAMOUS EPITHELIAL LAYER

The specimens were carefully studied for the presence of all abnormalities principally erosions and afterward we took a photographic record of the fresh specimen, or made a schematic drawing so that after formalin vapor fixation we could select the parts which appeared to be pathological in the fresh specimens. We adopted this procedure because after fixation the mucosa assumes a dark brownish color and small alterations and erosions fade out and are very difficult to find.

**Erosions** We studied the erosions very carefully as we hoped to gain a better understanding of the problems of ulceration through these small gastric lesions. In the first place we supposed that any erosion indicated a preulcerative process or was actually a very tiny ulcer, and we were extremely careful to avoid the neglect of any details. We selected the whole portion containing the erosion for study and made it into a paraffin block for serial section. As a result of this we have been able to describe the full meaning of erosions that is, the erosions which represent preulcerative processes, and the erosions which represent the postulcerative processes and which will be described later.

**Preulcerative erosions** Our observations made during the study of the preulcerative lesions disagree completely with the descriptions of the same process as given by different

authors as they have not been able to consider the significance of the semisquamous epithelial layer when making a study of these lesions.

Our investigations of the preulcerative lesions have brought us to the conclusion that they have two typical characteristics. One is the lesion of the semisquamous layer itself and the other is in the mucous membrane.

The lesion in the semisquamous layer itself is represented by an extensive infiltration of round cells and polymorphs which are linked by means of a cellular bridge with the submucosa in a similar way to that which takes place in ulcerative colitis. This bridge contains occasionally small capillaries and the layer may be thick and irregular in appearance (Fig 2).

The lesion in the mucous membrane is characterized by an intense disorganization of these glands and some of them appear to be breaking up their morphological structure and there is an extensive infiltration of polymorphonuclear and round cells. It is still possible however to recognize normal parts of the gastric mucosa (Fig 3).

**Ulcer** The study of ulcers was made by means of a similar technique to that used for investigation of the erosions, and the whole ulcer was embedded in a paraffin block and made into sections. We carried out our observations on serial sections and these were of great interest principally in the edges of the ulcer at the union between the normal gastric mucosa and the ulcer itself.

As we had expected we found that the semisquamous epithelial layer was missing from the gastric ulcers and by making sections of the whole ulcer, it could be appreciated that the layer disappeared after covering the normal mucous membrane at the edges of the ulcer and was absent from the center of the ulcer (Fig 4). In some ulcers it could be seen how the crater contained some slough

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Fig. 1



Fig. 2



Fig. 3



Fig. 4

tissue, and it was doubtful if this really represented the semisquamous epithelial layer but further observations cleared up this doubt. When the ulcer was stained with thionin it could be seen that the crater was full of microorganisms, some of them included in parts of the tissue itself forming what appeared to be colonies. When stained with mucin stains, the material contained in the crater of the ulcer had none of the characteristics of mucus. Another observation we made was that in some ulcers there was a foreign body included in the crater of the ulcer. Studying the ulcer crater by high magnification it can be seen that the semisquamous tissue disappears at the edge as an independent morphological structure and the crater itself is formed by an accumulation of round cells which are linked together by fibrotic tissue and plasma (Fig. 5).

After these investigations, therefore we can conclude that the crater of the ulcer is without any protection from the semisquamous epithelial layer.

At the edge of the ulcer and covering the mucous membrane can be found capillaries or venous dilatations, some of them being the

Fig. After formalin vapor fixation. The semisquamous epithelial layer showing a unicellular structure in some places.

Fig. 1. Preulcerative process. Notice the bridge joining the semisquamous epithelial layer with the submucosa and also the cellular infiltration.

Fig. 3. Further advancement of the preulcerative process. Observe how the semisquamous epithelial layer is joined by bridges with the submucosa. Notice also the disorganization of the mucous membrane.

Fig. 4. A large, simple ulcer of the stomach. Notice how the semisquamous epithelial layer finishes at the edges of the ulcer. It is remarkable that the crater of the ulcer does not show any mucous material.

largest vessels we have found in the semisquamous epithelial layer of the gastric mucosa (Fig. 6).

The protective function of the semisquamous epithelial layer is fully demonstrated by the study of the process of cicatrization of the ulcer. We have divided the mechanism of healing and mucous membrane reconstruction into 4 parts.

In the first one we can see how the semisquamous epithelial layer begins to grow from the edges and covers the upper part of the ulcer and in some cases a bridge is formed, and under the cover of the new layer the mucous membrane spreads toward the center of the ulcer (Fig. 7).

By the second process the mucous membrane cells using the protection of the bridge formed by semisquamous cells, form islands of mucous cells floating in the space between the protective layer and the new mucous membrane, and these free accumulations of cells will form new glands (Fig. 8).

The third process can be found in the crater of the ulcer itself where occasionally there are islands of mucous membrane cells which ap-



Fig. 5.



Fig. 6.



Fig. 7



Fig. 8.



Fig. 9.

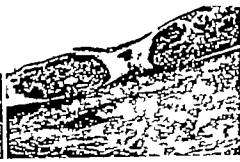


Fig. 10



Fig. 11



Fig. 12



Fig. 13

Fig. 5. A gastric ulcer at the edge of which it can be seen how the semisquamous epithelial layer joins with the crater of the ulcer and disappears as a detached body.

Fig. 6. A large blood vessel at the edge of a gastric ulcer.

Fig. 7. The edge of a gastric ulcer. Notice how the mononuclear mucous membrane spreads toward the crater and is protected by the semisquamous epithelial layer.

Fig. 8. An island of mucous membrane cells which are growing to form new gastric glands, protected by the semisquamous epithelial layer.

Fig. 9. A patch of glandular tissue in the center of a gastric ulcer from which the mucous membrane spreads toward the edges of the ulcer.

Fig. 10. The mucous membrane throwing out projections which will form new glands. All are protected by the semisquamous epithelial layer.

Fig. 11. Details of the new unicellular mucous membrane layer in which can be seen cells with a cuboid aspect. Notice the thickness of the semisquamous epithelial layer.

Fig. 12. Postulcerative process. Notice the complete mucous membrane which is found to be unicellular in some cases, and the presence of a strong semisquamous epithelial layer.

Fig. 13. Final healing process of an ulcer. Notice what appears to be an atrophic mucous membrane, and a complete semisquamous epithelial layer.

pear to be protected by semisquamous epithelial cells and under this protection they are able to begin another process of healing by spreading toward the edge of the ulcer (Fig. 9).

The fourth process is more a process of reconstruction than a proper healing mechanism. From the layer of new mucous membrane cells we could see how they project groups of cells like fingers and these projections go toward the making of new glands. But in this case

the whole mucous membrane is fully protected by a new semisquamous epithelial layer (Fig. 10).

It is important to mention here that when studying the cellular morphology of the new healed mucous membrane one is struck by the fact that there are present a large quantity of polymorphonuclear leucocytes, which by following exactly the same mechanism of growing their protoplasm and losing their nuclei



Fig. 4. Pseudoulcer from the pyloric region of a stomach, which shows gap in the mucous membrane. Notice that the gap is covered by the semisquamous epithelial layer which comes in contact with the Brunner glands.



Fig. 5. A gap in the pyloric region which is occupied by what appears to be venous sinus.

as we have studied in the milk and pus cells (3, 4) settle there and form the new mucous membrane layer. The cells of the new mucous layer have the appearance of cuboid cells with a nonmucous protoplasm very similar to some epithelial cells, which form the wall of breast cysts or the glandular cells making up the structure of the acini in colloid goiter and later on these cuboid cells begin their secreting process and have the aspect of normal mucous membrane cells (Fig. 11).

*Postulcerative process.* Studying the mechanism of ulcer cicatrization we could recognize the difference between an erosion which precedes a gastric ulcer or an erosion which follows it. It is necessary again to remark that the picture of a postulcerative process has been taken by a number of authors to mean a preulcerative process. The basic difference is that in the postulcerative lesion there is a perfect and what appears to be healthy semisquamous epithelial layer with some cellular

infiltration present but it is not linked with any cellular bridges as we have seen in the preulcerative process and on the other hand the mucous membrane has the appearance of a very atrophic mucosa with a very good mucous cellular layer. Sometimes this is monolayered and without any other glandular structure and the appearance of the mucous membrane cells in cuboid form, as we have previously explained in the description of the formation of the new mucous membrane (Figs. 12, 13).

*Pseudoulcer.* It is interesting to find when studying different gastric mucosa, how occasionally in different parts of the stomach, but principally in the pyloric region it is possible to observe a gap in the mucous membrane where the whole mucous membrane layer is missing but this part is without any cellular reaction of the submucosa and the gap is covered and protected by what appears to be a healthy semisquamous epithelial layer



Fig. 6.



Fig. 7.



Fig. 8.

Fig. 6. Gastric carcinoma showing ulcerative process.  
Fig. 7. Part of gastric carcinoma surrounded by gastric glands with normal aspect. Notice the semisquamous epithelial layer covering the whole structure.

Fig. 8. Section of tissue removed from gastric carcinoma which shows a total disorganization of the gastric glands but what appears to be well defined semisquamous epithelial layer.

In some cases the spaces where the mucous membrane is missing are occupied by large blood dilatations similar to small angiomatous conditions (Figs. 14, 15) This is one of the facts which called our attention when we began to study the semisquamous epithelial layer. The absence of the mucous membrane in the pyloric region has been confirmed by studying different stomachs and it appears that probably in some gastric mucosae, there is an embryonic defect at the point where the two different histological structures meet. This gives place to a gap in the mucous membrane. If the gap is a genuine one it can be proved by the fact that the whole of it is protected by the presence of a semisquamous epithelial layer. The study of these pseudoulcers convinced us that if histologically they give a very abnormal picture they may have very little pathological meaning because (a) there is a very good protective layer present and (b) there is an absence of any cellular infiltration of the gastric wall which disagrees entirely with the pathological picture of inflammation.

After our description of the semisquamous epithelial layer which covers the normal gastric mucosa, and of the layer in different pathological processes it follows logically that the criterion of ulceration should be changed accordingly. The presence of an irregular mucous membrane with a very strong infiltration of cells, will signify an ulcer only if the area of mucous membrane is not covered by a semisquamous layer and there will not be an ulcer if this layer is present, independent of the condition of the mucous membrane. We should keep in mind that this pathology of the mucous membrane should be compared to the pathology of the skin, that is, as long as the stratum corneum is complete there is no ulceration independent of the condition of the other strata.

*Carcinoma of the stomach* The carcinomas given to us from gastric resections were far enough advanced to have given clinical or roentgenological signs which warranted their resection. For this reason, therefore we have been unable to throw more light on the problem as to whether carcinomas always arise from an ulcer or whether they can arise with-

out any previous lesion of the semisquamous epithelial layer, the mucous membrane layer only being involved. In all our studies of carcinoma, except one, we have always found large areas of ulceration, but whether these were primary or secondary we are unable to say.

As a result of our investigations we are able to describe two histological pictures of gastric carcinoma which appear simultaneously in all the carcinomas studied so far. (a) Typical carcinomatous ulcers, in which case, in the crater of the ulcer can be found carcinomatous cells. The ulcer is not protected at all by a semisquamous epithelial layer and this is similar to the process found in the simple gastric ulcers (Fig. 16). (b) In the region between what appears to be normal mucosa and the carcinomatous ulcer, it can be seen that there are regions where the mucous membrane changes, and appears to pass from normal mucosa to carcinomatous mucosa, but the whole mucous membrane is protected by the semisquamous epithelial layer. This is the area where the carcinoma spreads toward the normal tissue (Fig. 17).

In a carcinoma which appeared to have a nonulcerative mucous membrane we found that after formaline vapor fixation and section that the mucous membrane was very disorganized but was covered by a well defined semisquamous epithelial layer. This layer showed areas of extensive infiltration and in some parts there appeared to be present some very tiny ulcers of the semisquamous epithelial layer.

On the whole this carcinoma was suggestive of a neoplastic process arising firstly from the mucous membrane itself without any previous degree of ulceration of the semisquamous epithelial layer. This is the only observation we have done, however in which it appears that the primary lesion is in the mucous membrane and there is only secondary involvement of the semisquamous epithelial layer (Fig. 18).

I cannot see any possibility of clearing up this problem, except for people like the medical legalists who may be in a position to study very early carcinomas from people who have been killed by accident, and who may have

early carcinomatous changes of the mucous membrane which have not arrived at the stage of giving clinical signs. Naturally this examination of the gastric mucosa must be carried out as soon as possible after death before auto-digestion has set in.

#### SUMMARY

We have described the pathology of the semisquamous epithelial layer in the preulcerative processes, the absence of the layer in the ulcer itself the aspect of the layer in the post-ulcerative lesion and also how this layer is necessary in the process of cicatrization. We

have studied the relation of the layer to gastric carcinoma.

Our investigations have enabled us to give evidence that the layer plays a very important part in the protection of the gastric mucosa as without it the mucosa is destroyed, and there is a picture of gastric ulcer. The layer is absolutely necessary for the healing and reconstruction of the histology of the gastric mucosa.

#### REFERENCES

1. DURAN-JORDA, F. *Acta med. scand.*, 1945, 31.
2. *Idem.* *Brit. J. Surg.*, 1946, 33, 346.
3. *Idem.* *Nature, Lond.*, 1944, 154: 704.
4. *Ibid.*, 1945, 56, 110.

# NOTES ON THE HISTORY OF RESUSCITATION IN THE MEDITERRANEAN THEATER OF OPERATIONS

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THE Mediterranean campaign lasted 30 months and was one of the longest undertaken by the United States Army since the Civil War. Tragic as this was in many ways, it did give the inestimable advantage of time to correct errors, time to introduce test and establish good practices.

## THE TREATMENT OF TWO PATIENTS

Two years and many a medical *tour de force* are spanned by the following 2 cases. It is a long stretch from the Atlas Mountains, over the Apennines, to the Alps. Not only a treacherous enemy operating in a countryside all ways favorable to him, but mistaken concepts of treatment had to be surmounted and new procedures introduced in the slow journey that was made. There may be some value in recording why and how and when our practices became as they were at the end of the war.

### TUNISIA<sup>1</sup>

March 21, 1943

Infantryman H was wounded by a shell fragment and tagged at the Regimental Aid Station at 1100 hours, March 21, 1943 with the diagnosis of compound fracture of the left humerus and laceration of the left side of the chest.

First aid: Morphine grain  $\frac{1}{2}$  was given at 1100 hours. Sulfanilamide dressings and a Thomas arm splint were applied. He was promptly sent to the Clearing Station where 1 c.c. tetanus toxoid was injected and 500 c.c. (2 units) blood plasma administered. His general

### PO VALLEY<sup>2</sup>

April 21, 1945

Infantryman R, age 26, was wounded by shell fragments at 1300 hours, April 21, 1945 with compound fractures of the left femur and of both ankles, a penetrating wound of the chest with hemothorax and multiple lacerations of the legs and the face.

First aid: In the Collecting Company at 1315 hours, 1500 c.c. (6 units) of blood plasma was given as were dressings, leg supports, and morphine grain  $\frac{1}{2}$ . He was evacuated to the Clearing Station where 20,000 units penicillin were in

condition was not described in his record.

Hospital entry: At some time in the afternoon he was evacuated to a Surgical Hospital. At 1715 hours his blood pressure was 110/70 with pulse of 120. More complete examination was carried out here than he had had previously. It revealed absent breath sounds and hyperresonance on the left. His abdomen was rigid and tender. At 1745 hours a further 500 c.c. (2 units) plasma injection was given. Fluoroscopy was then carried out. A fracture was found in the lower  $\frac{1}{2}$  of the left humerus with lateral bowing present. There was increased density in the left chest with the mediastinum pushed over probably by fluid. A large foreign body was seen in the stomach region.

The chest wound was sutured. There was no evidence of "sucking". At the time of the fluoroscopic examination the blood pressure was good and the pulse of fair quality. It was judged that the patient had a combined thoracic and abdominal wound with ruptured viscera and probable hemorrhage. Transfusion and immediate operation were decided upon. One 500 c.c. blood transfusion was given. The abdomen was opened through a long left rectus incision. This was accompanied by a gush of blood and air with

PO VALLEY  
jected, 250 c.c. (1 unit) plasma was administered and because of his exceptionally poor general appearance 1000 c.c. whole blood was obtained from the adjacent field hospital and given. His blood pressure was 90/60.

Hospital entry: At 2100 hours. On arrival his blood pressure was not measurable. His face was pale but warm. The extremities cool, and veins collapsed. Shock was classified as severe. His blood volume was measured (see below). In the ensuing 4 hours he was given 500 c.c. (2 units) plasma and 2000 c.c. whole blood. His blood pressure had risen from 0 to 110/65. The pulse rate was 138. He received 25,000 additional units of penicillin. Operation was carried out at 0330-0600 hours. April 22 under intratracheal nitrous oxide oxygen. Guiltotine amputation of the left thigh was performed. Débridement was made of the extremity and chest wall wounds with aspiration of 1000 c.c. blood from the right pleural cavity. Penicillin 25,000 units was placed in the chest. He was put on nasal oxygen. Subsequently the patient made an excellent recovery.

Laboratory notes: At 2300 hours, April 21. Hemoglobin 9.8 grams per cent, hematocrit 29, blood volume 5020. This

<sup>1</sup> From Report by Major (later Colonel) Howard E. Snyder (14)

<sup>2</sup> From records of Board For The Study of The Severely Wounded (6)

## TUNISIA

Immediate respiratory difficulty. A 4 centimeter laceration of the dome of the diaphragm was found and closed. After this the patient's condition improved greatly. A 10 centimeter laceration of the stomach near the greater curvature was present; this was closed. It had been caused by a 1 by 1 by 3 centimeter shell fragment. The only other injury found in the abdomen was a small laceration of the spleen. This was not bleeding. Twelve grams of sulfanilamide powder was dusted into the abdomen and the incision was closed. Shortly after this the patient developed a sucking wound of the chest at the site of the entrance of the missile previously sutured. Closed drainage was established and the wound was packed tightly with vaseline gauze. The patient died at 2315 hours March 21.

**Comment:** The patient was clearly desperately wounded; he was resuscitated by 4 units of plasma and one blood transfusion. Although the blood pressure is recorded finally as normal, the pulse of rapid and only fair quality gives evidence of inadequate resuscitation. It is impossible to judge how serious the pneumothorax was; that seems to have been the cause of death or whether a bilateral pneumothorax may have been overlooked however the fall ure to surmount accidents during and soon after operation is characteristic of the bled-out patient resuscitated by plasma, without adequate blood replacement.

## PO VALLEY

Is 19 per cent below his calculated blood volume normal. If corrected for fluids administered he had lost since wounding 76 per cent of his normal blood volume, and 35 per cent of his normal hemoglobin.

**Comment:** Blood plasma, 2250 c.c. (9 units) and 3000 c.c. whole blood were used here for resuscitation. (In addition, blood was used liberally in the postoperative period to overcome the acute anemia and to promote wound healing.) Penicillin was available here but not for the earlier case. The tremendous blood loss emphasizes how dangerous it would have been in this case to have attempted to get along on plasma alone. Oxygen was available and used.

While these figures are from those of the Board for the St. dy 1 Th 8 ly Wounded (6) careful measurements of blood volume were first made in the Theater by Lieutenant Colonel John D. Stewart and Captain Frank Warner. Observation on the Severely Wounded in Forward Field Hospitals with Special Reference to Wound Shock (2).

Most of the serious problems of resuscitation of the wounded are in fact problems of the treatment of shock. Shock, in turn is a disability of the circulatory system that parallels (is caused by) loss of effective blood volume and of hemoglobin. The major problem, then is how can this loss best be overcome, at least to the point where the patient can withstand transport to and the necessary surgery at the most forward hospital. The account of resuscitation as dealt with here is, broadly speaking chiefly a history of blood volume replacement therapy in the general management of the wounded man. The history of resuscitation in this theater can be epitomized in the innovations made and their consequences in a description of several changing trends. Some discussion of the goals sought and the errors it became necessary to avoid will clarify the reasons for the innovations.

While differences in terminology in organization in evacuation, in resources technical and human vary so from World War I to World War II comparisons are in most cases useless; however the organization and mission of Field Hospital 127 in France in 1918 are said to have been comparable to that of the 33rd Field Hospital in the Mediterranean Theater in 1943 so the following table can be used for the valid illustration of a point.

	Field Hospital 27 1918	Field Hospital 33 1943
Number of days included	7	30
Cases admitted	250	297
Deaths without operation	4	0
Deaths after operation	34	56
Total mortality rate	20.3 per cent	18.8 per cent
Operative mortality rate	5.8 per cent	18.8 per cent

The interesting point in the table is the fact that all patients were prepared for operation in the 1943 group whereas 41 or 16 per cent never were considered to be ready for surgery and died without operation in 1918. There are chances for serious error in this type of comparison but there can be no doubt that striking differences in surgical management are illustrated here and that the key to these is resuscitation.

## GOALS SOUGHT

The final statement in Dickinson Richards's Harvey Lecture says, 'The greatest mis-

## BEECHER RESUSCITATION

take is to suggest, as some have done, that shock is a problem that has been solved (Certainly few therapeutic attempts can be said to be completely successful.) Dr Richards's point is a sensible one but there is another view that must be considered as well. In the report of the Board for the Study of the Severely Wounded, the statement is made

the results (of this study of battlefield casualties) have shown in a useful way what appears to be a quantitative relationship between blood loss and degree of shock long recognized but always in need of all the support possible in order to outride the ever recurring storms arising from suggestions that the cause of shock is mysterious and to be explained by toxins or the breakdown of some vague but vital force. To recognize the relationship of blood loss to degree of shock as a practical guide in treating patients is not to minimize the interest or the importance of the shock problems awaiting study, nor is it to undervalue the importance of applying the therapy we know to be effective. Too much preoccupation in the clinical treatment of patients with the unsolved problems of shock can have the indirect but very closely associated result of leaving the physician without access to adequate necessary equipment for applying the therapy well proved to be effective in the treatment of shock blood as needed. This was the unfortunate fact in Tunisia.

A shrewd estimate of the extent to which the patient has suffered from his wounds (15) is necessary for a correct appraisal of the therapy needed in order to enable him to withstand transport to the forward hospital. Once there his response to the journey and to subsequent therapy will give valuable information as to what support he needs to withstand the surgery necessary. When the patient has been rescued from the condition where organic damage may occur as a result of inadequate circulation a very important element in his care lies in the correct timing of resuscitative measures and of operation. These matters have been discussed by Beecher and Burnett (1944) (5) and by Beecher (3) 1945. Lulich (10) and Lulich and Mason (11) in detailed

reports described careful studies to aid in appraising the patient's condition and to guide in determining quantity and timing of fluid therapy as well as timing of operation.

INNOVATIONS AND THEIR CONSEQUENCES  
TRENDS

*Plasma*<sup>1</sup> The early difficulties of resuscitation in Tunisia (described below) are directly attributable to a mistaken concept of the limits of usefulness of human blood plasma. While there is no need to dwell upon this fact, long since corrected, any account of resuscitation would not be complete without some reference to it.

A misconception. The use of plasma suggested by Ward (1918) during the last war, but the agent did not become available then. Presumably this suggested use grew out of the belief that the method of blood transfusion then available, plus the hazards involved, offered too great obstacles to the widespread use of whole blood for resuscitating battle casualties, hazards that were too great to be allowable.

In Ward's communication (19), which was in the form of a letter to the editor of the *British Medical Journal*, he said, "There is abundant clinical and experimental evidence that it is not the corpuscles that are wanted, but the ideal fluid for keeping blood pressure at the proper level. A man dying from hemorrhage is not dying from lack of hemoglobin but from draining away of fluid, resulting in devitalization and low blood pressure."

These incorrect remarks were followed by the sensible suggestion that trial of plasma should be made and *controlled with the same number of whole blood transfusions*. Apparently this was not done.

Plasma<sup>2</sup> was recommended in 1939 as "an ideal substitute for whole blood in the emergency."

This article was written in Italy with little possibility of checking the references. All care possible has been taken to insure accuracy of quotation of spirit as well as of word. If error of fact or wrong emphasis has been made in the references given, this can be attributed to the circumstances, and is deeply regretted by the writer.

While one might have concluded from reading much of the literature of the period that the importance of hemoglobin had been forgotten, this was not everywhere the case. For example Klotz and DeBakey (9) emphasized the importance of hemoglobin (p. 777).



gency treatment of shock and hemorrhage from war wounds, by Tatum, Elliott and Nasset (17). Many other references could be given along this same line but there is no reason to do so. The changed point of view has been so well summarized by De Bakey and Carter (8) it may be quoted here rather fully.

Although the development of plasma has undoubtedly been a great contribution, its usefulness in shock therapy can now be viewed in proper perspective. Unfortunately, the early enthusiasm that accompanied this development was so forceful that it pushed aside sound clinical judgment and led to the widespread misconception that plasma could be used as an effective and complete physiologic substitute for whole blood in the management of shock in the seriously wounded. This misconception became so firmly entrenched in the minds of both administrative and professional personnel that it somewhat handicapped the organization and development of more effective measures for the management of shock. With increasing experience in the treatment of shock, it became more and more evident that plasma could not be used as a complete substitute for whole blood. It was found that while seriously wounded men could be brought out of shock with plasma they were frequently unable to withstand the life-saving surgery that was subsequently necessary. Superficially such patients appeared ready for surgery, but it was soon realized that this appearance gave a false sense of security for even movement of the patient, anesthesia, and other procedures in preparation for surgery often caused the patient to fall back into shock. It soon became evident that whole blood transfusion was essential for the proper resuscitation of these patients and that whole blood is the only therapeutic agent that will prepare seriously wounded patients to withstand the surgery that is essential for the saving of life and limb.

The now widely recognized misconceptions that plagued the early use of plasma should by no means obscure the remarkable value of the substance as a life saving innovation. It has superbly filled the need of supporting life while the patient is transported to a place where whole blood transfusion is feasible. It also is useful where blood concentration is present, chiefly in burns, in crushing injuries, and in some abdominal wounds. The shifting emphasis in the use of the agent is shown in the following section.

*Plasma and whole blood.* A detailed consideration of these agents will be presented by Lieutenant Colonel Eugene R. Sullivan in a history of the base blood bank. He also will

present a description of the available equipment for transfusing blood its inadequacies and shortages in the early Tunisian campaign responsible in part for the relatively infrequent use of whole blood during that period. A few sample figures may be given here.

In general, the records of the use of plasma are too inaccurate to justify detailed presentation. A few dependable samples of these are:

Use of plasma in the Tunisian campaign is shown in the following II Corps report for the period 1 February to 31 March 1943: number of casualties needing plasma, 972; per cent of casualties needing plasma, 34.3; unit consumption per 1000 for the period, 320.

In a sample of 431 seriously wounded men admitted to the hospital in the II Corps, January 21 1943 to February 28 1943, 101 patients received plasma (total quantity not stated) and 31 blood transfusions were given. In March 561 patients were admitted to Surgical Hospital No. 48, 741 operations were carried out, 97 whole blood transfusions were given.

These data contrast with the following also from seriously wounded patients (6): Pre-operative blood plasma, 3.08 units per man (based upon an average of 122 cases); blood plasma given during operation, 1.68 units per man (based upon an average of 10 cases); pre-operative whole blood, 1450 c.c. per man (based upon an average of 127 cases); blood given during operation, 1160 c.c. per man (based upon an average of 95 cases).

The average of these very seriously wounded patients thus received from the time of wounding until the end of operation 3 to 4 units of plasma plus 5 blood transfusions.

In a letter written by Lieutenant Colonel (now Colonel) Frank Berry, surgical chief of the 9th Evacuation Hospital to the Surgeon of the North African Theater of Operations on July 1 1943, the following data are of interest.

Date	Number of battle casualties treated	Number of blood transfusions given	Ratio of transfusions to battle casualties
March 1943	140	17	07.4
April 1943	1358	24	28.0
May 1943	207	27	14.7

# BEECHER RESUSCITATION

903

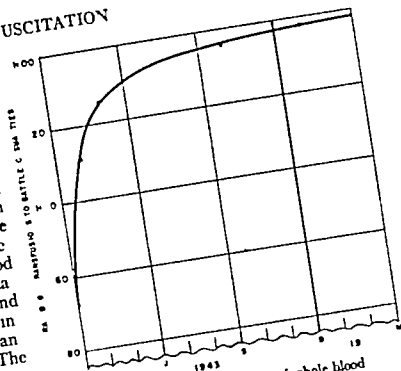


Fig 1 Showing increasing use of whole blood

standing the theoretically greater power of the albumin. The chief advantages of this agent center around its small bulk and ready availability for use in difficultly accessible situations where space and weight are at a premium.

## 'STABILIZATION' VERSUS RAPID PREPARATION OF BATTLE CASUALTIES FOR SURGERY

At about the time of the crossing of the Volturno River, when the fighting was quite heavy below Venafro early in November 1943, a new point of view began to appear in the shock tents of the Fifth Army to the effect that too much urgency was exercised in the preparation of the wounded for surgery. After 2 or 3 months this view had lost its negative character and during the prolonged fighting before Cassino, in the early months of 1944 it came to be stated in a positive way. In effect what was said was this: "The wounded get along better if surgery is delayed even after the blood volume and hemoglobin and blood pressure have approached normal." Patients were said to profit by some thing vaguely described as "equilibration or stabilization." What it was that happened merely with the passage of time was never very clearly defined. They just did better. And of course there is some basis for such a view although hardly as it came to be em-

This remarkable trend continued. In an average of the data from 8 evacuation hospitals for the first 100 days of the Italian campaign, beginning September 9, 1943, the ratio of transfusions to battle casualties was 1.45. For all Fifth Army Hospitals for January, 1944, the ratio was 1.24. The base blood bank was introduced in February and in March the ratio had changed to 1.19. The trend is rather strikingly shown in the figure. The rapid rise in the incidence of the blood used was due to two main factors: (a) realization that plasma alone was not adequate and that whole blood was necessary; and (b) increasing availability of the necessary organization and equipment for transfusion. The undramatic change shown between January and March of 1944, during which time the base blood bank began to function (February 23, 1944), does not justly characterize this important innovation. While it is true that blood in large volume was being obtained before the base blood bank was established, from local institutional blood banks, from local emergency bleeding as needed and by borrowing from the British the generally greater safety and uniformity of the blood bank is, of course not shown in a graph such as Figure 1. Moreover the ready availability of very large volumes of blood up to several liters for a given case is a very important consequence of the introduction of the base blood bank, emphasized by Lieutenant Colonel Sullivan's (16) observation that in the first 100 days of the Italian campaign the field hospitals cared for one-thirteenth of the battle casualties and used one third of the blood. A few of the very badly wounded used a disproportionately great volume of the blood.

Albumin Albumin was first used in the field in this theater by Beecher and Burnett 1914 (5). In some 200 patients no definitely significant untoward effects were observed. As expected on the basis of clinical trials in the United States, low blood pressure was elevated although transiently by the albumin. Clinically, one unit of albumin was found to be about comparable to one unit of plasma in its blood pressure elevating effect notwithstanding

ployed. Anyone could see that seriously wounded men who had been bounced over rough roads in a long ambulance haul, resting poorly often in great pain as the result of movement frequently arrived with rapid weak pulse and low blood pressure. With nothing more than 10 or 15 minutes of rest the blood pressure would rise and the pulse improve in quality. The chief gains to be obtained by rest at this stage of the patient's treatment are usually achieved in about 15 minutes. On the other hand as stated elsewhere (3)

the wound has set several continuing processes in action there is bleeding and plasma loss from serous surfaces and into traumatized tissues. Contamination leads to progressing infection. With these and other drains upon him the seriously wounded patient must have constant external support by way of blood and plasma. If as a principle, one can say that the smallest quantity of blood and plasma should be used that is compatible with the patient's well being then early operation appears desirable on this basis. Unquestionably delay in operation necessitates the use of larger quantities of blood and plasma to maintain the patient on an even keel than otherwise is the case. A further point is important in this connection. It has been well established in the cases of peritoneal contamination encountered in perforated peptic ulcer that the mortality rate rises sharply with the passage of time. With the grosser contamination met in warfare this is probably also the case. The passage of time is against the patient's good.

Beecher and Burnett 1944 (5) proposed following a study of 2853 battle casualties at Cassino and Anzio from which the shock cases 72 were filtered, that surgery be undertaken as early as possible and as arbitrary guides suggested that when the blood pressure is swinging up and is not below 80 millimeters of mercury systolic and the pulse rate falling if the patient's skin is warm and of good color that he be taken at once to surgery and what ever further blood administration is necessary be given during surgery *surgery being considered an integral part of resuscitation*. The results of this policy in the 2853 patients referred to were excellent, and while the proposal caused considerable discussion and disagreement at first, it has gradually come to be accepted as a satisfactory general working principle.

#### ERRORS TO AVOID

Any history of resuscitation in this theater would not be complete without some mention of the errors it was found necessary to avoid. The usual ones involved in poor medical care need not be reviewed here such as poor splinting inadequate protection from weather and so on rather several things will be mentioned here that are either new or have received new emphasis in the campaigns in this theater.

*Morphine overdosage* It very early became apparent in Tunisia that the half-grain (30 mgm.) morphine syrette was too large. Medical corpsmen in this campaign were permitted to administer morphine for the first time in the history of the United States Army. While some have attributed the difficulties with the half-grain morphine syrette to this fact, it was the general observation that medical officers seemed more often to be at fault in their over use of morphine than were the men.

In the cold wet early days of November 1943 it was repeatedly observed (2) that patients whose peripheral circulation was sluggish as a result of either chilling or low blood pressure absorbed subcutaneous or intramuscular injections of morphine slowly or not at all. This *delayed morphine absorption* too often led to the conclusion that the patient, who naturally got no effect from the unabsorbed morphine, was resistant to the drug and a second or third half grain was injected. This added drug had disastrous consequences when simultaneous and rapid absorption of all of the morphine injections occurred after the peripheral circulation was re-established as a result of resuscitation and the application of warmth.

The Surgeon of the Fifth Army established the rule late in 1943 that corpsmen were not to administer more than half of a morphine syrette. In addition to this, a vigorous educational program and the appreciation of the possibilities of delayed morphine poisoning all led to a sharp reduction in the accident of overdosage.

In a study (4) carried out chiefly on the Anzio beachhead, it was found on the basis of an extended factual inquiry that severe pain

<sup>1</sup>This had also been pointed out year earlier in civilian disaster (Cococant Grove) *Ann. Surg.* 94, 17

## BEECHER RESUSCITATION

is much less common in the severely wounded than had been supposed, and that those who wanted (in response to a direct question) further pain therapy even though no morphine had been administered for several hours were surprisingly few. It was observed that certain wounds, notably penetrating abdominal wounds, are far more painful than others, but that morphine is as likely to be given to a patient with little pain as to one with severe pain. The observation was made and subsequently confirmed throughout the Theater that the severely wounded are often in need of a modest dose of a barbiturate will control in some cases manic behavior formerly attributed to pain, and in many cases will obviate the need for morphine. As a generalization, the wounded were found to need small doses of both a sedative of a barbiturate type and of morphine. It was found that *this combination would often accomplish what large doses of either agent alone would fail to do*.

*Delay in evacuation.* It was not until in the Italian campaign that it came to be generally appreciated that too much time was consumed and too much handling of the patient undertaken by the too frequent insistence on an out of the ambulance checking of the patients at each stop along the evacuation trail. Not enough by passing of some installations was carried out in order to expedite the passage of the wounded man to the hospital where he could get emergency surgery. This problem is difficult to solve with the present evacuation system. Various suggestions have been made that this be critically reviewed and modified in the light of experience. It seems inevitable that men of little clinical experience must staff the forward (the collecting company, the clearing station) installations. Perhaps something can be accomplished by education. It is more likely that a major step toward solution of the problem will occur only when the opportunities are reduced for these young and eager men to exercise their in some cases not yet adequately trained judgment, that is, only when one of the way stations is eliminated. The rather constant average of a 5 hour interval from hospital entry to surgery in the case of the seriously wounded seems too long.

It was shown (5) that this could be reduced to 2 1/2 hours but in general not enough progress was made in cutting down this time.

*Overuse of plasma preceding hospital entry.* Notwithstanding earlier views to the contrary the truly vital importance of hemoglobin has been established. The administration of plasma preceding hospital entry beyond the point where the blood pressure is elevated enough to get the patient out of the critical shock level, will lead to renewed bleeding and perhaps critical loss of hemoglobin. Resuscitation by plasma alone can give a false appearance of well being in the patient and a false sense of security in his doctor, preserved as long as the patient is not subjected to any strain. The true weakness of the patient was often revealed in the early part of the Tunisian campaign (where large volumes of plasma were used without adequate blood transfusion), as soon as any strain was put upon him such as that due to anesthesia and operation.

## STUDIES INSTITUTED WITH A VIEW TO IMPROVING THE RESUSCITATION OF THE WOUNDED PATIENT

These studies can be grouped under five headings they have been reported in detail elsewhere.

The laboratory and clinical studies of Lieutenant Colonel John D. Stewart and Captain Frank Warner (6) those of Captain Joseph J. Lahich and Major James M. Mason, III (10, 11) those of Lieutenant Colonel Henry K. Beecher and Major Charles H. Burnett (5, 7) the observations of the Board for the Study of the Severely Wounded<sup>1</sup> and finally the observations that grew out of astute clinical observation alone for example those of Major Luther H. Wolff and Captain Troger F. Adkins (20) on tourniquets and Major Luther H. Wolff and Captain Robert D. Beech (1) on gastric dilation.

Less planned but equally important to the patient's welfare were the countless and inspiring examples of ingenious resourcefulness and devotion to the patient's well being shown on all sides. Examples of these impromptu

<sup>1</sup>Members of Board: Lieutenant Colonels Tracy B. Malloy, Florindo A. Simeone, Henry K. Beecher, and Eugene R. Sullivan, Major Charles H. Burnett, Captain Seymour L. Shapiro, and Louis D. Smith.

studies are too numerous to describe but one or two may be mentioned. Captain William Weiss's efforts to devise an apparatus whereby air or oxygen could be administered under positive pressure was one example from the early days in Tunisia. His efforts to devise a satisfactory suction apparatus were finally successful when he passed a tube from the operating tent to the windshield wiper of a truck parked outside. Justly celebrated was Captain Werner Hoeflich's preoccupation with any wrecked airplane that he could get his hands on in order to get the parts necessary to build a workable positive pressure apparatus to be used in conjunction with a breathing bag (basket ball bladder) he had obtained. Captain W. R. Turnbow made many ingenious improvisations for the care and safety of the patient in the operating room.

## REFERENCES

1. BECKER, R. D. and WOLFF, L. H. *M. Bull. Mediterranean Theater Operations*, 1945, 3: 86-189.
2. BELCHER, H. K. *J. Am. M. Ass.*, 1944, 124: 1193.
3. *Ibid.* *Ann. Surg.* 1945, 1: 769.
4. *Ibid.* 1946, 1: 596-606.
5. BELCHER, H. K. and BERNETT, C. H. *Bull. African Theater Operations*, 1944.
6. Board for Study of the Severely Wounded. Report of September 1944 to May 1945 in forward 5th Army Hospitals.
7. BERNETT, C. H., BLAND, L. F. and BELCHER, H. K. *J. Clin. Invest.*, 1945, 24: 657.
8. DELBARK, M. C. and CARTER, D. N. *Ann. Surg.* 1945, 121: 345.
9. KILDETT, R. A. and DELBARK, M. *The Blood Bank and the Technique and Therapeutics of Transfusions*. St. Louis: C. V. Mosby Co., 1943.
10. LALICH, J. J. Transfusion therapy in the battle casualty exhibiting evidence of circulatory failure. Report to Commanding Officer Second Auxiliary Surgical Group, June 20, 1941, later sent to Surgeon, Mediterranean Theater of Operations.
11. LALICH, J. J. and M. 1944 *J. M. Surgery* 1945, 18: 74-75.
12. PHALEN, J. A. The blood plasma program, National Research Council, Division of Medical Sciences. Issued by Office of Medical Information, 1944, July 15.
13. RICHMOND, D. W. JR. The circulation in traumatic shock in man. The Harvey Lecture Series, 1943, 44: 39-217.
14. STODOLSKA, HOWARD E. Care of the wounded. Report to Surgeon H Corps, 1943, Apr. 3.
15. STEWART, J. D. and WARREN, F. *Ann. Surg.* 1945, 122: 129-146.
16. SULLIVAN, F. R. Personal communication.
17. TATUM, W. L., ELLIOTT, J. and NABSET, A. *Mill. Surgeon*, 1943, 85: 481.
18. *Ibid.* Quoted by Phalen, loc. cit.
19. WARD, G. R. *Brit. M. J.*, 1948, 1: 301. Quoted by Delbark and Carter and by Phalen, J. A.
20. WOLFF, L. H. and ANDERSON, T. F. *M. Bull. Mediterranean Theater Operations*, 1945, 3: 23-25. *Bull. U. S. Army M. Dept.* 1945 (No. 87) 77-84.

# EDITORIALS

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## THE VALUE OF RED CELL TRANSFUSIONS

THE large scale preparation of plasma during the recent war made available considerable quantities of red cell resuspensions. The value of red cell transfusions in the treatment of anemia was recognized first in England and later in this country. Through the Blood Donor Service of the American Red Cross, red cell suspensions were distributed without cost to civilian hospitals in several urban centers. Over 15,000 red cell transfusions were given in the Detroit area alone. Red cells were also generally obtainable and had wide use in hospital blood banks where plasma was processed. Through these experiences red cell transfusions for the treatment of anemia have become a well established therapeutic procedure.

Red cells may be given in their concentrated form or isotonic saline solution equivalent to the amount of plasma withdrawn may be added. The hematocrit of a concentrated red cell

suspension averages 85 to 95 per cent which means that about 10 per cent of the plasma remains behind. This is sufficient to allow such a suspension to run freely through an 18 or 19 gauge needle. The flow is facilitated by raising the height of the suspension and by occasional agitation. Because of the small amount of plasma present concentrated type O cells can be given safely to recipients of any blood group. As a precaution the recipient's serum should always be matched against the donor's cells before use. Some authors have pooled the cells from two or three type O donors thus giving the recipient a large transfusion without changing bottles. Red cells remaining from blood that has been drawn into citrate solution should be used within five days. It has been shown that addition of a 10 per cent solution of corn syrup will preserve red cell suspensions for 14 to 21 days.

The main indication for the use of red cell transfusions is to raise the oxygen carrying power of the blood in patients with anemia. When anemia is associated with shock or hypoproteinemia whole blood certainly is to be preferred. In such cases however, red cell suspension supplemented with plasma should produce the same effect as whole blood. Toward the end of the war the superiority of whole blood over plasma in the emergency treatment of hemorrhage with shock became well recognized. In this regard, it is interesting to note that, in recent experiments on dogs red cell suspensions were more effective than plasma in overcoming shock produced by a single large hemorrhage.

For the treatment of anemia, red cell transfusions are as effective as an equivalent amount of whole blood. A similar rise in the erythro-

cyte count and hemoglobin value occurs and the survival period of the cells are the same with both types of transfusion. In many of the reported series of cases, the percentage of adverse reactions are somewhat lower with cells than with whole blood.

There are certain advantages of the transfusion of red cell suspensions over whole blood. Probably the chief advantage is the factor of economy. Blood obtained from professional donors has always been expensive and the supply from friends and relatives is often limited. Thus many patients do not receive the amount of blood necessary to restore the erythrocyte count to normal during periods of stress. As there will continue to be a demand for human plasma, it would seem desirable to divide the cost of whole blood between the plasma and red cells. Both products would then be more available to low income patients. Another advantage of red cell suspensions is the fact that type O cells can be given to recipients of any blood type. Type O whole blood with a high agglutinin titer in the serum is a potential source of danger when used universally. The reduced volume of concentrated red cell suspensions as compared to the original volume of the whole blood from which it is obtained also has advantages. The cells from one to two liters of blood can be given over a period of several hours thus causing rapid and marked increases in the erythrocyte count. In some cases it is desirable that sufficient blood be given to raise the erythrocytes and hemoglobin to normal over a short period of time. The danger of overloading the circulation is an important consideration in patients with cardiac disease or with anemia alone. Deaths due to cardiac failure may result from the rapid administration of blood to a severely anemic patient. This danger is lessened with the use of concentrated cell suspensions.

In the average hospital over half of blood

transfusions are given primarily for the treatment of anemia. These patients would benefit equally from red cell suspension transfusions. Because of the expense and unavailability of whole blood it is not uncommon for sick patients to receive only one or two pints of blood regardless of the degree of anemia. If red cells were available at a low cost they could be used more freely than is the present practice with whole blood. Preoperatively and postoperatively the erythrocyte count and hemoglobin level could be maintained at normal levels regardless of the amount of cells required. In patients with iron deficiency anemia the hemoglobin can be raised rapidly with cell transfusions as the transfused cells die off the iron released becomes available for the formation of new erythrocytes. Spontaneous recovery of the anemia following hemorrhage or the recovery of pernicious anemia with liver therapy requires about six weeks. Convalescence is greatly hastened in such cases by the transfusion of the red cells from one or two liters of blood. Red cell transfusions are ideal for patients with aplastic anemia and other blood dyscrasias where the rate of blood formation is less than that of blood destruction.

It is needless to say that red cell transfusions just as whole blood should be given only when clear cut indications are present. In individuals over 60 years of age erythrocyte counts of 4.0 million and hemoglobin values of 12 grams fall within the normal range. Nothing is to be gained by raising the erythrocytes and hemoglobin over these levels. By so doing the tendency to cardiac embarrassment and thrombosis is increased. Patients with a low grade static anemia as from sepsis or azotemia are probably little benefited by temporarily raising the red blood cell count. The dangers of transmitting hepatitis, malaria and syphilis are present with cell suspensions as with whole blood.

At the present time, red cell suspensions are not easy to obtain. The discontinuation of mass blood donation to the armed forces for the processing of plasma has eliminated this source of cells. Further Red Cross lyophilized plasma has been given to civilian hospitals throughout the country. Therefore there is little demand for fresh plasma from which the red cell residues ordinarily would be available. When the present supply of Red Cross plasma is exhausted, there undoubtedly again will be an extensive processing of plasma and the red cells can be salvaged. The increasing use for various protein fractions from human plasma is another potential source of red cells. When red cell suspensions again become plentiful they deserve general usage in the treatment of anemia.

HOWARD L. ALT

## ANEMIA IN BURNS

WITH the treatment of burns becoming sufficiently advanced to make it possible to keep the deeply and extensively burned patient alive the anemia of burns is being encountered more frequently and of a severity often incompatible with life. Previously accepted as rare and of little concern, it has emerged from obscurity during the period of war research to be defined to the extent that it should be predicted and forestalled.

As a result of recent study of the anemia of burns, more causes for it have been found than were heretofore considered. To external blood loss have been added the effect of heat upon the circulating red cell, the internal disappearance of cells presumably the result of widespread infection and inhibition of red cell regeneration. The obvious loss of blood from the granulating wound surfaces<sup>1</sup> and the

occasional finding of blood in the stools<sup>2</sup> had made it reasonable to ascribe the anemia to external blood loss. The presence of hemoglobinuria in victims of the Coconut Grove fire suggested to Shen and Ham<sup>3</sup> the probability of an internal breakdown of red cells as well. In these and subsequent patients they observed an increased fragility and abnormal spheroidal shape of the circulating red blood corpuscles. On the basis of experimental evidence in human and dog blood these abnormalities were ascribed to the effects of the heat upon those cells circulating in the periphery.

The findings of Shen and Ham have been elaborated by Brown of the Burns Unit under Colebrook at Glasgow<sup>4</sup>; the increased fragility of the red corpuscles was found to be limited to the hours immediately following the trauma. The increase was gradually supplanted by a subnormal fragility which lasted until the tenth day the normal level of fragility was passed at the thirty-sixth hour. The subnormal fragility was ascribed to the disappearance from the circulation of the more fragile cells. It was postulated from experimental observation that the volume of cells hemolyzed could amount to as much as 8 per cent of the original number present before trauma. The hemolysis of fragile cells was also correlated with the extent of the burn. Although increased fragility was found in patients with less than 15 per cent of the body surface burned, it was only in patients with burns of more than this extent that a decreased fragility and a subsequent anemia were discernible. An internal disappearance of red cells has also been demonstrated beyond that which can be accounted for by the hemolysis due to the burn trauma. Investigators of the Har-

HARRISON, H. N. *Surgery* 1938, 3, 608.  
 1. SHEN, S. C., HAM, T. H., and FURBER, E. M. *N. England J. Med.* 1943, 280, 701.  
 2. COLEBROOK, L., et al. *Studies of Burns and Scalds (Reports of the Burns Unit, Royal Infirmary Glasgow 1942-43)*. Medical Research Council, Special Report Series 249. London: His Majesty's Stationery Office, 1944.



vard Medical School and the Massachusetts Institute of Technology using precise methods for determining the red cell mass and pigment excretion have observed a massive disappearance of red cells in deeply and extensively burned patients in the first two months after injury.<sup>1</sup> The maximum loss observed was 318 cubic centimeters of packed red cells per day for the six days following injury. This loss was observed in a healthy young woman with a burn of 78 per cent of the body surface, 45 per cent of the surface being of full thickness destruction. From the fifteenth to the seventy-second day this same patient was found to be losing cells again and at the rate of 65 cubic centimeters of packed cells per day. Another severely burned patient, from the tenth to the eighteenth day after injury lost 191 cubic centimeters per day and from the nineteenth to the thirty-sixth day 74 cubic centimeters per day. The internal disappearance was not observed in patients with extensive partial thickness or only circumscribed full thickness burns and unexpectedly not in two elderly deeply and extensively burned patients who did not die until the eighth and tenth days after injury.

The origin of this internal loss or disappearance of red cells is obscure but since it appears only in patients with extensive deep burns, it is tempting to ascribe it to the infection of mixed organisms characteristic of the full thickness burn wound allowed to be fallow and separate its slough spontaneously. That it is not due to the trauma sustained by the red cells at the time of the burn is proved by the observation that cells transfused into the patient after the injury partake equally in the disappearance. For this determination tagged cells were used prepared by injecting volunteer donors with radioactive iron.

The fate of the vanishing red cells is also obscure. Although an excess of urobilinogen was found in the urine during the periods when the red cell mass was observed to be shrinking the excretion products of blood pigment accounted for but 10 per cent of the loss. The recent work of the Menkins<sup>2</sup> and of Wintrobe and his collaborators<sup>3</sup> suggests that the red cells and hemoglobin may be disintegrated at the inflammatory barrier.

The possible failure of red cell regeneration as a contributing cause of the anemia has also been explored by injecting radioactive iron into the burned patients.<sup>4</sup> The rate of red cell formation was judged by the rise in the level of radioactivity of the circulating red cells. In an unburned normal person 70 per cent of the radioactive iron injected is elaborated into the hemoglobin of the circulating cells at the end of eight days. In a patient with a severe burn the red cell formation may be reduced to less than a third of the normal.

The early anemia due to initial hemolysis and massive internal red cell disappearance must be differentiated from the pseudanemia of hemodilution which occurs from the third to sixth day after injury. The pseudanemia is due to an enlarged plasma volume and results from a resorption of wound edema at a rate in excess of renal excretion. The distinction between the true and false anemias is important from the point of view of therapy.

The treatment of the true anemia of burns is whole blood transfusions; the circulating red cell mass should be maintained as nearly complete as possible at all times. The treatment of the false anemia of burns is the curtailment

MENKIN, V. and MENKIN, M. F. *J. Exper. Med.* 1943, 53, 519.

CARTWRIGHT, G. E., LAUTNER, M. A., JONES, P. J., MENKIN, V. M., and WINTROBE, M. M. *J. Clin. Invest.* 1944, 23: 65.

CARTWRIGHT, G. E., LAUTNER, M. A., HUMPHREYS, E., JONES, P. J., MENKIN, V. M., and WINTROBE, M. M. *J. Clin. Invest.* 1945, 24: 41.

MOORE, F. D., PEACOCK, W. C., BLANKET, E., and COPE, O. *Ann. Surg.* 1945, 24: 811.

MOORE, F. D., PEACOCK, W. C., BLANKET, E., and COPE, O. *Ann. Surg.* 1946, 24: 811.

of fluid therapy Transfusion of the patient with a false anemia results in a further increase in blood volume and the danger of cardiac insufficiency and pulmonary edema. In the effort to forestall the true anemia of the extensively and deeply burned patient it is tempting to inject large volumes of whole blood in the first days after injury with the understanding that the blood given in the initial hours would be a part of the therapy for the burn shock Whole blood and saline solution instead of plasma have been recommended by Moyer and associates for the treatment of burn shock<sup>1</sup> Should the anticipated red cell destruction and anemia not be

realized, however, the excessive red cell mass will prove embarrassing To ascertain, therefore, whether whole blood is indicated periodic measurements of the plasma volume and red cell mass are required. The dye technique for these measurements is simple, accurate, and well established, the hospital caring for burn patients should provide the surgeon with this laboratory aid

Although we are able to predict and forestall the anemia of burns, we still do not know how to preclude the continued red cell disappearance Because the infection of the wounds is possibly an instrument of red cell destruction, expeditious closure of full thickness wounds and administration of polyvalent chemotherapy are not amiss

OLIVER COPE

Moyer, C. A., Collier, F. A., Iot, V., Vaughan H. H., and Mackey D. Ann. Surg., 1944, 120 367



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## THE BOOK SHELF

### DID CHOLERA DEFEAT CUSTER

PAUL R. HAWLEY M.D., Major General U.S.A. (Ret.) Washington District of Columbia

ON October 31 1848 the Swanton sailed from Le Havre with 280 steerage passengers, most of them German emigrants, and arrived in New Orleans on December 17 having lost 16 of her passengers en route with an intestinal complaint. She proceeded directly to her dock and discharged cargo and passengers. The next day one of the surviving passengers was admitted to Charity Hospital with a frank case of Asiatic cholera. Other cases followed in rapid succession the disease spreading among the inhabitants of the levee district. In less than 2 weeks there were from 40 to 50 deaths from cholera per day in New Orleans.

Within an incredibly short time practically every packet boat on the Mississippi River was infected and the epidemic spread to Memphis, St. Louis, Nashville, Louisville, Wheeling and Pittsburgh. On Christmas day 1848 victims of the disease were removed from a river boat in Cincinnati and taken to the General Hospital. During the winter weather sporadic cases occurred among the local population in Cincinnati but, when the weather turned warmer in Spring the disease burst forth in epidemic violence to disappear in the Autumn. It reappeared in June 1850 but with diminished fury.

For more than 25 years after the opening of the Santa Fe Trail in 1822 hostile Indians menaced its travelers. Along its middle reaches in what is now the State of Kansas the Pawnees were the fiercest but the Kaws who inhabited the valley of the Kansas River (about and north of the present Council Grove) while not warlike were assiduous cattle thieves and made frequent raids upon the wagon trains passing through their locality.

Fort Atkinson was established in 1850 on the Arkansas River about 6 miles above the site of

the present Dodge City. Its garrison afforded some protection in Southwestern Kansas, but the nearest Army post to the east was Fort Leavenworth on the Missouri River, almost 400 miles distant by trail. The Kaws, therefore were relatively free to plunder unguarded wagon trains.

The discovery of gold in California greatly increased the traffic over the Santa Fe Trail and the thuevery of the Kaws grew apace. Being unable to protect this section of the trail from his base of operations at Fort Leavenworth the Commanding Officer of the First Dragoons recommended to the War Department on July 31 1852 that another Army post be established 'at or near a point on the Kansas River where the Republican fork unites with it.' Acting upon this recommendation the Secretary of War, Mr. Jefferson Davis, directed that a Board of Officers be appointed to select the site for a new post in the vicinity of the fork of the Kansas River and late in the Autumn of 1852 a company of the First Dragoons escorted this Board to the spot where the Smoky Hill and Republican Rivers join to form the Kansas River.

It is interesting to note in passing that the temporary camp pitched there was named Camp Center because these officers knew at that early date that they were not far from the geographical center of the United States. That the Coast and Geodetic Survey of the United States was sufficiently accurate in 1852 for such a close approximation is surprising. For many years the monument marking the geographical center of the United States stood within the easy throw of a stone from the junction of the Smoky Hill and the Republican Rivers but later refinements in the survey have located the point about 100 miles away.

After the favorable report of the Board was approved and money was appropriated by the Congress, the construction of temporary buildings was begun at Camp Center. After the death of

Major General Hawley is Chief Medical Director Veterans Administration

Brevet Major General Bennett Riley in June of 1853 the new post was given the name of Fort Riley. The Congress that adjourned on March 3, 1855 appropriated funds for the expansion of the post with permanent buildings and the contract for this work was let to the firm of Sawyer and McIlvain, of Cincinnati. This firm prepared the millwork, procured the hardware and collected the artisans in Cincinnati, and shipped all by river boat to Fort Leavenworth, whence they were transported to Fort Riley by wagons. The Board had reported an ample quantity of good building stone at the site.

Work commenced on the new construction early in July 1855. Before the end of the month there were 2 deaths from a disease very like cholera. On the first of August the epidemic began in earnest. There were several deaths each day and the presence of Asiatic cholera was no longer in doubt. Panic seized the camp. The Constructing Quartermaster died of the disease. Workmen opened his safe with explosives, divided among themselves the gold it had contained for their pay and scattered over the plains. The Army doctor, fearing for the safety of his wife and family, deserted his post and drove away with them in an ambulance. For this he was tried by court martial and dismissed from the service.

The epidemic burned itself out rapidly; its fuel being depleted by death and desertion. Convalescents regained strength and were reinforced with new recruits from the East. Work was resumed and the post completed without further incident. Some of the survivors of the epidemic remained as permanent employees of the post.

George Armstrong Custer was graduated from the United States Military Academy on June 24, 1861, at the age of 21 years, and was commissioned a Second Lieutenant of the Second Cavalry, United States Army. Less than two years later he was a Brigadier General and within another year was a Major General commanding a Cavalry Division.

The surrender at Appomattox found Custer not yet 27 years old, a major general whose only future in the Army was a garrison life on a frontier post with occasional brushes with small bands of Indians. At that he fared far better than many of his older comrades who had served with distinction in the war. One of the new Regular regiments created in the reorganization of the Army was the Seventh Cavalry, and Custer was given the permanent grade of lieutenant colonel of this regiment—a grade which often required 30 years

to reach in the peace-time Army. Furthermore, the colonel of this regiment was employed almost all the time on detached service, and Custer held uninterrupted command of the regiment.

Until the Spanish American War the Army maintained the system of brevet rank in lieu of medals for distinguished service. The only military decoration was the Congressional Medal of Honor and achievements not warranting this decoration, and some that did, were recognized by conferring a brevet rank upon the officer. A brevet rank was, for practical purposes, only an honorary rank. Thus a captain could be brevetted, for successive deeds, a major, a lieutenant colonel, and even higher while remaining a captain. His command authority continued to be that of a captain, but he took precedence among captains by virtue of the date and grade of his brevet rank.

With his reduction to the permanent rank of lieutenant colonel in the demobilization of the war time Army Custer retained his brevet rank of Major General. It is necessary to remember this in order to understand the administrative maneuvers that occurred when the selection of a commander for the expedition against the Sioux was under consideration.

The year 1867 found the newly organized Seventh Cavalry stationed at Fort Riley, Kansas, under the command of Custer. Garrison routine was broken by occasional forays against hostile Indians. Custer employed the slashing cavalry tactics of the period and was uniformly successful—on the surface, at least—in his encounters with Indians. His favorite method of attack was a mounted charge through the Indian camp, launched before the warriors had recovered sufficiently from the surprise approach of the troops. It has been alleged that rarely was a living creature—braves, squaws, or papooses—spared in these encounters.

During the summer of 1867 when the Seventh Cavalry was on an Indian-hunting expedition in what is now Western Kansas and Eastern Colorado, Asiatic cholera again broke out in Fort Riley. There was the usual panic that accompanied the appearance of this terrifying disease. The news reached Custer in the field and he became alarmed over the safety of Mrs. Custer who was living at Fort Riley.

Upon his own authority, he left the regiment in command of the next senior officer, and, with an escort of 100 troopers, Custer set off post-haste in a mule-drawn ambulance for Fort Harker near the site of present Ellsworth, Kansas, whence he boarded a train for Fort Riley. For this violation

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of the Articles of War, charges were preferred against Custer and he was ordered to appear for trial by a general court martial.

The initial charges were that he had without authority left his command—in other words, had been AWOL. But now that the hitherto untouchable favorite of higher commanders had made himself vulnerable, past offenses—the knowledge of which had rankled in many breasts for some months—were brought to light. Additional charges were preferred. It was alleged that, during the dash across the plains to Fort Harker his small rear guard of troopers had been attacked by Indians and that he had pushed on without sending assistance back to them. There were casualties and the question was raised as to whether or not some of the living troopers did not fall into the hands of the Indians.

It was an unpardonable sin in the unwritten code of Indian warfare to abandon any living soldier to the mercy of the Indians. The whole force must be risked to save a single trooper. Yet Custer was to be accused, although not formally of a repetition of this offense at the Battle of the Washita a little more than a year later. There it was said Custer abandoned Major Elliott and a detachment who had been cut off while making a flank attack in obedience to orders.

Whether or not these accusations were true—and there can be no doubt that they were true at least in part—and whether or not, if true, the acts were justifiable, the respect and affection of a considerable proportion of the regiment were alienated. So long as Custer commanded it thereafter the Seventh Cavalry was not a happy outfit.

And then there were incidents on the march of the regiment to Colorado. The Morning Reports of the regiment during this period are evidence of an unhealthy state of discipline in the regiment. There was scarcely a night during which one or more of the troopers did not desert on the trackless plains infested with hostile Indians, armed only with their carbines and a few rounds of ammunition. To desert under such unfavorable conditions one must have compelling reasons.

One afternoon the regiment made camp within several hours of daylight remaining. Without waiting for the protection of night, some ten or twelve troopers "went over the hill." A few took their mounts, others went on foot. Their departure was soon discovered, and some of them were seen in the distance. A specification of one of the court-martial charges against Custer alleged that he ordered the Officer of the Day to pursue the deserters with the guard and to shoot them down

without quarter. The guard set out at once. A few of the deserters were captured and brought back to camp. Two of these had been shot and were seriously, though not critically wounded. It was further alleged that Custer directed the wounded men to be placed in a wagon, and that he forbade the regimental surgeon to go near them or provide any medical care for them.

The court martial convicted Custer and sentenced him to loss of rank and pay for one year. Custer served this sentence and rejoined his regiment in 1868, but the reputation of the "boy general" was tarnished. The effect of this humiliation is apparent during the remaining years of his life. He had been, in his own estimation the victim of persecution by small jealous competitors. The giant had been severely wounded, and the wound festered leaving an ugly scar. His pride had been leaving an ugly scar. This scar could be made less noticeable less disfiguring, only by repolishing his reputation to a brilliancy that would blind the public to the defect.

Custer's first effort to re-establish his importance was unsuccessful. His second effort was fatal. His first opportunity came when the scandal of President Grant's administration exploded. Belknap, Grant's Secretary of War, was accused of selling positions, among them the positions of post trader on Army posts. The post trader's store was the prototype of the post exchange. It was a private concession, the profits of which often were huge. Custer accepted the invitation of the Senate Investigating Committee to testify against the Secretary of War. Here was his opportunity to have revenge on the "brass hats" in the War Department—and he made all that he could of this opportunity.

But all that he could was not enough. He knew little of his own knowledge. His testimony was mostly hearsay, and would not have been admissible under any rules of evidence. On the one point on which he testified as having personal knowledge he was wrong, and afterward had to retract his testimony. But he had taken advantage of the opportunity to release some of his spleen. This was in March 1876.

President Grant, never condoning dishonesty nor protecting malefactors, nevertheless was not pleased with this gratuitous attack upon one of his cabinet officers. Especially did he resent such conduct upon the part of an officer of the Regular Army—and more especially because it was apparent that the intent of the attack was merely to smear one of his appointees rather than to offer any acceptable evidence of malfeasance. The

President, however took no action at the time. But he remembered and he did not have to remember very long

In 1868, the United States Government entered into a treaty with the Sioux Nation which guaranteed the Indians a large territory, in what is now the Dakotas, to have and to hold in perpetuity. No white men would be permitted to encroach upon it. This land was not considered valuable to or particularly usable by the white man, and there was no reason why the Indian should not have it in exchange for his promise to relinquish all claims to much more valuable lands elsewhere.

But unfortunately it was not known at the time that there was gold in the Black Hills. When this was discovered, the situation was altered. The white man had been "gypped." The fact that he had not known of the presence of the gold when he signed the treaty obviously made the treaty null and void. Any lawyer could prove that.

So with the discovery of gold, the whites rushed to the Black Hills. The Indians protested this treaty violation to the Government but the Government was deaf. So the misguided Indians decided to take the matter into their own hands. Any white could have told them that this was a mistake, but the obstinate Sioux were in no mood to listen to reason.

It is not necessary to describe the several tribes of Indians that constituted the Sioux Nation. It is only necessary to point out that there were eight principal tribes in the Nation, and that allied with these were the separate tribes of Cheyennes and Arapahoes. The social organization of the Indian was not sufficiently developed to permit of either large or permanent alliances. So it is a measure of the intensity of the Indians' resentment of this injustice that they were able to perfect an effective alliance of many tribes, and to hold it together for a considerable time.

Two great Indians were largely responsible for the success of the alliance—Sitting Bull the Hunkpapa medicine man, and Crazy Horse, the Oglala warrior the greatest tactician ever produced by Indians. Our distorted histories have created the common misimpression that Sitting Bull was the great warrior chieftain of the Sioux. This is not true. He was their great demagogue. But whenever there was any fighting Sitting Bull repaired promptly to his tepee and occupied himself in making medicine. It is doubtful that his name derived from his posture and his professional incantations, but it is certainly a coincidence.

Active resistance on the part of the Indians commenced in 1875 when they began to commit a series of what, in recent times, are known as overt acts. They roamed beyond the borders of the reservation—their own reservation, within the borders of which the white men were roaming in violation of the treaty. They murdered they pillaged. They were fighting an undeclared war.

The situation worsened steadily until in the spring of 1876 the Government decided it could no longer ignore such open rebellion on the part of its wards. An expedition was planned, the purpose of which was to quell the uprising and force the Indians to return to their reservation.

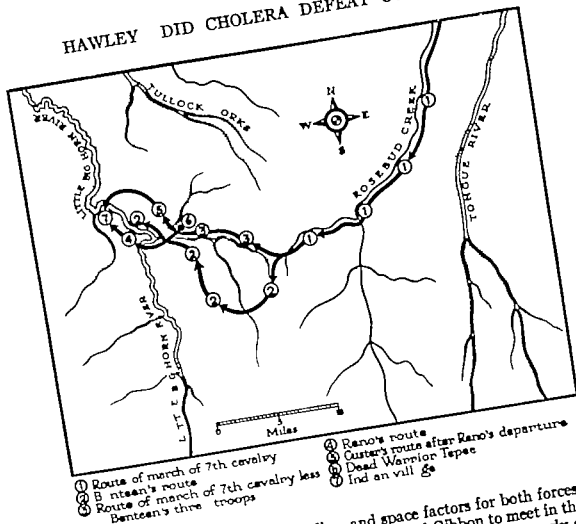
This expedition was planned to consist of three columns of troops: a column under Crook to move northward from Fort Fetterman on the North Platte River (in what is now Converse County Wyoming) a column under Gibbon to move eastward from Fort Ellis (in what is now Meagher County Montana) and a column under Custer to move westward from Fort Abraham Lincoln, located just across the Missouri River from Bismarck, North Dakota.

The plan was submitted to President Grant. He approved the plan but with one important exception. Custer would not be permitted to command any part of the expedition. In fact, he would not even be permitted to accompany his regiment on the expedition. The President had had enough of this publicity hound who thought nothing of embarrassing his Commander In-Chief in order to promote his own reputation. The chicken of the testimony in the Belknap case had come home to roost.

General Alfred Terry was selected to command both the expedition and the column from Fort Abraham Lincoln. Custer made frantic efforts to be reinstated but only after the kindly intercession of General Terry did the President relent, and then only in part. Custer could go along in command of his Seventh Cavalry but he could not command a column—although his rank might entitle him to the command of the eastern column under the over-all command of Terry. Thus Custer's escutcheon was marred by another spot—and such spots were intolerable to George Armstrong Custer. This one, too, must be polished out at the earliest opportunity.

The eastern column left Fort Abraham Lincoln on May 17 1876. By the 10th of June it had reached the Yellowstone River at a point not far from the location of present Miles City Montana. Terry had made contact with Gibbon and began to plan the further operations. Crook had not yet been heard from—and was not to be heard from

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for some time because Crazy Horse with a well armed well-controlled force was to meet Crook's column on June 17 and treat it so roughly that it had to turn back to camp to lick its wounds.

The location of the Indians had not yet been discovered and Terry ordered wide reconnaissances of the area. Custer's cavalry searched many square miles during the next week. Some traces of Indians were found but no Indians. By June 21 Terry had enough information to prepare further plans. Gibbon was to cross the Yellowstone River and march up the Big Horn and Little Horn valleys. Custer was to lead the Seventh Cavalry up the valley of Rosebud Creek to ascertain the direction of an Indian trail which had been previously reported.

Terry's orders to Custer were in writing. They were clear. If this Indian trail led across the divide into the valley of the Little Big Horn Custer was not to follow it, but was to continue on southward for the dual purpose of exploring the area of the headwaters of the Tongue River and of cutting off the escape of any Indians that might be flushed by Gibbon as he marched up the Little Big Horn. After reconnoitering the upper reaches of the Tongue, and then only Custer was to turn westward cross the divide, and march down the Little Big Horn toward Gibbon. Estimating the time

and space factors for both forces, Terry expected Custer and Gibbon to meet in the Little Big Horn valley late on June 26 or early on the 27th.

Custer set off on June 22 with his entire regiment of twelve troops of cavalry—approximately 600 strong—and with some forty friendly Indian scouts. Before they left Terry offered to reinforce the Seventh Cavalry with a Gatling gun battery and four additional troops of cavalry from another regiment. But Custer declined the offer—an action which seems most significant in the light of the subsequent events. Was it that Custer had already decided to do the job alone not sharing the glory with anyone?

By the evening of the 24th Custer had found the Indian trail he was seeking and had also learned that it did cross the divide to the valley of the Little Big Horn. His next duty was clear. He should have reported this fact to Terry by courier and continued his reconnaissance to the south. But here was the opportunity to show the world that George Armstrong Custer assisted only by his own regiment of cavalry was more than a match for all the Indians on the plains. Why should he share the glory with Terry, Crook and Gibbon? He would show the President, the War Department, and all the people who had persecuted him in the past, just how unjust they had



been—just how greatly they had underestimated him. He would destroy the Sioux alone and unaided. The Lord had delivered them into his hands, and who was he to defy the Lord by passing up this opportunity to reinstate himself as a national hero?

So at once during the hours of darkness, the Seventh Cavalry began following the Indian trail leading into the Little Big Horn valley. Custer halted the regiment in the early hours of the morning until his Indian scouts could send him more information. But it was daylight before the Indian camp was located. Custer's previous experience had taught him the incalculable advantage of surprise—to steal upon a camp in the night and deliver a smashing attack in the early dawn before the Indians were even aware of his presence.

Should he now conceal his command during the daylight hours of the 25th approach stealthily during the night, and deliver his attack at dawn on the 26th? His military judgment said yes. But there was the possibility that Gibbon would have arrived by the morning of the 26th—and sharing this providential opportunity with Gibbon was unthinkable.

The regiment resumed its march in the day light. At noon Custer halted. He ordered Captain Benteen, with three troops, to make a reconnaissance to the left of the direction of march of the main body. The orders given Benteen were vague and they were further confused by additions and amendments. Benteen afterward testified before a Court of Inquiry that a strict interpretation of his orders would have required him to continue his reconnaissance until stopped by the Pacific Ocean but, fortunately, Benteen interpreted them reasonably rather than strictly.

Benteen left with his troops, and the main body continued along the Indian trail. Indian signs were fresher and there were more of them. About 2:00 p.m. the column reached a tepee beside the trail in which the body of an Indian warrior lay on a bier. Custer never knew it but this was one of Crazy Horse's braves who had died of wounds on the way back from the fight with Crook. In fact, the trail had been made by Crazy Horse's force.

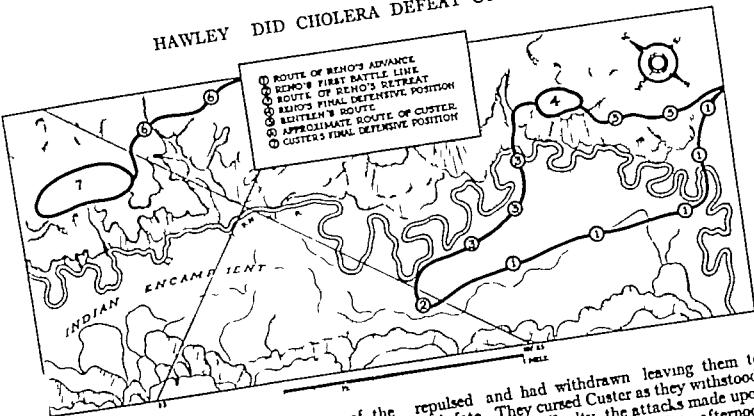
It was at about this point and this time that the Indian camp became visible in the Little Big Horn valley some five miles distant. Because of the rough terrain intervening little could be seen of the details of the camp or of the ground over which any attack would have to be made. No further reconnaissance was made, however. With no information as to the strength and disposition

of the Indians, and with practically no information as to the terrain Custer issued orders for the attack. Major Reno was to take three troops and advance rapidly toward the cloud of dust that marked the Indian camp and, as soon as he came within striking distance, was to charge the camp. Other than telling Reno that his little force would be "supported by the whole outfit," Custer gave him no information of his further intentions. Reno did not inquire because the relations between him and his commander were strictly official. There were many in the Seventh Cavalry who had never forgiven Custer for abandoning their comrades in previous Indian fights and the regiment was torn with schisms.

Without further word Reno set out. He had three miles to go to reach the Little Big Horn River, and this he made at a fast trot. He forded the river about three miles above the Indian camp and stopped to water his horses. Then he reformed his command in the fringe of trees along the river and began his advance on the camp. Two of his troops were in the front line with one following closely in reserve—a brave little band of 112 marching on several thousand Indians. After clearing the cover of the trees, they took up the trot. Soon hundreds of Indians were riding to their left, and firing on them from the flank and rear. Already Reno was confronted by many more Indians than his own little command numbered, and he was nowhere near the Indian main body. Reno halted, formed a dismounted battle line and assumed the defensive. He was driven back by hordes of Indians and, as he fell back, he pivoted on his right flank so as to place the river and the trees on its bank to his rear. The fighting increased in intensity. More and more Indians joined in. The cavalry were losing men rapidly, and it was apparent to Reno that they would all be lost if they continued the attempt to hold this position. He ordered the survivors to mount. The Indians dashed in and fired volleys at point blank range, throwing the troops into confusion. Reno ordered a charge into the mass of Indians. In the confusion, seventeen men were left in the strip of woods but the rest, led by Reno, literally cut their way through solid masses of Indians and then fled, with horses at a dead run, toward the ford at which they had first crossed the river.

But the Indians kept heavy pressure upon the right of the fleeing column, and it was unable to reach the ford. The troopers were forced across the river about a mile below the ford and they assembled on a nose of the bluff on the right bank of the river—here to make their last stand which it seemed evident, would be of short duration.

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No sooner had they reached the top of the bluff than they saw a column of cavalry approach ing over the high ground. Was this Custer? Was he belatedly coming to their rescue? No it was Benten with his three troops. It was a joyful reunion, in spite of the fact that it didn't alter the situation very much. Even with the addition of Benten's command they were still outnumbered twenty to one by the Indians. It could be only that more of them would perish.

"Where is Custer?", they demanded of Benten. But all Benten knew was that he had been recalled from his reconnaissance mission by a laconic message from Custer scribbled on a scrap of paper. Benten, come on. Big village. Be quick. Bring packs. Upon receiving this, Benten had turned back until he struck the Indian trail and had not even waited for the pack train to catch up. Hearing the sound of the firing in Reno's fight, he had cut across the country in its direction. He had supposed it was Custer with the rest of the regiment, who was engaged with the Indians. Where, then, was Custer? Had he abandoned them as he had abandoned parts of his regiment before? No one doubted that this had happened.

Shortly after Benten's arrival other sounds of firing were heard from the direction of the bluffs on the right bank of the Little Big Horn some two or three miles farther down stream. The firing was at first heavy but gradually lessened and finally ceased. Now the besieged band was certain of what had happened they decided that Custer had attacked the Indian village, had been

repulsed and had withdrawn leaving them to their fate. They cursed Custer as they withstood sometimes with difficulty the attacks made upon their little stronghold during the late afternoon and evening.

It was a long night. There was much commotion in the Indian village, but eventually this quieted and except for occasional shots fired by Indian snipers, the only sounds were the groans of the wounded and the muttered curses of the embittered soldiers while they waited for their last dawn.

As soon as the hilltops were light, the Indian attack was renewed with vengeance. Reno's little command was completely surrounded and the Indians were firing on them from all sides. When the Indians crept close enough to make their fire too accurate, the soldiers drove them back with courageous counterattacks.

This bitter fighting continued all morning. If Custer didn't come soon, all would be over. The arrival of the pack train in the late afternoon of the previous day had brought them plenty of ammunition but their water was exhausted and the sun was terribly hot. A few men, at very great risk crept to the river to fill their canteens but these dribbles were only enough for the wounded. The end was in sight.

Suddenly around noon the Indians broke off the attack. The soldiers could see the tepees being struck in the Indian camp. Pony herds were collected and the large force of Indians with their squaws and children, started slowly westward toward the Big Horn Mountains and gradually disappeared in the distance. That they were mysti-

fied by this sudden tactic of the Indians in no wise lessened the rejoicing of Reno and his men

Let us return to Custer as he sat on his horse near the Dead Warrior Tepee as it became known in history in the early afternoon of the 25th. He has already dispatched Benteen with three troops on a vague mission. He has just made his decision to attack and has started Reno with three troops more, on his mission. One troop is some distance to the rear guarding the pack train that is unable to keep up with the pace Custer set in his impatience to close with the Indians before Gibbon arrives. This leaves Custer only five troops—a total of about 225 officers and men.

He has divided his total force three ways—and this in the face of an enemy of unknown strength on ground that no one in his command has ever seen. It is not a happy situation. Perhaps Custer is not particularly pleased with it. But the urgency of the moment, the overwhelming desire to accomplish this coup without assistance carries more weight than the evident danger of disaster.

What Custer intended to do with the five troops, which he retained under his own control, can only be surmised. But the circumstantial evidence is rather convincing that he intended to move it down the right bank of the Little Big Horn (instead of crossing the river where Reno crossed) until he was opposite the Indian camp and there to ford the stream and charge into the village in a direction at a right angle to the direction of Reno's attack—in technical language an enveloping attack for which Reno should furnish the holding attack except that the mission given Reno went well beyond the usual scope of a holding attack.

Custer moved to carry out some such a plan. He soon found his column in very rough terrain, in which the high ground near the river was badly cut up by deep gullies, the axes of which were perpendicular to his line of march. This slowed up his march very much and explains why Reno had been fighting for more than one hour before Custer closed with the enemy.

For another reason the plan was doomed to failure from the start. Adjacent the Indian camp the right bank of the river was a steep cliff and the horses could never have reached the stream at this place. But Custer did not know this until too late—if indeed, he ever knew it. He made no reconnaissance and he knew nothing of the terrain.

As Custer's column was struggling across the narrow gullies in the hills opposite the Indian camp it was struck without warning by an overwhelming force of savages under Crazy Horse. From the mute evidence left by the bodies of men and horses, there can be no question that this attack had come as a complete surprise. One troop had been completely annihilated in march formation with scarcely a carbine discharged.

The white survivors of this initial assault had formed hasty lines of battle on the top of the ridge opposite the Indian camp. The arrangement of the defense had not been the best in the world but there had been no time to seek perfection. It would have made little difference. It had all been over in an incredibly short time. There were some carbines here, too that had not been fired often. Sometimes this was because the trooper didn't live very long. But many other times it was because the brass in the cartridge made by grafting commercial firms, was of such poor quality that the ejector tore through the lip without removing the spent case. When this happened the soldier had to punch the case out with his ramrod. This slowed his rate of fire which was slow enough at best because these were only single-shot weapons. The Indians, on the other hand, were armed with the most modern Remington repeating rifles which they had obtained in great numbers in exchange for fur and hides at the trading posts of the American fur companies. That it was a criminal offense to sell, barter or give a firearm to an Indian was no deterrent to these great American merchants.

How shall we evaluate Custer's actions on June 25, 1876, and how shall we account for them? Neither is possible with complete accuracy but both the evaluation and the explanation of his actions have been subjects of much speculation and many controversies.

As to judgment of his actions, hindsight is always more accurate than foresight. Monday morning quarterbacks are always successful. How much did Custer know when he made his plan of attack? This cannot be answered categorically. Custer was not on social speaking terms with many of his officers, and especially was not with Reno and Benteen who left the main body before Custer discussed its employment—if indeed, he ever discussed it with any of his officers. None in the five troops, that went with him to their doom, had the opportunity of recording any of his further orders. But there is ample evidence that his knowledge of the strength of the Indians was either false or entirely lacking—probably the latter. It is certain that he knew nothing of Crook's defeat

And no one with any knowledge of the terrain across the river from the Indian camp would have selected that area as the place from which to launch an attack. So it is safe to say that Custer knew very little about the situation when he ordered the attack.

This leads only to the conclusion that his action was unsound to the point of recklessness. This was no insignificant campaign against a small band of hostile Indians. The very size of the Army forces indicated that this was generally realized. Terry's instructions urged caution and joint action by the several commands.

Why then did Custer pursue this course of action? His defense of his abandonment of parts of his command in previous fights had been that the safety of the bulk of his command demanded such action. Why on this occasion did he risk the safety of his command by precipitate action by attacking in broad daylight at the sacrifice of the important element of surprise by launching the attack with woefully inadequate information? This, too, is anyone's guess, but motivation by an overwhelming desire to re-establish a reputation that had been sadly damaged by unwise exploits seems to me to be the most satisfactory explanation.

It is a curious chain of events that led to Custer's first difficulties with higher authority which engendered such bitter resentment on his part. How much this resentment governed his future actions may lie in the field of pure speculation, but there is evidence that it did exert a considerable influence. A few cholera vibrios slipped away from Europe with political refugees fleeing persecution. No sooner had their descendants arrived in America than they created havoc along thousands of miles of waterways and other highways of travel. Then, after having retired into obscurity for several years, succeeding generations again migrated hidden among artisans who were to build an outpost of civilization in the western wilderness, there again to emerge long enough to cause a minor disaster. Finally after twelve more years of inactivity they crept out once more from hiding to create in 1867, a situation which exerted a profound influence upon the life and career of George Armstrong Custer.

These generations of microbes traveled thousands of miles. They struck down hundreds of people, but the ultimate tragedy of their making it seems to me, happened in the valley of the Little Big Horn River almost three decades after they first came ashore in New Orleans.

## A PSYCHIATRIST LOOKS AT CUSTER

KARL MENNINGER, M D Topeka, Kansas

**D**R. HAWLEY has asked me as a psychiatrist to make some comments upon the psychiatric implications of his fascinating account. We are given a portion of the case history of a cavalry officer of about 45 who was killed in action. We have the following pertinent data. He was a man

1. Who stood 34th in his class at West Point.
2. Who was made a Major General at the age of 23.
3. Who achieved a certain amount of military distinction in the services of the Union Army where his actions were characterized by aggressiveness.

4. Who was noted for his ostentatious dressing and bad manners. (See J. C. Haskell and other references cited by Douglas Southall Freeman in *Lee's Lieutenants* New York, Charles Scribner & Sons, 944 pages 734 ff.)

5. Who at the moment of supreme victory (Appomattox, April 9, 1865) violated military etiquette in many ways, loudly demanding surrender from his defeated and inactive enemy (General Longstreet) while General Lee and General Grant were conferring. (Op. cit.)

6. Who "took care of" and refused to return famous pair of spurs given by General Santa Anna to the father of one of his friends. (Op. cit.)

7. Who in the name of warfare ordered and executed surprise attacks upon communities of men, women and children and slaughtered the women and children along with the men.

8. Who took his own wife with him to a frontier assignment and later became so worried about her that he was impelled to forget or neglect his military duties.

9. Who deprived wounded soldiers under his own command of medical and surgical attention.

10. Who disregarded the safety and welfare of his troops to the extent of sending them into hostile territory with insufficient military preparation and protection to their almost certain (and quite pointless) death.

11. Who was convicted of one desertion of his own troops and was suspected of others.

12. Who either committed perjury or at least gave incorrect damaging testimony in court to satisfy personal spite.

13. Who disobeyed specific orders given by the one friend he seems to have retained and the one General that favored him in his behalf.

14. Who presumably planned the sacrifice of the lives of

From Winter Veterans Administration Hospital Topeka, Kansas

the bulk of his command in order to attempt to achieve minor piece of personal military glory

These data describe a personality type only too familiar to psychiatrists, falling into a category of psychopathology typically characterized by excessive vanity, complete disregard for the feelings or safety of others, a lack of loyalty either to cause or to friends, either to the principles of humanity or to the established code of ethics, and a conspicuousness of achievement at times passing for success under circumstances where ruthlessness and boldness are to some advantage.

When this type of personality was encountered among the enlisted men in World War II, it was very apt to come rather promptly to the attention of the psychiatrists and such individuals were "boarded out" on Section VIII or the equivalent. But when a man wears stars on his shoulders, he can "get away with" things for which he would be court-martialed or hospitalized were he a private. This is not to imply that this happened often, but every time it happened it destroyed the morale, if not the lives, of thousands of men committed to the charge of such incompetent leaders.

Three corollary questions come to my mind.

First of all, what is to be said of the act of General Terry—a man whose name and reputation are completely unknown to me—who in spite of Custer's bad record, in spite of the court-martial, in spite of bad behavior in connection with the trial of the Secretary of War and in spite of General Grant's express wishes, insisted on giving a position of leadership and responsibility to a man like Custer?

In the second place, why does the name of Custer still stand in the mind of the average American as that of a great hero?

And thirdly—if by some accident of fate Custer had been successful in his disobedient and ill-planned attempt at coup, what would have been the verdict of history?

## REVIEWS OF NEW BOOKS

SINCE the text *La chirurgie en obstétrique* has been prepared for the use of the medical students at the University of Strasbourg, France, it is not particularly detailed in its presentation of the various subjects but strives instead to enunciate the principles of surgery as applied to common surgical conditions occurring in obstetrics. The line drawings prepared by the senior author, Dr Keller, aid greatly in the elucidation of the text.

Surgical treatment of genital abnormalities such as imperforate hymen, acquired sterility due to pelvic inflammatory disease, ectopic pregnancy, various types of phlebitis, inversion of the uterus and genital prolapse are a few of the topics discussed. The subjects of immediate repair of perineal tears and of epilation are not presented. In view of the omission toward whom this text is directed this omission would seem to be a definite oversight. A short discussion of genital prolapse is well done.

The subjects are definitely brought up to date.

Many subjects are definitely brought up to date. Ligation of the vena cava of the utero-ovarian plexus, of the internal iliac and of the common iliac are all mentioned under pelvic thrombophlebitis. Low cervical caesarean section is popular in Strassburg and is fully discussed. It is given a prominent place in the treatment of placenta previa and of cephalopelvic disproportion.

A plea is made in the preface for unified combined departments of obstetrics and gynecology for teaching, scientific research and clinical work. Strasbourg and Tarnier are the only such in France. It is stated that those having combined interests are the most observant and the most scientifically productive. Mention is made of the 1921 French Surgical Congress at Paris on Low Cervical Cesarean Section at which Schickel and Brindeau dethroned the classical section and it is further stated that such capacity and understanding presupposes a surgical education preliminary to obstetrical gynecological specialisation. With such training behind him he holds the scalpel." — VICTORIE LEPAGE.

MANY unrelated conditions from various fields of surgery are discussed in *Grandes problemas de clinica quirúrgica*.<sup>3</sup> Representative chapters include those on acute appendicitis, hyperthyroidism, cancer of the rectum, fracture of the wrist, gastric cancer, Buerger's disease, and diabetic gangrene. In all these and glandular ulcer and diabetic gangrene. In all there are thirty-one sections each devoted to a case presentation followed by a comprehensive discussion of all phases of the problem involved. There is a

"LA CONDUITE EN OBSTETRIQUE. By R. Koffer and J. Paris: Masson et Cie, Editeurs, 1946.  
 "GRANDES PROBLEMAS DE CLINICA GINECOLOGICA. By Velasco S. Santiago, Chile: Central de Publicaciones, 1943.

larger section on infection presenting the newer knowledge of the mechanisms of infection and immunity as well as the diagnosis and treatment of infection. The discussions are interesting with emphasis on the important points and the outstanding problems.

The discussions are interesting with emphasis clearly placed on the important points and the material is well organized from a didactic standpoint. The case presentations are careful and complete. There is little that is original and the volume will be of value chiefly for the teaching of fundamentals.

AURA P. DUKER

Unpublished Introduction

AURA P DUKE

THE small monograph of 208 pages entitled *Introduction to Surgery* by Frantz and Harvey presents in a clear concise manner the fundamental principles of surgery. There are six well arranged sections so grouped that the student may learn and quickly review the essentials he must know. The instructor of surgery will find the book most helpful if he insists that his students understand its contents. By so doing he can be assured that they have the background necessary to absorb whatever surgical subject he may teach.

As it is true that those who work in surgery should have an understanding of medicine, so too medical men could profit well by reading this book of surgical principles. The authors are to be congratulated upon their excellent and helpful contribution.

RUSSELL T. BOTHE.

RUSSELL T BOTHE.

THE text on gynecological diagnosis by Professor Neuweiler<sup>1</sup> of Bern combines painstaking thoroughness with strict observance of the limitations imposed by his title. In the first section he describes the proper method of taking the history and carrying out both general and special types of examination. There are excellent illustrations, particularly those of uterosalpingography in a variety of pathological states. The remainder of the book is devoted to the diagnosis of the various gynecological diseases, to their treatment, and to the prognosis.

The remainder of the book is devoted to the diagnosis and differential diagnosis of gynecological disease under headings subdivided according to their anatomical location. Descriptions are accurate and complete and illustrations are abundant.

The text presents the subject almost exclusively from an anatomical point of view. Endocrinological and chemical diagnostic methods are not discussed nor is functional gynecological disease. The volume should be helpful not only to the student learning practical gynecological diagnosis, but also to the practitioner confronted with the occasional diagnostic problem.

HOWARD ULFELDER,  
 Portland, Maine, M.D.

HOWARD ULFELDER.

INTRODUCTION TO SURGERY By Virginia Kneeland Frantz, M.D.  
and Harold Dorte Harvey M.D. New York: Oxford University Press  
1946.

LEHRBUCH DER GYNAKOLOGISCHEN DIAGNOSTIK FÜR ARZTE UND  
STUDIRENDE. By Dr. W. Neuwirth. Bern: Hans Huber 1946.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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## PRELIMINARY PROGRAM FOR 1947 CLINICAL CONGRESS NEW YORK SEPTEMBER 8 TO 12 1947

THE thirty third Clinical Congress of the American College of Surgeons will be held in New York at The Waldorf Astoria from September 8 to 12. Planning of the program is being resumed at the point at which it was discontinued last year when the New York meeting had to be postponed because of the arrangements for the United Nations Assembly. The plans made previously will be carried out for the official meetings, operative and nonoperative clinics, panel discussions, symposia, forums, medical motion picture showings, and technical and scientific exhibits. The twenty sixth annual Hospital Standardization Conference will also be held as part of the Clinical Congress, with a four-day program of panel discussions, symposia, and round table conferences.

### SIXTH NEW YORK CONGRESS

This will be the sixth time that the Clinical Congress has been held in New York. The first time was in 1912 when the old Waldorf Astoria was the scene of the third Congress. Dr. George E. Brewer was the Chairman and Dr. Charles H. Peck the Secretary of the 1912 Committee on Arrangements. Dr. Edward Martin of Philadelphia was then President of the Clinical Congress of Surgeons of North America. More than 2,600 physicians registered and the lack of organization for regulating the attendance at the clinics precipitated the proposal by Dr. Franklin H. Martin

at the business meeting on November 15 for the creation of the College. Later Congresses were held in New York in 1919, 1924, 1931 and 1938.

### CLINICAL PROGRAM

The hospitals and medical schools of Greater New York are co-operating in scheduling operative and nonoperative clinics. The program that they prepared last year under the guidance of the local Committee on Arrangements, when there was prospect of holding the Congress in New York, is substantially the same as that planned for this year with such revisions as seem desirable in view of scientific developments and changes in personnel. The preliminary program was published in the August, 1946 issue of SURGERY GYNECOLOGY AND OBSTETRICS, pages 275 to 288.

Visiting surgeons will have ample opportunity to attend well arranged programs of many different kinds in a number of the excellent hospitals in the New York metropolitan area. General and special demonstrations will be held on subjects such as fractures, cancer, maternal morbidity and end result studies, newer diagnostic and therapeutic procedures, preoperative and postoperative supportive treatment, anesthesia and conditioning. Clinicopathologic and x-ray conferences will also be held. The newer techniques and surgical procedures may be observed.

The medical schools will hold a series of exhibits demonstrating their work which will be on

# PRELIMINARY PROGRAM—1947 CLINICAL CONGRESS

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display in their affiliated hospitals. The program of each hospital will be arranged to cover subjects in general surgery, obstetrics and gynecology, fractures, orthopedic surgery, thoracic surgery, neurosurgery, genitourinary surgery and ophthalmology and otolaryngology.

## PRESIDENTIAL MEETING

On Monday evening in the Grand Ballroom the Presidential Meeting will be opened with the impressive processional of the officers, Regents and honorary guests. Welcome to the assembly will be extended by the Chairman of the Committee on Arrangements, Dr. Howard A. Patterson. Dr. Irvin Abell of Louisville, President of the College, will preside and will deliver the Presidential Address. An inaugural ceremony will be held for the incoming officers. Foreign guests will then be introduced.

The second Martin Memorial Lecture will be delivered. This lectureship was established upon motion of the Board of Regents at its midyear meeting on April 1, 1946 as a memorial to both Dr. Franklin H. Martin and Mrs. Martin. The founder of the College and of SURGERY, GYNECOLOGY AND OBSTETRICS was joined by his wife in making the College the beneficiary at their deaths of the Journal together with its physical plant operated by The Surgical Publishing Company of Chicago of which they were the owners. Doctor Martin died in 1935 and Mrs. Martin in 1945. The Martin Memorial Lecture is to be given annually during the Clinical Congress. It will deal with a scientific subject of the author's own choosing. It supplants the former Annual Oratorical Address in Surgery.

## CONVOCATION

The Convocation is scheduled for Friday evening, the plan of separating it from the Presidential Meeting having proved to be quite successful. At the 1946 Clinical Congress in Cleveland an Assembly of Initiates will be held prior to the Convocation on Friday in order to instruct them in the Convocation procedure and other matters.

The Convocation will open with a processional of officers, Regents, and Governors. The new President, Dr. Arthur W. Allen, will preside and will make the opening remarks, confer the honor ary fellowships, and present the candidates for fellowship. Following this ceremony the Fellow ship Address will be given.

## SCIENTIFIC SESSIONS

The scientific sessions, to be held on Tuesday, Wednesday and Thursday evenings, will be ad-

dressd by eminent surgeons and specialists recognized as authorities in their fields. Special scientific meetings will be arranged on the same evenings for specialists in ophthalmology and otolaryngology. The newest developments in general and special fields will be presented in the well rounded program.

Every afternoon, from Monday through Thursday, panel discussions led by recognized authorities in each field, aided by well qualified collaborators, will be held. Similar meetings held during past Congresses have been most successful, largely because they permit the participation of a large number of surgeons, thus increasing the opportunities to learn from the experiences of others.

Preliminary plans include the holding on one afternoon of a symposium on fractures and other traumas, and a symposium on cancer on another afternoon. There is always wide interest in these special meetings. Plans for several new features have been discussed but cannot be announced until definite decisions have been made in consultation with the Committee on Arrangements.

## FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

The Forum on Fundamental Surgical Problems will be conducted on Tuesday, Wednesday, Thursday and Friday mornings. Included will be brief reports of original clinical and experimental observations relating to the broad aspects of surgery and the surgical specialties. No prepared discussions of the reports are planned, but questions and comments will be invited. Dr. Owen H. Wanger, chairman of the committee, is working toward which is planning the program is working toward representation of as many as possible of the various university departments of surgery in this presentation of clinical and experimental research work.

The enlistment of the interest of young men who are doing original work, through the Forum, is one of the most beneficial results of these sessions which are now considered to be an indispensable feature of every Clinical Congress.

## HOSPITAL STANDARDIZATION CONFERENCE

The first formal session of the Clinical Congress will be the opening meeting of the twenty eighth Hospital Standardization Conference. Dr. Irvin Abell of Louisville, President of the College, will preside. The hospital conferences will continue on Monday afternoon with sessions following on Tuesday, Wednesday and Thursday mornings, afternoons, and evenings.

Hospital administrators, members of governing boards, heads of the various hospital departments



and their personnel, nursing groups, and many other persons directly or indirectly concerned about hospital progress will be interested in the discussion of current hospital problems. National organizations representing various groups of hospital personnel will co-operate and participate in the meetings, which will include formal sessions, panel discussions, round table conferences, and open forums.

#### ADVANCE REGISTRATION

The hospitals and medical schools of New York afford accommodations for a large number of visiting surgeons. However in order to insure against overcrowding attendance at the Congress will be limited to the number that can be comfortably accommodated at the meetings and also by accommodations in the hotels. It is therefore expected that surgeons who wish to attend the Congress will register in advance.

The members of the Board of Regents regret that conditions beyond their control will not permit unpaid registration at the 1947 Clinical Congress. They voted to restore the registration fee of \$5.00 for Fellows and for endorsed Junior Candidates. Non-Fellows attending as invited guests of the College will pay a fee of \$10.00. No fee will be required of initiates of the class of 1947.

To each surgeon who registers in advance a formal receipt will be issued. This is to be exchanged for a general admission card upon his registration at headquarters during the Congress. This card is not transferable and must be presented in order to obtain clinic tickets and admission to scientific sessions.

#### TECHNICAL AND SCIENTIFIC EXHIBITION

The technical exhibit, together with the registration and clinic ticket bureaus, will be located in the Basilcon Room, Jade Room, and Astor Gallery all on the third floor of the hotel. Leading manufacturers of surgical instruments, x-ray apparatus, sterilizers, operating room lights, ligatures, dressings, hospital apparatus and supplies of all kinds, and pharmaceuticals, and publishers of medical books will be represented in the exhibition.

#### HOTEL RESERVATIONS

Although the prospect is that the hotel situation in New York will be more favorable than it would have been last year nevertheless there is still a critical shortage of hotel rooms and early reservations are most desirable. In making these, it is urged that communications be addressed to the New York Convention Bureau, through which all reservations for the Clinical Congress are to

clear. No correspondence should be sent directly to the hotels. A letter will be received by all Fellows in which the procedure will be outlined, with which will be enclosed a form to be used in making reservations. First, second, third fourth, and fifth choices of hotels may be designated. The following hotels are recommended by the Committee

	Minimum rates with bath	
	Single	Double
Albion House, 143 East 39th Street	\$ 75	\$
Albion House for Women, 130 East 57th Street	3 00	
Ambassador, Park Avenue and 51st Street	6 00	
Astor Broadway and 44th Street	3 50	4 00
Barbison (Women) Lexington Avenue and 63rd Street	3 50	
Barclay, 111 East 48th Street	6 00	8 00
Belmont Plaza, Lexington Avenue and 49th Street	4 00	6 00
Beverly Lexington Avenue and 30th Street	5 00	
Billmore, Madison Avenue and 43rd Street	5 5	7 50
Bristol, 120 West 48th Street	3 50	3 50
Capitol, 5 st Street and 8th Avenue	3 00	4 50
Carlisle, Madison Avenue at 76th Street	6 00	
Chesterfield, 30 West 49th Street	3 50	4 00
Commodore, Lexington Avenue and 42nd Street	3 50	5 50
Concourse Plaza, Grand Concourse and 161st Street	3 50	5 50
Cornish Arms, 3 West 43rd Street	25	4 00
Delmonico, 502 Park Avenue	6 00	8 00
Essex House, 60 Central Park South	6 00	8 00
Fifth Avenue Hotel, 24 Fifth Avenue (9th Street)	4 00	6 00
Governor Clinton, 3 st Street and 7th Avenue	3 50	4.40
Henry Hudson, 353 West 57th Street	2 5	3 50
Kenmore Hall, 145 East 43rd Street	2 00	3 50
Lexington, 48th Street and Lexington Avenue	4 00	6 00
Luxor Baths Hotel, 121 West 46th Street	3 25	
McAlpin, Broadway and 34th Street	3 50	4 95
Martinsburg, Broadway at 32nd Street	75	3 85
Midston House, 22 East 36th Street	3 50	4 00
New Weston, Madison Avenue and 50th Street	4 00	7 00
New Yorker, 34th Street and 8th Avenue	3 85	5 50
Paramount, 46th Street, West of Broadway	3 00	5 00
Park Central, 7th Avenue and 55th Street	4 00	6 00
Parkside, 8 Gramercy Park South	2 75	
Pennsylvania, 7th Avenue and 43rd Street	3 85	5 50
Piccadilly, 27 West 45th Street	3 00	5 00
Plymouth, 143 West 49th Street	2 50	3 50
President, 224 West 48th Street	2 50	4 00
Prince George, 14 East 28th Street	2 50	4 00
Roosevelt, Madison Avenue and 45th Street	4 50	6 50
Shelton, 49th Street and Lexington Avenue	3 5	5 00
Taft, 7th Avenue and 50th Street	3 00	5 00
Times Square, 43rd Street and 8th Avenue	2 5	4 00
Tudor, 304 East 42nd Street	50	
Victoria, 7th Avenue and 61st Street	3 00	4 50
Waldorf Astoria, 50th Street and Park Avenue	7 00	
Warwick, 54th Street at Sixth Avenue	5 00	
Wellington, 7th Avenue and 55th Street	3 00	4 50
Woodstock, 27 West 43rd Street	3 00	5 00

# CLINICAL CONGRESS PROGRAM IN BRIEF

## Monday

- 9:30 General Assembly for Surgeons and Hospital Representatives, Grand Ballroom
- 1:30-3:00 Panel Discussion, Empire Room
- 2:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 2:00 Hospital Conference, Sert Room
- 2:00 Surgical Film Exhibition (General) Grand Ballroom
- 3:30-5:00 Panel Discussion, Empire Room
- 8:15 Presidential Meeting, Grand Ballroom

## Tuesday

- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Hospital Conference, Sert Room
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat), Jensen Suite
- 10:00 Surgical Film Exhibition (General) Empire Room
- 10:00 Panel Discussions
- 11:00 Panel Discussions—Otorhinolaryngology
- 1:30-3:00 Panel Discussion, Grand Ballroom
- 2:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 2:00 Hospital Conference, Sert Room
- 2:00 Symposium on Fractures and Other Traumas, Grand Ballroom
- 2:00 Surgical Film Exhibition (General) Empire Room
- 3:30-5:00 Panel Discussion, Grand Ballroom
- 7:00 Surgical Film Exhibition (Eye Ear Nose and Throat), Empire Room
- 7:30 Hospital Conference—Trustees, Sert Room
- 8:00 Scientific Session General Surgery Grand Ballroom
- 8:00 Scientific Session Ophthalmology Jensen Suite
- 8:00 Scientific Session, Otorhinolaryngology Le Perroquet Suite

## Wednesday

- 8:00 Meeting of Cancer Committee, Carpenter Foyer and Dining Room
- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Hospital Conference, Sert Room
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat), Empire Room
- 10:00 Surgical Film Exhibition (General) Empire Room
- 9:30 Executive Committees } Empire Room
- 10:15 Credentials Committees and Applicants Committees on Applicants } Empire Room
- 11:00 Judiciary Committees } Empire Room
- 11:00 Panel Discussions
- 11:00 Panel Discussions—Otorhinolaryngology
- 12:00 Meeting of Board of Governors, Jensen Suite
- 1:30-3:00 Panel Discussion, Grand Ballroom
- 2:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 2:00 Symposium on Cancer Empire Room
- 2:00 Surgical Film Exhibition (General)

- 2:00 Hospital Conference Sert Room
- 3:30-5:00 Panel Discussion, Grand Ballroom
- 7:00 Surgical Film Exhibition (Eye, Ear Nose and Throat), Empire Room
- 7:30 Hospital Conference, Sert Room
- 8:00 Scientific Session, General Surgery Grand Ballroom
- 8:00 Scientific Session (Eye, Ear Nose and Throat) Empire Room

## Thursday

- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Hospital Conference, Sert Room
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat), Empire Room
- 10:00 Surgical Film Exhibition (General) Empire Room
- 11:00 Panel Discussions
- 11:00 Panel Discussions—Otorhinolaryngology
- 1:30 Adjourned Meeting, Governors, Grand Ballroom
- 1:45 Annual Meeting Fellows, Grand Ballroom
- 2:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 2:00 Hospital Conference, Sert Room
- 3:00 Panel Discussion—Graduate Training in Surgery Jensen Suite
- 3:30-5:00 Panel Discussion, Grand Ballroom
- 3:30 Surgical Film Exhibition (General) Empire Room
- 3:30 National and Regional Fracture Committee, Le Perroquet Suite
- 4:00 Committee on the Library Room 4 J
- 4:00 Surgical Film Exhibition (Eye, Ear Nose and Throat), Empire Room
- 7:00 Surgical Film Exhibition (General) Empire Room
- 8:00 Scientific Session General Surgery Grand Ballroom
- 8:00 Scientific Session, Ophthalmology Empire Room
- 8:00 Scientific Session, Otorhinolaryngology Sert Room

## Friday

- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat), Empire Room
- 10:00 Surgical Film Exhibition (General) Empire Room
- 1:30 Assembly of Initiates, Grand Ballroom
- 1:30 Panel Discussion, General Surgery
- 2:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 2:00 Panel Discussions
- 2:00-4:00 Panel Discussions
- Obstetrics, Sert Room
- Plastic Surgery 4 U Blue Room
- Neurological Surgery Assembly Room M N
- Thoracic Surgery Jensen Suite
- Urology Le Perroquet Suite
- Orthopedic Surgery Carpenter Foyer and Dining Room
- 2:00 Surgical Film Exhibition (General) Empire Room
- 3:30 Panel Discussion, General Surgery
- 8:15 Convocation, Grand Ballroom

# BOARD OF REGENTS OF AMERICAN COLLEGE OF SURGEONS CONSIDERS DELAYS IN APPOINTMENTS TO HOSPITAL STAFFS

COMPLAINTS having come from several sources about difficulties being placed in the way of returning medical veterans who were applying for hospital privileges, the Board of Regents of the American College of Surgeons at a meeting in Hot Springs, Virginia, on April 24 carefully considered the problem of helping veterans and other younger surgeons in obtaining appointments. Several specific cases of seemingly unjustifiable delay were studied, together with such contributory hospital conditions as the existing shortage of beds and long waiting lists of patients. The result of the deliberation was the presentation and adoption by the Board of Regents of the following resolution

WHEREAS it has come to the attention of the American College of Surgeons that many well trained surgeons, especially returned veterans, who have located or have signified their intention of locating in communities where there are hospital facilities have been denied hospital privileges until they had been in residence in that locality for six months to a year

BE IT RESOLVED that the Board of Regents of the American College of Surgeons disapproves of the practice and although fully cognizant of the shortage of hospital beds, the Board believes that such well trained competent, and ethical individuals should be given similar opportunities as offered established medical practitioners of the community

May, 1947

**SURGERY**  
**GYNECOLOGY AND OBSTETRICS**  
*Supplement*

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## COLLECTIVE REVIEW

### THE TREATMENT OF INJURIES OF THE SPINAL CORD

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**D**URING the decade just past there has been a mounting interest in the problem of the patient with traumatic paraplegia, and the literature has been swollen with the opinions of general surgeons, orthopedic surgeons, neurosurgeons, neurologists, pathologists, and physical therapists, as well as of those interested in the complications of these injuries, such as the plastic surgeons and urologists. The record attained in the treatment of these patients in World War I is not a very enviable one, and it is quite apparent that the methods of treatment of traumatic paraplegia were not improved by the rich experience of that war. In the succeeding years the majority of the patients were injured in industrial or traffic accidents, and the greater part of the injuries were of the closed fracture-dislocation type. With the advent of World War II and its tremendous number of patients with injuries of the spinal cord from every conceivable cause, a second opportunity for improvement in methods of treatment was at hand. To judge from the number of reports alone, one must conclude that a renewed interest in the subject of traumatic paraplegia has arisen out of the earnest effort of the medical corps of the United States Army and Navy to meet the challenge of the care of these tragically injured patients. It is quite apparent, as might be expected, that all military care was not ideal; it is also apparent that the civilian standards of care have left and still do leave much to be desired. The present literature is not 100 per cent assuring, but the current general

methods of treatment are for the most part in accord; they are based on sound surgical principles and a knowledge of physiology and they have been matured by the recent experience of the war.

This review has to do with the subject of treatment only and is concerned only with those patients in whom the spinal cord or cauda equina was injured and not with spinal injuries alone. The literature from 1936 to 1940 is noteworthy for its paucity of new ideas or fresh statements. However with the war there came a deluge of reports, some good, many bad, but all with undeniable fervor. Many authors have made the mistake of prefacing an otherwise good paper with long and tedious accounts of the anatomy and physiology of the vertebral column and the spinal cord—an undertaking invariably better handled by the average text of anatomy. Over and over again the reader is forced to review the mechanism of the flexion injury to look at time-worn diagrams and reproductions of roentgenograms. One encounters hobbles which have been ridden until they are irritating. But the whole composite, taken, sifted, and digested, is bound to leave the reader with something new, appealing, useful, and hopeful.

One encounters at every turn in the expressions of all authors the same recurring questions. When shall decompressive laminectomy be done? What are the criteria for operation? How can the spinal deformity be best reduced, by the closed method such as the Taylor method, or by the traction methods with a chin halter or the Crutchfield tongs in the cervical injuries? Are casts ever to be used when there is severe neural injury? Of what prognostic value are the reflexes? What are the

From the Department of Surgery Northwestern University Medical School, Chicago, Illinois. A review of the literature from 1936 to 1946.

disasters resulting from the transportation of the injured patient, and how are they to be avoided? How long must the injured spine be immobilized in the various types of fractures? (Opinions vary from 6 weeks to 12 months) What is the best method for the care of the paralyzed bladder? How far should surgery go in the correction of spasticity, spasms, and pain? Is surgical repair of the cauda equina feasible? To judge from the lack of agreement between writers whose opinions must be respected, one would at first gain the impression that nothing new is gained, nothing old has been solved. Yet that is not the case. The treatment of the paraplegic patient has improved immeasurably during the past 10 years, and it is still improving.

#### THE EARLY PHASE OF TREATMENT

*First aid transportation* "The management of a patient who has a spinal injury should begin at the scene of trauma" (78) "Proper early care depends upon proper early diagnosis" (12) Those and many other authors (1 11 21 22 51 57 59 76 80 82 91 100 115) have stressed the importance of intelligent early treatment of the patient with an injury of the spinal cord. Well intentioned but bungling first aid workers, resuscitating squads, anxious relatives, policemen, and even bystanders at the scene of an accident may by their improper handling of the patient, add irreparable damage to an already injured spinal cord by their insistence on doing something for the injured person. As in any other serious injury, there is seldom great need for special haste in moving the patient, and care mixed with emotional stress is likely to result in further disaster. Palmer pointed out that any unconscious patient who may have received a spinal or spinal cord injury should be treated exactly as if he were known to have been so injured, until the actual extent of injury can be ascertained, and others, as Thomson, have warned against the danger of increasing the jackknife deformity by lifting the patient improperly or without sufficient help. The simple instruction stated by Davidoff that the first point of emergency treatment is to leave the patient flat on the ground, right where he originally lay until proper help and means of transportation are available, is perhaps the most important and altogether sane procedure that can be advised, for Davidoff as the others, is most concerned with the additional trauma that can be caused by loosened vertebrae and bone fragments when the patient is moved. It is stressed by many who have had the early care of such patients that at least 3 and preferably 4, persons are required to

lift the patient with an injured spine, and if there is injury to the cervical spine or cord, an extra person is needed to hold the head in a fixed, slightly extended position throughout all the maneuvers of moving.

Many patients with recent fracture of the spine, with or without cord injury, suffer severe root pains at the segment of injury. Authors are disagreed upon the subject of administration of morphine to relieve the pain. Coleman and Pilcher (78) state "Morphine sulphate should be given without hesitation in dosage (0.016 gm. or  $\frac{1}{4}$  gr) sufficient to bring relief of this pain" Knight, McAlpine, and others agree to such medication. Others, however as Wortis and Sharp, made special admonition against such medication, and Davis (22) stated "Morphine should not be given to patients with injuries to the cervical spinal column. It would seem best, everything considered, to avoid morphine if other measures to allay the pain can be found, for certainly patients with injuries to the cervical cord, especially may already have respiratory difficulties which would only be increased by morphine in sufficient dosage to stop the pain, and, furthermore, such medication may mask other important neurological signs. Root pains are most likely to occur in cervical spine injuries; fortunately, this is the portion of the spine most easily handled by traction, and it is the usual thing to see a patient immediately relieved of his root pain as soon as adequate traction is applied to pull the involved vertebrae apart.

The subject of the position of the patient while in transit from scene of accident to the hospital has been a matter of detailed description as well as of disagreement among many surgeons. Why there should be disagreement is a strange thing, since it would seem obvious, (as it has to many experienced men) that the preservation of the anatomical position, with fixation and immobilization by temporary means at the level of injury is the all important consideration. Thomson was so concerned that the jackknife deformity be not further increased that he advised the transportation of all patients with spinal injuries in the prone position apparently even advising this for cervical injuries. Platt, on the other hand, believed that patients with cervical injuries should be transported in the supine position, with the neck immobilized but that in all other spinal injuries the patient should be transported prone, except that when there are chest injuries or when the fracture is a lower lumbar one the patient should lie face up with proper support under the lumbar curve. McAlpine advised the prone position for lumbar injuries and the supine position for cervical in-

jures, in either case immobilizing the spine at the level of injury and adding extra support to maintain the normal points of curvature. Knight recommends the prone position either on a blanket or stretcher, to maintain hyperextension of all parts of the spine. Other authorities (76-100) recommend the supine position for all methods of transportation. The majority of neurological surgeons insist upon the supine position, on a rigid surface. Such a position allows satisfactory examination does not interfere with the treatment of chest or abdominal complications permits the maximal respiratory excursion for the patient, and, with the cervical and lumbar spine supported with a roll of clothing or blanket, keeps the proper position of moderate hyperextension. Davis (22) stated the problem tersely and is here quoted

"The most important principle in the emergency treatment of fracture-dislocations of the spine is to do nothing which will increase the bony deformity. The patient should not be moved unless it is absolutely necessary because each new movement may cause bony fragments to cut into the spinal cord. The patient's head should not be raised to give him a drink or cigarette. A rolled blanket or pillow should not be placed beneath the head. He should not be lifted off the ground unless he is on a litter or other rigid support. Reduction should not be attempted. Plaster casts should not be applied. The patient with a fracture dislocation of the cervical spine is in the optimal position when he is lying on his back with a folded blanket 3 to 4 inches thick beneath his shoulders, with his head below the level of his shoulders and his neck in slight dorsiflexion (hyperextension). Folded blankets should be secured at both sides of the head to prevent lateral movement. He should not lie face down with his neck twisted nor upon his side with his neck flexed laterally. Care should be taken that clothing and blankets are smooth beneath the patient. Pockets should be emptied. Three persons are needed to turn properly a patient with a fracture dislocation of the neck onto his back from some less favorable position. One should grasp the chin and occiput and exert steady traction in the line of the long axis of the body. The second should grasp the ankles and exert equal countertraction along the same line of pull. The third should then kneel beside the patient, reach across his body and grasp the patient's clothing near the shoulder and near the hip joint with his 2 hands. He should then gently rotate the patient toward himself while the men at the head and feet exert their traction. The head, neck, body and legs should

be so placed on the ground or the litter that the patient's shoulders finally come to rest on top of it when rotation has been completed. This position will allow the head to hang down slightly and permit a moderate dorsiflexion (hyperextension) of the cervical spine, a position which tends to correct the deformity caused by the fracture-dislocation. If the patient is lying face upward on the ground the 3 men should take the same position as for turning him, with the exception that the man at the side should grasp the patient's clothing on the side nearest to himself. The 3 men should then gently slide the patient from the ground onto the litter without lifting him. The 2 men at the head and feet should meanwhile maintain a strong longitudinal traction. The fundamental principles for the emergency treatment of compression fractures of the lumbar spine are essentially the same as for fractures of the cervical spine; the patient should not be moved unless it is absolutely necessary. He should not be picked up and carried from one place to another unless he has first been placed upon a litter or other rigid structure. There are two acceptable positions for a patient with a compression fracture of the body or one of the lumbar vertebrae. If an air mattress is available, the patient should be placed upon it, lying upon his back, with 2 or 3 folded blankets underneath the air mattress at the site of the fracture so placed as to produce hyperextension of the spine. If an air mattress is not available, then the best position is the face-down position. This position automatically prevents further anterior flexion of the lumbar spine. No other attempts at correction of the bony deformity should be made. The principles involved in turning a patient with a compression fracture of the lumbar spine are similar to those for turning a patient with a fractured cervical spine except that in fractures of the lumbar spine traction by the man at the head of the patient may be applied under the armpits. In transferring the patient from the ground to the stretcher the same principles apply as in the case of a patient with a fracture-dislocation of the neck.

Munro (70) advised the face-down position for the transportation of the patient with an injury of the cervical spine, and he agreed with most others that at no time should manual reduction of the injury be done at the site of the accident. Clark advised the earliest possible manual reduction of fracture-dislocations of the cervical spine at the scene of the accident, since he feared the ill effects of transportation on the unreduced spine and the adjacent injured cord. This is the one instance in which such early reduction is advised. Raaf has

found useful the immediate application of the Schreiber pneumatic collar before the patient with a cervical injury is started on his way to the hospital.

**Spinal shock** This term has been rolled about loosely frequently to the confusion of the reader. Certainly any patient with an injury of the spinal cord, with or without concurrent injury of other parts of the body may suffer from shock as it is usually known with a fall in blood pressure, a low body temperature, a poor pulse, and evidence of poor peripheral circulation. Obviously the usual supportive measures for such a condition must be instituted before any form of active treatment can be begun. Kennedy decried the use of the term, calling it inaccurate and unjustified, and pointed out that early in the phase of spinal cord injury (during spinal shock) nothing will prove the differentiation between a complete anatomical and complete physiological lesion other than direct inspection. Spinal shock is usually taken to mean that period following injury when the patient is completely flaccid and without reflex response of any type below the upper level of his injury and when cord function is completely lacking. Elsberg has stated that plantar flexion of the great toes is usually the only reflex movement that can be elicited upon scratching the sole of the foot during the first few weeks after complete transverse lesion of the spinal cord, and that the appearance of the Babinski sign within the first 3 weeks after injury is evidence of the incompleteness of the lesion. However the appearance of reflexes, either flexor or extensor does not necessarily always coincide with the change from flaccidity to spasticity and many authors would prefer to apply the term "spinal shock" for whatever indications it might have (and they are probably few) relative to surgical care, to that period of the first 2 to 4 days after injury when the patient is completely flaccid and without any response of any sort below the level of the lesion. At best, the term does not seem a very useful one for its indications as to care or prognosis. Kennedy believed that it is absurd and should be discarded.

#### THE PHASE OF ACTIVE TREATMENT

**Clinical examination the Queckenstedt test x-ray examination.** There is general agreement that the earlier the patient is examined and the extent of his injuries determined, the better it is for all concerned. Neurological surgeons and neurologists are interested primarily in the nature and extent of the neural injury; general and orthopedic surgeons are usually concerned with the bony deformity and the problem of its correction. Some

of either group are capable of combining these interests in the proper proportion. Davis (21 22) Coleman and Pilcher (78) Oldberg and other neurological surgeons insist upon the early neurological examination of the patient, without undue manipulation of his body and point out that such examination must be recorded so that subsequent examinations can be compared with the first findings. Spinal puncture with performance of the Queckenstedt test to determine the presence or absence of a block of the spinal fluid is usually done when the cord injury is attended by obvious spinal deformity whether the surgeon is opposed to operative treatment or not. Davidoff, Davis (21 22) Stuck (109, 110), Worts and Sharp, and others believe that a positive Queckenstedt test, along with other findings, may be one of the criteria for laminectomy but apparently no author believes that the presence of a block alone is sufficient cause for open operation when there is evidence of complete loss of cord function. Worts and Sharp state that "spinal tap should be performed and, if manometric block is present and the clinical signs increase (in the case of the incomplete cord lesion) decompressive laminectomy is indicated. This group is the only one in which spinal fluid manometric studies are of value. We do not believe that routine spinal taps in all cases of acute fracture of the spine are necessary. Only those patients should have lumbar puncture manometric tests who, it is believed, can be helped by operation.

The procedure has definite risk associated in the act of moving the patient." Pilcher believed, also, that when the lesion was apparently incomplete, a positive Queckenstedt test together with x ray evidence of compression constituted an indication for laminectomy. Mayfield and Cazan do not put much dependence in the Queckenstedt test, nor do they believe when it is positive that it is a good indication for laminectomy. It is not infallible because, as Poppen and Hunzthal showed, the response to jugular compression will be normal so long as the lumen of the subarachnoidal space is not less than the bore of the needle. Therefore, severe pressure may be present on the cord and still not show a complete block. "We would consider laminectomy indicated in compression injuries of the cord only if there was an incomplete lesion and the patient were showing progressive loss of function, and the loss of function could not be arrested by closed manipulation (58)

It is no surprise or secret that even the best of x-ray pictures of the injured spine may by no means show all the injury present, or the presence of such important factors as spicules of bone which

have been driven upon or into the cord. While it is the general consensus that careful and early roentgenological study of the injured spine is in order in every case of spinal cord injury no author has stated that evidence of bony damage by such examination constitutes alone an indication for open operation. It may, however, be an accurate guide to methods of closed reduction of the spinal injury. Kennedy noted that x rays of the spine are by no means conclusive of fracture of the laminae or the spines and quoted Browder and Miner as follows "Negative x ray findings do not necessarily exclude the possibility of a bone lesion." Jefferson (44) made the important observation that flat plates were not sufficient when the injured spine is x rayed, stereoscopic anteroposterior views should always be taken. Portable or other bedside films are usually of such poor quality that they will give only an approximate estimation of the bone injury although they have been found useful by all surgeons when the views are taken in a lateral position in cervical injuries to determine quickly and with little movement of the patient the presence and extent of a cervical fracture-dislocation. They are useful too after methods of closed reduction have been applied, to follow the course of the patient from day to day as he remains in position in his bed. However if operative indications depend heavily upon the extent and nature of the bone injury then the patient should be carefully studied by means of x rays on the regular x ray table fitted with a Buckey apparatus and the pictures should be taken with as little movement as possible. Usually such films are made while the patient is on his way to the operating room so that little additional movement is necessitated in obtaining these pictures.

*Closed reduction and conservative care as laminectomy.* With but very few exceptions most surgeons agree that treatment of the patient with a spinal cord injury should be delayed until he is out of his primary shock and in condition for whatever treatment may be necessary. Until that time he is given supportive care and maintained immobile without any attempt to correct the spine from its position when the patient was first found injured. All spinal injuries with or without cord injury should be corrected if possible. Packard stated All fractures with deformity should be corrected whether cord injury is present or not. If cord injury is present correction reduces pressure. If cord injury is not present, deformity is still undesirable as it produces a faulty weight-bearing line, chronic pain and disability. As Ruth pointed out, hyperextension is not a cure-all for

injuries of the spine. Emergency and therefore sometimes hysterical, attempts at hyperextension of the freshly injured back may do as much damage as flexion would do. In accord with the nature of the injury hyperextension may force backward upon the cord a displaced articular facet or fractured lamina and add an injury which did not originally exist. Ruth believed that there is a tendency in injuries of the spine for the parts to assume normal relationships and that maximum distortion occurs at the instant of the impact, the parts thereafter immediately springing back until their return is checked by abnormal bony impingement. Therefore x-ray examination rarely shows the maximum amount of displacement that occurred at the moment of injury, for it is, no doubt, at the very instant of impact and fullest distortion that the cord receives its maximum injury sometimes quite out of keeping with the later mild or absent signs of bone injury. For that reason Ruth believed that hyperextension should not be done until all means of full treatment are at hand and the exact nature of the bone change has been determined. Rather the spine should be stabilized in its original post traumatic state so far as early care is concerned.

Every author has his favorite method of effecting closed reduction. Johnson, along with many others (11 25 41 46 112) favors the Walton or Taylor method of closed manipulation for the reduction of spinal fractures, even in the cervical region, together with the use of such special apparatus as the Bradford frame, the Goldthwait frame, various types of hammocks and slings, and plaster immobilization. Jefferson (44) stated that he believed that to reduce cervical dislocations by such means was by no means a guarantee that the injury would stay in proper alignment, since the torn supporting ligaments frequently allow dislocation to recur. Morrison pointed out that while many cases the proper treatment, hyperextension is contraindicated (1) when there are obviously torn anterior vertebral ligaments, (2) when there are fractures of the elements of the posterior arches, and (3) when fractures associated with known cord damage will lead to open operation. Many writers have pointed out the danger of exerting hyperextension and applying a body jacket with a pad over the site of injury when the thoracic cord has been injured and fractures are present in the posterior spinal elements at the level of the lesion. By so doing they stated, the loose bone fragments may be forced down upon the exposed, swollen cord which is subject to further injury with but very little effort. Voris indi-



cated that manipulation with the patient under anesthesia probably gives a higher mortality than laminectomy and that it is a dangerous procedure in that further cord damage may result. Stuck (109-110) stated "Manipulation of the spine under an anesthetic, which has been advised for fractured vertebrae, is contraindicated because of the danger of further cord damage. He recognized that the early care of the patient may be entirely orthopedic in nature, but insisted that if the injury were cervical, the reduction should be accomplished by means of the Crutchfield tongs with the neck in hyperextension, whereas if the injury were thoracic or lumbar reduction should be accomplished by means of the proper cast or a hyperextension bed frame. Gallie apparently speaking from experience, stated "Efforts to reduce the dislocation by manipulation are attended by such appalling risk of damage to the spinal cord that they should not be employed. I saw one such disaster, and it was enough." Sammons saw no special value at any time in the operative treatment of compression fracture of the spine with a transverse lesion of the cord, but did believe that reduction by the closed method should be obtained early. He added, "Modern methods of reduction of fracture-dislocation have entirely supplanted laminectomy." That latter statement, however is not fully in accord with the majority of neurological surgeons, when one considers all the factors which must be gone over in arriving at the decision to operate or not to operate.

Most authors agree that the final position of the patient with an injury to the thoracic or lumbar spine, with or without cord injury and whether or not subjected to laminectomy when the cord has been injured, should be that of hyperextension, with fixation either on a special hyperextension bed with a reverse spring mechanism or by means of rolled blankets under the mattress and without a plaster cast (the methods most often used by the neurological surgeons) or with fixation by means of a plaster cast sometimes extending as far as the knees (the methods employed by some orthopedic surgeons). Most surgeons agree that plaster casts make many problems of nursing care, contribute to the formation of bedsores and frequently add to the general discomfort of the patient but then apparently some surgeons regard these complications as the natural and expected outcome of spinal cord injuries, especially the development of bedsores.

Aside from the advocates of the closed manual method of reduction of cervical fracture dislocation, most authors are agreed that some form of skeletal traction is preferable in the care of these

seriously injured persons. Munro and Wegner (73) have used the Hoen method of putting piano wire under the calvarium at the vertex and attaching weights thereto but they found the method unsatisfactory and prefer to use simple halter chin-occiput traction with no more than about 5 pounds of weight however this must be used over a period of from 5 to 6 weeks. They apparently do not use the Crutchfield tongs. Sucha also tried the Hoen method and discarded it because of its dangers and complications he now uses the original clevis type of skull tongs. Peyton Hall and French described a method of inserting fish hooks under the zygomatic arches and applying traction, pointing out its simplicity of application and its effectiveness because the use of heavy weights was possible. However in the hands of most neurological surgeons, and apparently also in those of an increasing number of general and orthopedic surgeons, the use of the Crutchfield tongs (17) has proved the simplest, most effective, and safest method of treating fracture-dislocations of the cervical spine. It has been the common experience of all surgeons using this method that the application of the tongs is a minor procedure quickly carried out without manipulation of the patient weights up to 25 or 30 pounds can be applied for reduction of the more severe injuries, reduction is usually obtained early and the patient is immediately relieved of local and root pains upon application of the weights. This method allows the free movement of the patient's body for nursing care, does not interfere with his eating, and does not subject him to all the well known annoyances which halter traction (so much less efficient in the hands of most surgeons) causes the patient who must wear such a contraption. It has become standard practice to apply traction early in cases of fracture-dislocation of the cervical spine when there is no open wound and when there is no evidence of indriven bone spicules or other foreign bodies. The method was used extensively in the military hospitals during the war just past, and repeated accounts of its use and the enthusiasm of the surgeons will be found in the reports of cord injuries in the Army and Navy journals.

The great bone of contention however in the treatment of injuries of the spinal cord concerns the problem of when, if ever laminectomy is to be performed. Almost every reference furnished with this review will be found to voice the author's individual opinions regarding the wisdom of performing decompressive laminectomy. Browder and Grimes, Davidoff Davis (21-22) Elsberg, Fay Jefferson (44, 45), Kennedy Denker and Osborne, Love, Mayfield and Cazan, Munro (65-

(13) Naffziger Coleman, Meredith and Pilcher (78, 13) Oldberg Pool, Rand Scarff (102) and Sharp and various medical authorities concerned with military medical problems (113) together with others experienced and well known in the field of neurological surgery and all well aware of the problems of the traumatic paraplegic patient, have clearly stated their stand and all with good logic. Yet, as will be seen later by comparison with the opinions of urologists on the care of the paralyzed bladder authorities disagree. The older neurosurgeons with a background of sound experience have as a group settled down to a not too-hopeful, most realistic, and not by any means colored with optimism attitude. Many of them have had experience with both the military and civilian types of injuries and therefore have dealt with both the open and closed types of injuries. The younger surgeons especially those who saw many patients with both types of injuries, but predominately those with the open type during for more service in the war just past have a much more hopeful and enthusiastic regard for the possibilities of early surgery. Perhaps their hope is based on insufficient experience but it is also possible, as indicated in a recent report by Tinsley that their hopes are well grounded and that their willingness to tackle the problem with unbiased enthusiasm will initiate a new attitude on the part of neurosurgeons in general. The older surgeons say in brief, "The damage is done why prolong the show?" The less pessimistic surgeons say "Nothing was ever gained by *laissez faire* give the patient the benefit of the doubt. Naffziger stated that with evidences of a complete lesion which persist for 24 hours after injury surgery is probably of no benefit and permanent paralysis is expected. He pointed out, however that the surgeon must not overlook the difference between the cervical and thoracic cord injury and injury to the cauda equina the last being of the peripheral nerve type and therefore much more amenable to surgical treatment. Rand among the older and more experienced group is more lenient toward operation although yet not misled by undue optimism. He stated "There is a certain psychological angle to be taken into consideration. Almost every patient with a broken back and paralyzed legs comes to feel sooner or later that he should have an operation. Therefore even though it offers very little, laminectomy may be carried out in order that he may feel that nothing has been overlooked. I have often felt that if I had broken my back and become paraplegic, I would prefer that the spinal cord should be explored. The same

question recurs every time I see one of these unfortunate individuals. Cases are on record in which patients with a complete transverse lesion of the cord persisting more than 24 hours before surgery have regained partial recovery after surgical decompression when block and compression existed, although the opinion has been stated by Naffziger and others that damage is *damage irre vocable* in the spinal cord, and that any recovery that comes about after surgery would most likely have appeared eventually even without the operation. Certainly decompressive laminectomy weeks and months after injury rarely offers any benefit when evidence of a complete transverse lesion has persisted. This is not true, according to various case reports, even in the late operations when the lesion has been incomplete and not progressive. Early or late, operation has much more to offer in injuries of the cauda equina than it does in injuries of the spinal cord. Even those who advocate routine laminectomy as soon as primary shock is over admit that the chances are that little, if any recovery will follow a decompressive operation if the patient has a complete lesion at the very beginning since it is the general consensus that the instant of impact was the moment when damage was created to all practical purposes and that pressure on an already irrevocably damaged cord cannot therefore, add more injury. Others (33) feeling that in many cases anatomical and physiological lesions cannot be differentiated for the first few days even if the effect is one of complete functional loss believe that operation should always follow when there is a block of the cerebrospinal fluid, even without (but especially with) x ray evidence of severe bone injury. All neurological surgeons of experience agree that by general principle it is more allowable to operate in case of injury of the thoracic cord than when the injury is cervical. In the latter case the effects of skeletal traction should always be tried first, and certainly it is generally agreed that early and premature cervical laminectomy within the first few hours or days is bad surgical judgment and is certain to be the one instance in which surgery contributes to the already poor prognosis of the patient.

In the closed type of injury as for instance that resulting from fracture-dislocation in any level of the cord with an incomplete lesion and either with or without evidence of bony compression but especially with such cause for cerebrospinal fluid block, it is well to operate to allow every possible chance for the cord to recover. Certainly when there are signs of progression of neurological symptoms in the incomplete lesion with evidence of compression laminectomy should not be de-

laid. It has frequently been pointed out that after a few hours or days a complete block may exist in either the incomplete or complete lesion without any bone injury whatsoever the block being due to edema of the cord at the level of injury. It has been the general experience that extradural extravasation of blood in significant quantity is a very rare complication. It has also been pointed out that a dissecting hematomyelia is a *fait accompli* and is not reversible by surgery.

Open wounds, such as frequently occur in military casualties, require the usual wound care of débridement that all such wounds require. It was the common practice in the war just past thoroughly to remove all bone fragments and make a clean toilet of the wound, the dura in the potentially infected field never being opened. Indriven spicules of bone and foreign bodies, if accessible, were usually removed. The dural rents were closed either by primary suture if possible, or by the application of living fascial grafts in order to stop the cerebrospinal fluid leak. While wide laminectomy was believed to be the proper operation in the closed injury, it was generally felt that in the fresh open wound only the bone that was actually damaged or in danger of not remaining viable should be removed. The excellent healing and frequent return of function, particularly in the incomplete lesions, which resulted from such treatment of the spinal cord injuries of World War II have given new hope and eagerness to the younger neurological surgeons. As Tinsley has pointed out, such early acquaintance with the actual situation in the cord be it found to be completely severed (a not very common occurrence) or injured to a lesser degree leads to more intelligent later care and permits a more accurate statement of the eventual prognosis. All open wounds, it is agreed, should be treated with the adjunct of chemotherapy but with no direct application of any sulfonamide to the exposed cord.

Certain aspects of the technique of surgical procedure are agreed upon by most neurosurgeons. All agree that insofar as possible only local anesthesia should be used for the operation of laminectomy. As Stoolkey has pointed out, it is unwise to open the dura out of curiosity over a freshly swollen cord if no bone fragments or foreign bodies are to be removed, for the softened cord will only tend to herniate through the dural slit and thus sustain further damage. The occasional article by orthopedic surgeons suggests the attempt at manual reduction of the fracture by means of prying the vertebrae back into position when the laminectomy has been accomplished others suggest further that at this operation the spine be fused.

Both such procedures are called by the neurosurgeons as dangerous and unwarranted. Clark, who advocated manual reduction of the cervical fracture-dislocation at the scene of injury before x-ray studies had been made, also advocated that when laminectomy was performed and the block was found to be due not to bone compression but rather to edema under the cord, a longitudinal slit should be made in the dura to relieve such edema pressure. Palmer stated that laminectomy is attended by a high mortality but this is certainly not the experience of either the neurosurgeons or orthopedic surgeons who perform the operation only when the patient is in proper condition or after the proper period of time in the case of cervical injury. It is the unanimous opinion of all surgeons with experience in the late war that the patient with a spinal cord injury suffers more in the theater of war from the ill effects of transportation than from the shortage of hospital refinements that speed and priority of evacuation should be given these patients, and that in the case of the open wound, primary healing of the wound itself and stoppage of the cerebrospinal fluid fistula is of first importance.

Concerning the indications for late operation, Worts and Sharp summarized the opinions of most authors. Cases of intractable root pain secondary to fracture of the spine or of a lamina will occasionally require the attention of the surgeon. In a few instances there may be an indication for late operative intervention in the following conditions: (a) Callous encroachment in the spinal canal giving slowly increasing neurologic signs. (b) Callous encroachment on the spinal roots giving intractable pain not helped by injection of the roots. Such patients may require rhizotomy or cordotomy. (c) Herniation of the intervertebral disc giving back pain, associated neurologic signs and roentgen or myelographic evidence of herniation of the disc. (d) Hypertrophy of the ligamentum flavum with increasing pressure on the spinal cord. (e) Post traumatic adhesive arachnoiditis. It is the repeatedly expressed opinion of many authors that decompressive laminectomy in a case of long standing complete neurological loss below the injury is a futile gesture, even though there is a complete block of the cerebrospinal fluid and demonstrable bony compression. However the occasional surgeon (Rand) does sometimes operate on such patients for whatever beneficial psychological effect it may have and in order to clinch with both the patient and his relatives a statement of the undeniable prognosis. But even those authors who discourage laminectomy at any time for a com-

plete transverse lesion of the cord advocate operation, either early or late for the injured cauda equina, since there the problem is a different one dealing as it does with the more favorable possibilities of the peripheral nerves. Knight, however has made the following unusual statement. It is, of course, unnecessary to remark that even in the case of the cauda equina which it is sometimes suggested should be sutured suture of divided nervous tissue is futile and should not be considered. Even in the cauda the absence of a neurilemma precludes regeneration.

### LATE CARE NURSING PROBLEMS

*Rehabilitation* The time arrives in a few weeks after injury when all active treatment for the injury itself becomes less hopeful. The bone has healed in most patients, and the major problem now longer is one of neurological recovery. The patient must be prepared for an existence as a bed patient (fortunately only a few are in this category) as a wheelchair patient or as a semiambulant patient with the need for crutches, walkers, or braces. World War II has given a tremendous impetus to the re-education of the paraplegic patient, and literature on the present day programs of rehabilitation used principally in the paraplegic centers of several Veterans Hospitals is only recently beginning to appear. These programs are being carried out on a lavish scale but are no more, actually than those which have long been advocated by such authorities as Davis (21 22) Elsberg Coleman and Pilcher (78) Stookey and others (113). Carefully supervised recreation, physical therapy and occupational therapy and study in trade schools are all a part of the general program to improve the morale of the patient, to re-adapt him to a happy and, if possible useful existence and to give him the maximum chance for physical recovery. Therapeutic exercises, and specially made and individually fitted braces are at this time being developed into something of an art, and the great force promoting such a program is, happily the United States Government, as reflected through the care given the paraplegic patients in Army Navy and Veterans' Administration hospitals. It has even been proposed (113) that those paraplegics not wishing to return to their homes or not being able to do so for one reason or another be grouped into communities where they will all look upon themselves as equals, where they will be less the object of pity and curiosity than they are in public institutions, and where they can work toward a semblance of normal existence.

*General nursing problems* The paraplegic patients present many special difficulties of nursing

care and it may well be said that after the first few weeks they constitute for the most part problems only for the nursing staff and not for the surgeon, although at all times every phase of the convalescent and chronic care should be under the supervision of a competent, interested physician. The government has found that in most instances the primary responsibility of the care should be that of the medical neurologist, with the aid of the neurosurgeon and of the orthopedic, urologic, general, and plastic surgeons as well as of the internist who can consult in problems of general medical care and nutrition. When thus handled this class of patients has apparently required no more special psychiatric care than has any other type of chronic patient. It has been repeatedly pointed out (21 22 26 78 84 113) that the main difficulties of nursing care, other than those of rehabilitation and education, have to do with nutrition of the patient bed sores, and the various complications of the paralyzed bladder. All these and other complications are discussed later in this review. Fay and Munro (69) have insisted along with others, upon the persistent attitude of optimism on the part of all ward personnel who nurse patients with injured cords. A defeatist attitude avoided at all costs. A hopeful, friendly interest approach by the nurse, whom the patient sees more than any one other person is a great factor for good in the comeback of these unfortunate persons.

### THE TREATMENT OF COMPLICATIONS

*Nutrition* Harper (113) has pointed out the necessity of careful supervision by a trained dietitian of the diets of paraplegic patients. He urged a high protein intake, and an average caloric supply of about 2 800 calories daily. It is not desirable for the patient to gain weight particularly although in many instances it is desirable to a certain degree since the well fat padded weight bearing points are less likely to develop decubitus ulcers. If such ulcers exist there is a serious loss of plasma proteins in the exudate, and this must be made up by a proper protein intake in the diet. A high vitamin diet is desirable and for the purposes of improving the bladder status a generous fluid intake is also urged by most dietitians.

*Decubitus ulcers* There is not an author but who insists upon every nursing measure possible to avoid rather than heal (if possible!) the bugbear of decubitus ulcer. There is no place where the ounce of prevention is worth so much more than the pound of cure. It is the unanimous opinion of all writers quoted that to prevent these sores

weight-bearing points must be rested frequently by turning the patient, and by massaging and drying the skin. Sheets must be clean and smooth. The skin must be bathed frequently and kept dry and free from feces, urine, and perspiration. Some surgeons apparently insist that the bedridden patient be turned every hour, others every 2 hours, with care each time to the surface that bore the weight. This, as in all the other care of the patient, assumes a well trained well supervised and willing nursing staff. Attention to the avoidance of decubitus ulcers must begin within the hour after injury and can never for the rest of the patient's existence, be relaxed at any time. Many of the recent articles, stemming from war experience, indicate the fact that delayed and inadequate nursing care during the first few days after injury in the theater of operations, was the main source of bed sores, and it is for this reason among others, that military surgeons have insisted (not always successfully) upon evacuation priority for these patients. It is almost the unanimous opinion of the neurosurgeons that plaster should never be used when it can be avoided, since beneath it sores can and do develop. Others just as strongly advocate its routine use. Apparently some surgeons still think bed sores are an act of God and entirely unavoidable. One author (7) stated that a method of avoiding bed sores was to put the patient in anterior and posterior body shells, from knees to shoulders, and turn the patient 1/2 or 3 times a day.

Once a decubitus ulcer has developed the general care of the patient becomes increasingly difficult. Munro (68) pointed out that the normal vasomotor reflexes of the skin are altered below the level of a spinal cord lesion, on account of a change in the sympathetics, and because of this fact, mild pressure, which would be tolerated by normal skin, quickly causes necrosis as a result of anoxia and anemia due to pressure. The fact that the skin is anesthetic is not the basis for the development of these ulcers. Munro cast out the term "trophic" in the description of these ulcers, pointing out that the same effect is frequently seen in the cachectic but normally sensitive patient who has had the same inattention to the skin. He strongly advised against the use of the Bradford frame, plaster-of Paris jackets, sawdust beds, rubber or other rings and "doughnuts," lambs wool pads, and other such devices. He recognized the sole importance of cleanly care to the skin and the frequent change of position for the patient, all of which are matters under the control of a willing nursing staff. It is his opinion that no mechanical tricks equal personal nursing attention and that,

of course, is the opinion of all well informed as those who have had extensive experience with the care of decubitus ulcers. Some authors suggest débridement of the ulcer as sloughs appear with simple dressings to the open wound. Munro advised against all incision and drainage of the ulcers, against débridement, and against moist dressings in any form. He, with most others, finds such lesions highly contaminated, but has found sulfa powder dressings useful, as well as painting with tincture of benzoin once daily when the ulcer is not a frank, open, exuding mass. Munro along with others (21 22 78) has advised the use of sponge rubber air or water mattresses, and the use of radiant heat and ultraviolet irradiation which has been found to be useful to promote healing.

The plastic repair of decubitus ulcers, once they are relatively free of infection, is successful in a great many cases. As Barker (113) pointed out, in some instances they can be closed by simple excision and primary closure. Some, such as those on the buttocks, will require the use of rotation flaps. Others can be closed by free grafts, although the latter method is sometimes less successful. In the well nourished patient, even extensive sores, if well tended may eventually show granulation and epithelization.

*Mass reflexes' spasm contractures* Scariff and Pool have recently proposed the interesting theory that the so-called mass reflexes and severe muscle spasm which are the lot of many paraplegic patients are influenced by scar at the site of the lesion on the end of the distal cord segment. They believe that this cicatrix heightens the irritability of the isolated segment of cord, and that removal of the cicatrix, excision of all local degenerated tissue, and surgical section of the dorsal columns in the upper portion of the lower cord segment helps to allay or completely remove this condition. Braden (113) found reason to believe that cure offers some limited improvement in this condition, although its effects are transient and not without undesirable side effects. Elkins and Maltby (113), as well as Munro (79) and others have advocated anterior rhizotomy for the relief of severe spasm, and Munro has given detailed instruction for the technicalities of the procedure. Mayfield (113) recognized the value of the procedure, but advised that it be put off for at least a year after injury or until it was certain that no further neurological recovery would be observed, since the operation is a permanently destructive one. Davis (21 22) has found obturator nerve section within the pelvis of distinct aid in overcoming the handicap of strong adductor contraction. It has the

advantage of not affecting the leg muscles most used in locomotion and is therefore less destructive in its effects. Along with others Munro has demonstrated that the relief from spasm means that the patient can be made ambulant with the use of braces and crutches, that he is more able to be up in a wheel chair that the development of bed sores is less a threat and nursing care is easier and that, above all, the patient's morale is improved. Tenotomy may be performed for the permanently contracted shortened muscles when all hope of recovery has been abandoned (87).

*Pain.* Mitchell (113) pointed out that inadequate early operation on the injured cauda equina or the presence of root pain with such injury were indications for secondary surgery and that the removal of depressed bone fragments or foreign bodies with some attempt at restitution of the nerves, would offer relief from the pain which is a common sequel to caudal injury. Others have pointed out that the root pains associated with cervical fracture-dislocation are frequently stopped when adequate realignment of the vertebrae is obtained. Intractable root pain in injuries of either the cervical or thoracic cord can be stopped by adequate posterior rhizotomy. Elkins (113) also pointed out that bony overgrowth the presence of a foreign body post traumatic arachnoiditis, and the spasm itself may be the source of such severe pain that surgical relief is necessary. When the cause can be removed this should be done when it cannot posterior rhizotomy or cordotomy (also 78) on the spinothalamic tracts should be performed. Care must be taken that additional injury to the motor tracts or an increase in the spasm is not produced by technically inadequate cordotomy. The role of the sympathetics is not understood by most surgeons and many patients with apparently complete lesions complain of unremitting burning pain which is not controlled by such questionable methods as novocainization of the sympathetics. It has been found too that many times such vague and pathless 'pain' has a strong functional element, and can be overcome by re-directing the attentions and interests of the patient. All are agreed that these patients should not be made drug addicts.

*The bladder.* The care of the bladder paralyzed by a spinal cord injury is a subject for great controversy between urologists and neurosurgeons, and between neurosurgeons. A review of the literature makes apparent the fact that most urologists consider the care of the bladder under such circumstances as a purely urological problem, some urologists and neurosurgeons consider it a joint problem and some neurosurgeons

believe that it is a neurological problem and they therefore do not seek urological consultation. All authors agree however, that the care of the bladder is a major problem, that it is a complication of the injury from the moment of the trauma, and that much of the success or failure of later bladder function depends upon the proper initial care.

It has been pointed out (63, 64, 115) that the appalling death rate among British casualties in World War I suffering spinal cord injuries was due to urinary sepsis and it is the belief of many British authors that this now somewhat embarrassing fact was due to early repeated manual catheterization. If one is to judge by articles dealing with the care of the bladder in the casualties of World War II it would seem that the method of choice was early suprapubic drainage with a large tube and the fistula placed well above the symphysis pubis later when the patient reached adequate hospital facilities, the tube was removed and replaced with a permanent indwelling catheter. It has often been said that the suprapubic tube is placed for purposes of transportation but it has been the experience of more than one surgeon to receive the patient at the base hospital with urine oozing out around a plugged up suprapubic tube (which promoted the formation of bed sores) with a necrotic fistula, or on occasion, with the long unattended tube simply rotted off and lying free in a mass of calculus in the bladder. Certain authors (2, 51, 116) particularly among the British dislike all apparatus which must be fixed to the penis. They describe a 'trocar' method of performing the suprapubic cystostomy, with insertion of the tube immediately above the symphysis a method most unpopular in America. Tidal drainage generally popular in America, has been found by many to be unreliable, dangerous when it does not work properly, and requiring too much close attention (2, 8, 114). In fact, Taylor believed he could trace 2 deaths directly to the use of the tidal drainage apparatus, whereas Munro, America's first proponent of the method quoted figures showing a sharp decrease in morbidity and mortality through the use of this method. Browder and Grimes (8) are among the few neurosurgeons who advocated the use of manual expression a method long in favor among British urologists and some British neurosurgeons. They (8) stated 'In an effort to eliminate the use of the indwelling catheter we have extensively employed manual expression of the urine by suprapubic pressure. Furthermore, the use of this procedure facilitates the establishment of automatic urination. Detailed instructions are given for the employment of this method and they go

on to say. Although the bladder cannot be completely emptied by this method, infection is extremely rare.

The intelligent co-operation of the staff (nursing) is a prerequisite if successful results are to be expected. An obese abdomen precludes the possibility of manual expression of the urine by suprapubic pressure. Elderly patients who may have thin vesicular musculature possible diverticuli of the bladder or urethral obstruction from hypertrophy of the prostate should never be treated for urinary retention of traumatic origin by this method. Oldberg has rarely seen the development of a true automatic bladder.

Munro (65-73) Scarff (102) and others have described in detail the construction, uses, and applications of the tidal drainage apparatus. They do not indicate that it is a simple self-regulating mechanism, but they recognize in it a means of continuous cystometric study and a means of keeping at a minimum the bladder infection which is bound to occur medication notwithstanding when any foreign body such as a catheter is placed in the bladder and they believe that some such continuous method of drainage is essential. They point out, too, that it is the only certain and safe means of training the bladder into automatic function, provided the injury is one of the cord and not of the cauda equina.

The various methods of treating the bladder are, in summary noninterference and letting the bladder distend until it overflows (if it will *before rupture*) as some authors have cynically pointed out) aspiration of the bladder with a large needle directly through the abdominal wall until some better method can be employed manual expression repeated intermittent catheterization use of the simple indwelling catheter which is allowed to drain freely use of the indwelling catheter which is opened for drainage every 4 hours, following which the bladder is allowed to collect a certain amount of urine by the closing of the stop cock suprapubic cystostomy perineal cystostomy with an indwelling mushroom catheter and use of the indwelling catheter with tidal drainage. The literature shown in the references to this review is replete with strong arguments for these various methods or against them, and the authors' views are illuminating reading.

Hinman, one of America's senior urologists, in a concise and instructive article has stated the problem very well. "The usual course of the effect on micturition of a transverse lesion of the cord at any level is first, retention, second, overflow incontinence, and third, automaticity. Automaticity never develops with destruction of sacral segments or cauda equina. He stated that actu-

ally there was reason to choose variously between the many methods of treatment, since all had their virtues and the particular case might demand one or the other procedure. He felt that the dissenting authorities were as reliable as those arguing for the use of noncatheterization and manual expression suprapubic cystostomy or retention catheter with or without tidal drainage. He only stated categorically that no paralyzed bladder should be let alone to distend and overflow and the urethral catheter should never be used casually or intermittently. Other than for the primary purpose of allowing the escape of urine bladder care need be concerned only with the prevention of sepsis and wetting of the patient with the resultant bed sores. The paralyzed bladder he believed, is strictly a urologic problem.

Hinman feels that manual expression is the one method of avoiding infection, but that its use requires a skill and regular attention not frequently found in nursing staffs. If infection does exist, the use of manual expression may cause an ascending pyelonephritis. Furthermore, the bladder may be ruptured. It is best never to resort to manual expression if the patient has at any time been catheterized. All in all, he feels that the suprapubic tube is the method of choice, and this is a common expression among urologists. Petroff (113) and others have agreed with most neurosurgeons that the suprapubic tube does not necessarily guarantee the least urinary infection for the patient, and that it is not the driest method by any means. He, with many others, has found that the early change from a suprapubic tube to an indwelling catheter was a great boost to the patient's morale, for he found that the suprapubic tube was repugnant to most patients. He advised the usual current method of placing a Foley catheter, small enough to allow the escape either into the bladder or externally of the urethral secretions, frequent cystometry and daily irrigation with "AI" solution or some other suitable bladder antiseptic. It is frequently pointed out that acid urine is the less septic, and the fluid intake of the patient should be at least 3,000 c.c. daily.

Emmett (29, 30) has recently advocated transurethral resection of the vesical neck in the management of cord bladders and actually this procedure has been in effect for some time in the hospitals of the Army Navy and Veterans Administration. In discussing the reasons why there is always residual urine in the "cord bladder" he stated "Modern urologic thought has suggested a more attractive and rational explanation. Inasmuch as it has been shown that no true internal vesical sphincter exists, it is assumed that the

vesical neck is simply the edge of the detrusor muscle and therefore takes part in the spasticity, hypertonicity and hyperplasia of the detrusor muscle as a result of transverse lesions of the cord. It is reasonable to assume that this muscle may act as an obstruction at the vesical neck and may be a considerable factor in the inability of the bladder completely to empty its contents. As time passes this condition may be aggravated by infection and subsequent fibrosis of the vesical neck. Such an explanation sounds logical. If it be correct, then transurethral resection of the vesical neck should offer a good chance of cure.

Petroff (113) has discussed the use of penicillin the sulfonamides, and other new antibiotics in the control of urinary sepsis. Joelson and Hamm (113) have summarized well the problems concerned with the prevention and treatment of urinary calculi.

#### SUMMARY

The paraplegic patient with his problems has been brought into the consciousness of the lay and medical public with a tremendous impact by the large number of such casualties incurred in the recent war. One has only to read of the medical experiences in the care of these patients after World War I and then the recent reports of the accomplishments under modern conditions to realize how much has been accomplished in the interval in the cure and rehabilitation of these patients. One also finds, as already indicated, that a wide divergence of opinion still exists, centered mainly about 2 problems (1) When is the patient to be operated upon for decompression of the cord? and (2) What is the proper care of the paralyzed bladder? One finds the attitudes range from the eager humanistic hopefulness of men like Temple Fay and many other younger surgeons with the experience of World War II, through the conservatism and latitude of opinion of such authorities as Coleman, Pilcher and Meredith (13, 78) Davidoff (20) Davis (21, 22) Oldberg (80) and others to the stark realism, even pessimism, of equally reliable surgeons as Elsberg (27) and Naffziger (74). It is generally agreed that the care of the paraplegic patient is in the main a nursing problem, but a nursing problem which in its many ramifications takes the constant supervision of a well trained interested, energetic, and open-minded doctor. It is a nursing care crammed with meticulous detail all of which must be religiously followed.

As already indicated in the literature there lurks many a statement which is patently false or even ridiculous and which should be pointed out to the unwary. To understand the care of the pa-

tient with an injured spinal cord a fundamental knowledge of neurology is an absolute essential. It is not a mechanical problem. It is not a problem to be covered by 'standing orders' or an attitude of 'let the nurses do it.' The paraplegic patients are here, and the problems of their care and treatment must be thoughtfully carried to their solution. There is no doubt but that these patients have been played up too strongly in the public mind. They have become the center of much interest, not medical, which may eventually make their management even more difficult. The very word 'paraplegic' is objectionable. It is frequently heard nowadays from the lips of patients and lay persons singling out, stamping and labeling these patients as doomed with a special and hopeless disability. Therefore, a less pointed less specific term should be adopted. These patients are seriously tragically injured persons, and should be treated as such but they should not be singled out from those with other types of injury for overindulgent publicity. They are before us as a medical problem to be continuously wrestled with. To quote Pilcher

'Like Humpty Dumpty the spinal cord can never be put together again! At first glance this gives the subject a hopeless case and suggests that this paper might better be left unread. However such a defeatist attitude would neglect the possibilities of prevention of further associated bony injuries, of palliative therapeutic methods, of avoidance of complications, and of adequate diagnosis with its resultant correct choice of therapy and accuracy of prognosis. In no field of surgery are the results perfect. Only by continuous study of our unsolved and seemingly impossible problems may further progress be made. To the neurosurgeon this is not a strange difficulty

#### REFERENCES

1. ALLEN, I. M. Aust. N. Zealand J. Surg., 1940, 10, 157.
2. ATWATER, H. L. Proc. R. Soc. M., Lond., 1942, 34, 197.
3. BADAL, D., MUNRO, D. and LAMB, M. E. N. Eng. J. Med., 1944, 230:688.
4. BARBER, C. G. Am. J. Surg. 1941, 53, 238.
5. BELL, C. C. Minnesota M., 1943, 26:687.
6. BOLDSLEY, E. Surg. Gyn. Obst., 1945, 80, 107.
7. BOORSTEIN, S. W. Am. J. Surg., 1946, 70:216.
8. BROWDER, J. and GRIMES, R. N. York State J. M., 1942, 42:866.
9. BROWN, M. M., and LITTLE, N. Med. J. Australia, 1939, 1, 798.
10. CHAPIN, W. R. N. England J. M., 1945, 233, 345.
11. CLARK, W. A. Arch. Surg., 1941, 42, 537.
12. CLEVELAND, D. A. Wisconsin M. J., 1937, 36, 343.
13. COLEMAN, C. C., and MEREDITH, J. M. J. Am. M. Assn., 1938, 111, 2168.
14. CONN, H. R. J. Iowa M. Soc., 1939, 29, 495.
15. CONWELL, H. E. Mississippi M., 1940, 18-19, 183.
16. COOK, E. N. Proc. Mayo Clin., 1942, 17, 561.



- 17 CRITCHFIELD, W. G. *J Bone Surg* 1938, 20 696
- 18 D. BY W. E. *Indust J M*, 1939, 8 381.
- 19 Idem. *J Am. M. Ass.*, 1942, 19 474.
- 20 DAVIDOFF L. M. *Surg. Clin. N. America*, Apr 94 p. 433.
- 21 DAVIS, L. *Illinois M J*, 1937 72 240.
- 22 Idem. *The Principles of Neurological Surgery* Philadelphia Lea and Febiger, 946
- 23 DETTRICH, R. J. *J Kansas M. Soc.*, 941 4 65.
- 24 DYCKER, H. *Surg. Clin. N. America*, 1943 p. 977
- 25 DUNLOP, J. *West J. Surg.*, 937 45 600
- 26 ELIAT E. C. *Proc. Mayo Clin* 946 2 97
- 27 ELBERG, C. A. In "Injuries of the Skull, Brain and Spinal Cord." Baltimore: Williams and Williams Co., 940
- 28 FINKERSON L. C. *Indust. M.*, 1939, 8 3
- 29 FLETCHER J. L. *Proc. Mayo Clin* 946 0
- 30 FLETCHER J. L. and DUNCAN J. H. *Surg. Gyn. Obst* 946, 83 507
- 31 EVERTS, W. H. *J Am. M. Ass.* 944, 26 45
- 32 EVERTS, W. H., and WOODSALL, B. T. *Am. New Am.*, 1944, 0.
- 33 FAY T. *Pennsylvania M J* 94 46 2
- 34 GALLIE W. E. *Am. J. Surg.*, 939 40 495
- 35 GORDON A. F. *Am. J. Surg* 937 23 374.
- 36 GORINSKY, A. and DREWING, E. *Lyon chir* 1936 33 44.
- 37 GOWLAND, L. L. *Brit. M J*, 1941 814.
- 38 GUTTMAN, L. *Med. Times, Lond* 945, 73 3 8
- 39 HANCOCK, E. M. *Wisconsin M J* 1936, 35 436
- 40 HARLEY H. R. *Gey's Hosp. Gaz Lond* 94 55 41
- 41 HARMON P. H. *Med Press & Circ Lond* 944, 2 170.
- 42 HILL, R. C. J. *J R. N. M. Serv* 945 3 35
- 43 HIRSHMAN J. *Surgery* 938, 4 649
- 44 JEFFERSON G. *Brit. M J* 936, 25
- 45 JEFFERSON G. et al. *Brit. J. Med.*, 936, 104
- 46 JOHNSON H. F. *Nebraska M. J* 936, 75
- 47 KELLEY E. T. *South M & S* 94 2 705
- 48 KIRKNEY F. DENKER P. G., and OSBORN, R. *Am. J. Surg.* 943 60 3
- 49 KISLOW A. *Problems of Neurosurgery Arch. Neurology, Moscow* 943, No 3.
- 50 KLIPFELDER, S. *Am. J. Surg.*, 936, 33 85
- 51 KROGAT G. *Postgrad. M. J. Lond*, 940, 6 247
- 52 LAFFERTY A. D. *Jou. S. M. Med.* 1936, 35 366.
- 53 LEWIS L. G. *Surg. Clin. N. America*, Dec 943, p. 1505.
- 54 Idem. *U. S. Army M. Bull.*, 943, 46
- 55 LITTLE N. *Med. J. Australia* 1938 80
- 56 LOW J. G. *Surg. Cl. N. America*, Aug 937 p. 1
- 57 MATHON D. D. *J. Neurosurg.*, 946 1 4.
- 58 MAYFIELD F. H. and CAHAN G. M. *Am. J. Surg* 1942 55 17
- 59 McALPIN D. *Practitioner Lond* 940, 44 237
- 60 MORRISON W. A., and FLEMING R. *J. California M.* 935 43 4 6.
- 61 MORROW, C. *Practitioner, Lond.*, 1942 148 305.
- 62 MULLER R. B. *J. Urol., Balt.*, 1946 55 470.
- 63 MURPHY, A. D. *J. Urol., Balt.* 937 37 54.
- 64 Idem. *J. Am. M. Ass.*, 944, 124 1120
- 65 MURRO, D. *J. Urol. Balt.*, 1936 36 710.
- 66 Idem. *N. England J. M.*, 936, 2 5 766
- 67 Idem. *Am. J. Surg* 1937 33 120.
- 68 Idem. *N. England J. M.* 1940, 223 301
- 69 Idem. *J. Am. M. Ass.*, 943, 1 5 953.
- 70 Idem. *N. England J. M.*, 1943 229 910.
- 71 Ibid., 1945, 23 453.
- 72 Ibid., 1946, 234 207
- 73 MURRO, D. & WEAVER, W. *N. England J. M.* 1940, 223 67
- 74 NAFFZGER, H. C. *J. Bone Surg* 938, 20 444.
- 75 NASH, C. C. *Dallas M. J.* 935, 2 05.
- 76 *Nerve Injury Com. Nat. Res. Comm. Bull. War Med., Lond.*, 944, 4 431
- 77 NERBIT R. M. and GORDON W. G. *Surg. Gyn. Obst.*, 94 72 328.
- 78 *Neurosurgery and Thoracic Surgery Military Manual VI Philadelphia W. B. Saunders Co.*, 1943.
- 79 NIMMER, K. I. *Proc. R. Soc. M. Lond.*, 94 35 797
- 80 OLDHRO, E. *Surg. Clin. N. America*, Feb 1936, p. 291
- 81 PACKARD, B. B. *Rocky Mountain M J* 939, 36 24
- 82 PALMER L. P. *Southwest M.* 938, 2 360.
- 83 PETTIT W. T., HALL, H. B. and FRANK, L. A. *Surg. Gyn. Obst.*, 1944, 79 3
- 84 PILCHER C. *South Surgeon*, 1942, 755.
- 85 PLATT H. *Brit. M J* 1938, 55.
- 86 PLEWIS, B. *Canad. M. Ass. J.* 938, 38 475.
- 87 POSE, D. H., ELKINS, C. W., WOODRUM, W. R., and BARKER D. E. *Ann. Surg* 1946 123 50.
- 88 POOL, J. L. *Surg. Gyn. Obst.* 945 8 67
- 89 PROFFER-GRAEDENKOV N. I. *Am. Rev. Soviet M.* 945, 292.
- 90 PYRHO, F. C. *Brit. M J* 936, 860.
- 91 RAAB J. *Am. J. Surg.*, 945 61 9
- 92 RAND, C. W. *The Neurosurgical Patient. Symp. Held Charles C. Thomas* 944.
- 93 RICHES, E. W. *Brit. J. Surg* 943 3 135
- 94 ROBINSON R. H. *Brit. J. Urol.*, 940, 244.
- 95 ROGERS, L. *Med. Press and Circ* 944, 2 1 148.
- 96 Idem. *Brit. J. Surg* 945, 5 55
- 97 RYGO-GUNN M. A. *J. R. N. M. Serv* 943, 4 28.
- 98 RUTH, V. I. *J. Low M. Soc.*, 938, 28 275.
- 99 SAMMONS, W. P. *J. Internat. Col. Surgeons*, 942 5 300
- 100 SANDOZ P. H., and GUTTMAN, L. *Middlewest Hosp. J.*, 1944, 44 67
- 101 SARTAL, P. C. *J. Ind. M. Ass.* 940 05.
- 102 SCARFF J. E. *Surg. Gyn. Obst.*, 945 8 495.
- 103 SCARFF J. E., and POOL, J. L. *J. Neurosurg* 946 11 285.
- 104 SCOTT R. T. *Northwest M.*, 94 4 356.
- 105 SUTCLIFF, R. G. and BRADFORD F. K. *South M. and S.*, 1939, 3 50.
- 106 STAR, L. D. *Am. J. Surg.*, 945 69 270
- 107 STEINLEDER A. *Proc. Internat. Postgrad. M. Ass. N. America* 944 58
- 108 STODOLY R. *Surg. Gyn. Obst.*, 937 64 407
- 109 STOCK R. M. *J. Kansas M. Soc.*, 939, 4 48.
- 110 Idem. *Southwest M.* 940, 23 57
- 111 STECKA, W. L. *Nebraska M. J.*, 1938, 23 47
- 112 SWIFT H. A. *West Virginia M. J.* 1939 35 80
- 113 *Symposium. War Wounds of the Spinal Cord. J. Am. M. Ass.* 945, 129 152.
- 114 TAYLOR, J. *Proc. R. Soc. M., Lond.*, 1940, 34 447
- 115 THOMPSON J. E. M. *Nebraska M. J.* 938, 23 45.
- 116 THOMPSON WALKER, J. *Brit. J. Urol.*, 937 9 246.
- 117 VORIS, H. C. *Surg. Clin. N. America*, Apr 1937 p. 543.
- 118 WALKER, F. M. R. *Lancet, Lond.*, 1944 73.
- 119 WORTH, S. B., and SHARP L. I. *J. Am. M. Ass.*, 94 1 7 585.

# ABSTRACTS OF CURRENT LITERATURE

## SURGERY OF THE HEAD AND NECK

### HEAD

Marino, H., and Cravotto M: Fracture of the Mandible (Fractura de la mandibula) *Pressa med. argent.*, 1946 33 1833

In common fractures of the mandible situated in the horizontal rami it is enough to fix both dental arches with ligatures to obtain excellent results but when dental fragments are absent and the fracture is situated behind the angle of the mandible the integrity of the maxillary arch which serves as the immobilizer is lost and difficulties arise. Intraoral appliances always fail because it is impossible to obtain good control of the ascending ramus which is pulled upward by the violent force of the pterygoid muscle.

Rainsford Mowlem the English plastic surgeon, used the method of Roger Anderson, i.e. reducing and fixing the bone fragments with pins or screws.

This method of treatment is indicated in the following conditions: fractures in the toothless with great displacement fractures behind the dental arch and fractures complicated by injuries of the face with lesion of the superior maxillary arch impeding intraoral prosthesis fractures without fissures which cannot be fixed by dental arches comminuted fractures with destruction of the osseous segment greatly displaced fractures and those in which intraoral treatment is no longer possible fractures in patients to be transported by sea or air and in those with vomiting fractures with great trauma of the face, accompanied by loss of substance and in which grafting is required and exposed comminuted fractures subject to early removal of bone splinters.

Contraindications to this method are: suppurative processes near or in the line of fracture or zone of insertion of the pins, fractures of the neck or the coronoids and sometimes the character of the bone. The advantages are: permanent and effective immobilization conservation of the masticatory function and acceleration of consolidation avoidance of articular rigidity facilitation of buccal cleanliness and feeding. Gingivitis and irritation by intraoral methods are avoided the patient is comfortable and without pain and the appliance is easily covered by a handkerchief or muffler.

The apparatus consists of 3 or 3 metallic walnuts formed by a central screw and two canalized hemispheres with a middle piece intermediate bars of union unoxidized steel wire pins and a wrench to tighten the screws.

The authors first secure a good roentgenogram showing the arrangement and relations of the neighboring dental fragments. Complete muscular relaxation is desirable. It may be obtained by means of intratracheal anesthesia or as preferred by the authors by local novocaine infiltration. The index finger is introduced into the mouth while the fingers of the other hand delineate the fracture externally and the assistant marks the posterior and inferior borders of the mandible with methylene blue or brilliant green. It is advantageous to insert the pins close to the line of fracture (about 1 cm.) but it is not always possible. They must be inserted at least 0.5 cm. from the inferior or posterior border so as to avoid the dental foramen with its nerves and vessels. To introduce the pin a mechanical or electric drill is used or the skin is perforated with a sharp pointed scalpel and the pin hammered into the cortex. Countertemperature is provided by the intraoral finger. Drilling should be done slowly to avoid heat necrosis around the pins. A metallic plate, to limit the depth of penetration, may or may not be used. For better control of the fragments the two pins should have a distance of 1 cm. between them. On the pair of pins corresponding to each fragment the squared half walnut is secured and the two pairs are fixed firmly with an intermediate bar which is fastened to the other canalized half walnut. It is not always possible to retain the ideal reduction, so it is wise to add an intermediate walnut formed by two canalized half walnuts and to use two smaller bars to obtain an adaptable universal joint. The simple external dressing is a small roll of gauze twisted at the level of the point of entry to the skin. Some surgeons apply a temporary interdental ligature or a sling bandage which is not necessary in the majority of cases. Clinically the walnuts are loosened and roentgenographic control is verified. The pins are extracted with pliers. The residual scar is minimal.

The authors cite the case of a patient with fracture at the inferior maxillary angle. His upper maxilla was entirely toothless there were some teeth in the anterior portion of the lower jaw and a right molar was present. On the left side where the trauma occurred there was a second molar and the root of the third molar passed through the line of fracture. The lesion had been suppurating for 12 days when the patient was first seen and there was a fistula in the region distal to the second molar. The pus was evacuated externally and the jaw was immobilized with penicillin was given. The pins were removed after 32 days the result was good. A. B. VINCIGUO MD

Stewart, M. B. and Conley J. J.: Fractures of the Maxillary Zygomatic Compound: Treatment by Improved Methods and Myoplasty. *Arch. Otol. Rhinol. Laryng.*, 1946 44 443.

The authors review the history of fractures of the maxillary zygomatic compound and discuss some of the

more popular methods of treatment in use at the present time.

The symptoms and signs of a fracture of the malar sygomatic compound are (1) pain (2) periorbital swelling and depression or flatness of the face (3) pain on mastication (4) trismus, if the arch is involved (5) intranasal hemorrhage on the injured side (6) diplopia (7) emphysema (8) a palpable depression extending into the orbit (9) subconjunctival hemorrhage and (10) neurological changes resulting from damage to the infraorbital nerve.

The four principal sites of fracture correspond to the articulations that is, (1) at the superior external orbital margin (2) the region of the infraorbital foramen, (3) the sygomatic arch and (4) the sygomatic process of the maxilla.

The authors mention the principal methods of treatment of simple depressed fractures of the sygomatic arch the first method being that of Blasas, in which a silver wire passed under the sygomatic arch and twisted over an external padded splint is used to hold the fragment elevated and in position.

Keen's intraoral approach through the buccal fold over the upper second molar is described briefly. This consists of elevating the fractured arch and maintaining this reduction by means of a lubricated pack.

The method of Manwaring and Gill consists of elevating the fragments by grasping the sygomatic fragment with a medium sized towel clip and manipulating it into position.

The Gillies method or temporal approach is the method of choice. It consists of making a horizontal incision over the temporal muscle and passing an elevator beneath the temporal fascia under the sygomatic bone. The skull is padded and used as a fulcrum and the fragments are manipulated into position. Approximately 95 per cent of the fractures of the arch can be reduced by this method.

In the treatment of malar fractures, manipulation is more difficult and fixation and traction are frequently required. The fragments are often impacted and reduction cannot be delayed as long as with a fracture of the sygomatic arch.

Roberts makes an incision over the malar eminence and elevates and manipulates the malar bone by using a corkscrew like instrument.

Fixation of the malar bone can be accomplished occasionally by direct wiring with tantalum wire. When traction with external fixation is needed a plaster of Paris head cap is constructed and a screw eye is inserted through an external stab incision into the malar fragment and held in position for about a week.

Lothrop's method consists of the antral approach with elevation of the malar bone and packing of the antral cavity.

Associated fractures of the maxilla can be reduced without a cumbersome head cap by internal fixation with wire this being placed through the orbital rim and through the soft tissues to be fastened to the teeth. These wires are left for several weeks and are then removed by opening the original incision, cut

ting the wires, and pulling them out through the mouth.

The author enumerates the more common complications of fractures of the malar sygomatic compound. These are diplopia, nerve injuries, hematoma in the maxillary sinus, and contracture of the masseter muscle. A special method of correction of the last named complication is described. This consists of a myoplasty in which three through-and-through transverse incisions are made in the masseter muscle at the sygomatic end one of them being in the anterior third and one in the posterior third of the muscle at the point of attachment to the sygoma. The third incision is made through the middle third of the muscle at some distance below the first two. This allows for greater opening of the mouth.

LOUIS T. BRAYS, M.D.

## EYE

Duggan, W. F.: Vascular Basis of Allergy of the Eye and Its Adnexa. *Arch. Ophth.*, Chic., 1946, 36 551

The author has reviewed the literature of allergy from the viewpoint of the etiological importance of histamine or histaminelike substance. His concept of allergy is that some influence, either chemical, nervous, humoral or climatic, through histamine, a histaminelike substance, epinephrine nicotine or over action of the sympathetic nervous system causes a smooth muscle spasm, capillary dilatation or both. The arteriolar constriction and the capillary dilatation cause a slowing of the blood stream in the capillary bed with a resultant capillary and tissue anoxia. The capillaries next become more permeable as a result of either lack of oxygen or of opening up of the spaces in the capillary walls and allow the passage of plasma, fibrin, white cells and red cells through their walls.

Since it has been shown that nitrites are beneficial in the treatment of anaphylactic shock and that there is a capillary and tissue anoxia, and since the author concluded that oxygen is a physiological antidote for histamine he reasons that drugs which increase the oxygen to those tissues should be of value therapeutically. He therefore used vasodilators in the form of sodium nitrite, amyl nitrite, erythritol tetranitrate and acetylcholine bromide in the treatment of conditions thought to be on this basis. The rationale was that it would reduce not only the offending agent, but also the resultant deficiency in oxygen. Foreign protein therapy was thought to be too dangerous and too likely to cause further allergic reactions.

Various eye diseases were then considered as being of possible allergic etiology. It is believed that acute glaucoma is a manifestation of capillary and tissue anoxia, and has the same pathological picture as that of histamine and allergy; and that if acute glaucoma is an angioneurotic edema of the eye it is due to histamine formed elsewhere and transmitted to the ciliary body where it acts on the capillaries and possibly the arterioles. In the

author's opinion the relief of anoxia by amyl nitrite accounts for some good results in the treatment of acute inflammatory glaucoma.

Herpes corneae, herpes zoster, and herpes irides are suggested as being allergic lesions on the basis of the typical pathology of allergy in the gasserian ganglion. This could be caused by histamine and treatment with vasodilators gave good results.

Various types of paralyses of ocular muscles may be due to allergy with consequent angiospasm and closure of one of the retinal arterioles with its result in some cases of retinal detachment is considered. The possibility of an allergic basis in the pathology of multiple sclerosis is compared with the pathology of allergy and found to be identical. It is thought that the local circulatory failure causes the myelin breakdown and that the glial overgrowth is secondary not primary. The pathological picture of retrobulbar neuritis was that of multiple sclerosis.

The causes of iritis and uveitis are listed and it is noted that all had vascular dysfunction in common thought to be allergic in nature. Acute exudative choroiditis and choroiditis serosa centralis are classed in this group. The pathological picture of scleritis and episcleritis was also suggestive of allergy.

The author has had excellent results in the treatment of these cases with vasodilators and he believes that although the treatment is nonspecific as regards the cause it is specific as regards the pathophysiological basis of the lesion.

ROBERT H. JOHNSON, M.D.

**Foster J. J. Certain Operations on the Superior Oblique Muscle.** *Br J Ophth* 1946 30 696

In the past Von Graefe had considered it better judgment not to operate on the oblique muscles. Since then myectomy of the oblique muscles, recession of the inferior oblique muscle have all been frequently performed with success although there has been relatively little surgery of the superior oblique muscle. Because of this relative rarity the author has reported 3 cases of surgery of the superior oblique tendon.

The first case was that of a man who had been hit in the forehead with a stone which had been hitting the forehead well above the orbital margin. Following this blow there was a paresis of the left superior oblique muscle resulting in a vertical diplopia in the whole lower field. Vertical prisms were of some benefit and orthoptic exercises were given. Later a partial tenotomy of the right inferior rectus muscle was done but the patient continued to have hyphema and cyclophoria. Because of this, the inferior oblique muscle was tenotomized by the Dunn-nington method. The superior rectus was divided to expose the superior oblique. A double armed catgut suture was inserted through the superior oblique tendon about 6 mm. from the insertion. This point was attached to the episclear tissue of the globe in

the line of the muscle without dividing the insertion. This, then was more of a tuck than a real advancement. The results were most successful clinically but there was a slight postoperative weakness of the left superior rectus muscle and residual overaction of the right inferior rectus and inferior oblique muscles.

In the second case the patient had had a basal skull fracture with a resultant paralysis of the fourth and sixth nerves. Surgery which included a 6 mm. recession of the internal rectus and inferior rectus of the lateral half of the superior and inferior rectus of the insertion of the external rectus and a 6 mm. tuck of the superior oblique tendon to its insertion was performed on the left eye. The results were satisfactory except for a restriction of the internal rectus muscle.

The third case had a marked limitation of the inferior rectus muscle of the left eye as a result of a penetrating injury in the orbit. Surgery of the inferior rectus was not satisfactory because of marked fibrosis and adhesions. An 8 mm. recession of the right superior oblique muscle was done with fairly satisfactory results.

McLaughlin R. S. ; Chemical Burns of the Human Cornea. *Am J Ophth*, 1946 29 1355

A chemical burn of the cornea was defined as an injury which results from local contact with a chemical to such a degree that there is alteration in the structure of the cornea and conjunctiva as demonstrated by a positive stain with 2 per cent fluorescein. The author reported on a series of 500 consecutive cases of this type. He found that 54 per cent of the injuries were caused by vapors and mists, 31 per cent by liquids, and 17 per cent by solids.

Because immediate care is of first importance a system of first aid was carried out in the industrial plants. The workers were instructed to wash their eyes thoroughly at one of the handy eye washing fountains. They were then taken to the dispensary where the type and pH of the offending agent were recorded. The eye was anesthetized gross particles were removed, and the eye was irrigated with a copious flow of normal saline solution for 15 minutes. Fluorescein was instilled and if the eye stained it was again washed for 15 minutes.

The patient was referred to the ophthalmologist for further irrigation by the ophthalmologist. The treatment by the ophthalmologist consisted of punctate and sulfathiazole (or sulfadiazine) ointments and patching. However it was found that neutral organic compounds had a delayed action. The organic compounds frequently caused opacification of the cornea and adhesions in the superficial layers of the cornea. These same chemicals were found to form a grayish well defined areas in the superficial layers of the corneal epithelium. It was thought that the for protein structures of the cornea. Then a portion of the absorbed chemical denatured the cellular pro-

tein which resulted in a liberation of the remaining unaltered chemical, and this in turn caused more damage both to the epithelium and Bowman's membrane.

Since in animal experimentation attempted neutralization caused no amelioration of the injury the cornea and conjunctiva were completely denuded of epithelium in the staining areas. This was done thoroughly with a cotton swab under cocaine anesthesia after which the eye was flushed with stainless merthiolate. By this method it was hoped that all the offending agent was removed. After acid and most neutral chemical burns, the eye was just debrided and irrigated. Then all types were treated with pontocaine and sulfathiazole (or sulfadiazine) ointment and patching. Homatropine was reserved for those who were not doing well on the second day. The instillation of methylene-blue powder and atropine, the use of foreign protein and sodium salicylate, and a search for foci of infection were begun if healing was not complete on the third day. The author believed that more vision was lost in chemical burns because of foci of infection than because of the actual effect of the offending agent.

Of these 300 cases, 91.3 per cent healed in 48 hours, 7.4 per cent healed slowly and 1.4 per cent healed with a residual loss of vision. The last 7 cases were reported.

ROBERT H. JOHNSON, M.D.

Carpenter, C. P., and Smyth, H. F., Jr.: Chemical Burns of the Rabbit Cornea. *Am. J. Ophth.*, 1946, 29: 1563.

This study was undertaken to help in estimating the damage to an eye by various chemicals and in the hope of instituting more rational therapy.

The authors first graded the severity of the eye burns resulting from a large number of chemicals and mixtures instilled in rabbits' eyes. This grading was based on the appearance of the cornea and iris before staining and on the area of the cornea that stained. The grading was felt to be reliable because the higher the score the longer the eye took to heal and because the higher the concentration of the chemical used the higher was the score.

To test the various chemicals and their dilutions a measured amount of fluid was instilled in a proved normal eye of an albino rabbit. The eye was examined from 18 to 24 hours later and the injury was scored. A total of 180 chemicals were arranged according to the grade of injury and listed in a table.

Since it has been thought that neutralization of acid or alkali burns is good treatment, the authors burned rabbits' eyes with acetic anhydride and then treated them with milk of magnesia. They found that milk of magnesia was of no benefit and did harm in some cases. They then burned rabbits' eyes with sodium hydroxide and irrigated them with 2 per cent acetic acid or 0.85 per cent saline solution. There was considerably less damage to the eye that was irrigated with saline solution alone. It was then found that citric acid in 2 per cent and in 0.5 per cent solutions damaged normal rabbit eyes.

The authors divided chemical burns of the eye into three categories, namely those produced by neutral, acid, and alkaline agents. In this article they investigated alkaline burns of the cornea. It was found that alkaline (and some neutral) agents caused a delayed damage to the eye even after prolonged irrigation. The authors were able to show that a rabbit's cornea retained a higher pH following a sodium hydroxide burn even after prolonged irrigation. This was demonstrated with a sealed hanging-drop preparation of corneal tissue and with a glass electrode. An *in vivo* test was devised in which the cornea of one rabbit was burned with sodium hydroxide and then well irrigated. A superficial section of this cornea was removed and placed on the eye of another rabbit for 1 hour. Repeated tests showed that the recipient eye had a higher pH when treated with a burned cornea than when treated with a section from a normal cornea. From this it was concluded that the alkaline molecules reaching the cornea are bound in some fashion to the epithelial cells and are not removed by prolonged washing with saline solution or water.

Since McLaughlin had experienced good results by removing the epithelium of human eyes which had been burned by alkaline material these authors applied the same technique to the experimental alkaline burns of the rabbit cornea. They found, contrary to McLaughlin, that any mechanical interference retarded rather than hastened the natural healing process in rabbit eyes.

ROBERT H. JOHNSON, M.D.

Arruga, H.: Detachment of the Retina: Pathological and Therapeutic Considerations. *Arch. Ophth.*, Chic., 1946, 36: 531.

Detailed studies of the ocular fundus, and histological examination have demonstrated that in cases of idiopathic detachment the retina is much altered. In many eyes which have not had detachments, atrophic and degenerative lesions which reduce the thickness of the retina (histologically) to one-third normal are seen. In some eyes retinal holes have been seen without retinal detachment. Therefore many eyes are predisposed to detachments but do not develop them. It is thought that an adhesion of the retina to the vitreous is necessary to raise and jerk the retina away from the choroid, but if the retina and choroid are tightly adherent, the retina will not detach in spite of this. Trauma is now considered less important than it was formerly. Small tears have a more rapid resorption of the subretinal fluid and a better prognosis than large tears or dissections.

Another factor in the formation and cure of detachments is the condition of the choroid. It is thought that little change in the choroid is required to make a detachment possible. A detachment which is replaced by rest has a good prognosis, since the choroid has shown that it is in good condition for reabsorption of fluid. This is necessary for the absorption of exudation caused by future diathermy. If

the choroid does not absorb the subretinal fluid well, the prognosis is not as good. There is also a variable response of the choroid to diathermy: those with less response (no uveitis) have a better prognosis. For this reason it is advisable to localize the diathermic action as much as possible. Immediate repetition of the operation is advisable only when tears appear which were not reached by the preceding diathermy.

Bed rest and binocular bandaging both before and after surgery improve the results of treatment.

ROGER H. JOHNSON, M.D.

Wilder, H. C.: Intraocular Tumors in Soldiers. *M/I Surgeon* 1946 99 459.

The author reports that he found a number of intraocular tumors in healthy soldiers from 18 to 38 years of age during World War II. True intraocular and potentially neoplastic tumors occurred in 42 (1.08%) of a series of 3,882 enucleated eyes of soldiers who were examined during the period between Pearl Harbor and VJ Day at the Army Institute of Pathology.

The reported series of cases includes benign and malignant melanomas of the uvea, bilateral intraocular metastases from pulmonary carcinoma and from malignant skin melanoma, malignant dyskeratosis in a traumatic intraocular epithelial implant and Von Hippel's disease.

The type of tumor most commonly observed was a malignant melanoma of the uvea, next in frequency was the benign melanoma. Benign melanoma of the choroid was found in several eyes which were enucleated following trauma—in 1 case of phthisis bulbi and in 5 cases in which the condition would probably not have been diagnosed in civilian life. Carcinoma of the choroid rarely metastasizes from the lungs. Melanomas in patients under 40 years of age are believed to be less malignant than those which occur in the later decades of life.

The author points out that the percentage of cases of intraocular tumors of the type usually observed was surprisingly low for the large number of patients examined.

JOSHUA ZUCKERMAN, M.D.

Sorsby, A. and Ungar, J.: Pure Penicillin in Ophthalmology. *Br J Ophth* 1946 2 73.

The authors discuss the value of pure penicillin in ophthalmology. Pure penicillin (calcium or sodium) salt is a white crystalline substance which is freely soluble and more stable than commercial (impure) penicillin, and remains stable for months at room temperature. One milligram of pure penicillin corresponds to 1,660 Oxford units. Whether applied locally to the eye as an ointment (containing up to 100,000 units per gram) in aqueous solution intra-vitally, or subconjunctivally, pure penicillin is well tolerated. By the introduction of concentrated ointments into the conjunctival sac, adequate therapeutic levels of penicillin can be obtained in the aqueous. To obtain higher levels, subconjunctival injection is necessary. Systemic administration of massive doses will yield adequate although evanescent, levels

Adrenalin added to the subconjunctival injection increases persistence. Beeswax for intramuscular injection helps to sustain the level of concentration.

Experimentally infections of the anterior chamber are readily controlled by the use of concentrated ointments, subconjunctival injections and systemic administration of penicillin. Infections of the vitreous are satisfactorily controlled only by subconjunctival injection.

Clinical trials show that the experimental results are applicable to man. JOSHUA ZUCKERMAN, M.D.

Harrington, D. O.: Autonomic Nervous System in Eye Disease. *Am J Ophth* 1946 29 1405.

In this article the author discusses the clinical manifestations of certain functional and organic eye conditions which have as their common etiology dysfunction of the autonomic nervous system.

Various conditions in which this subject could be clinically studied were illustrated by patients having (1) central angiospastic retinopathy (2) ocular changes associated with Raynaud's disease (3) amaurosis fugax (4) commotio retinae (5) migraine (6) contusion retinopathy (7) blast concussion retinopathy and (8) solar retinitis. The autonomic stimulæ are enumerated and the importance and frequency of psychic trauma as a cause of autonomic instability are shown. HURTER H. ROMANOW, M.D.

## EAR

Brown, J. B., Cannon, B., Lischer, C. E., Davis, W. B., and Others: Further Reports on the Use of Composite Free Grafts of Skin and Cartilage from the Ear. *Plast Reconstr Surg* 1946 1 130.

Losses of the ala, columella or tip of the nose, due to trauma, burns, wounds or operative causes have always presented a problem in repair. Correction has usually necessitated the utilization of local flaps which may alter a normal feature on or adjacent to the nose, or it may be necessary to transfer a remote flap which requires multiple procedures.

The use of a free transplant from the ear comprising two surfaces of skin with cartilage between has made possible these corrections in a single procedure. There is minimal deformity of the ear which is repaired either by closure of the defect, grafting of the raw surface or the use of a scalp flap.

Further experience with the use of composite free grafts from the ear in columellar tip and nostril margin repairs confirm the initial enthusiasm for this method. A total of over 50 operations of this type have been performed with failure in only 4 instances.

NOAH D. FABRICANT, M.D.

## MOUTH

Maxwell, M. M., Schock, C. J., and Heldt, E.: The Rationale of Treatment in Maxillofacial Injuries. *J Oral Surg* 1946 4 369.

The dual purpose of this article is to stress the necessity of adhering to a logical sequence of treat-

ment factors in the successful management of complicated jaw injuries and to emphasize pertinent fundamentals of concern to the oral surgeon.

In hospital practice the handling of these cases is a mutual responsibility of various services, of which the dental the plastic or orthopedic, and neurosurgical play the principal roles. It is of the utmost importance that the closest possible liaison exist between these services in the development of a rational plan of procedure. When a number of operations are involved in a case of maxillofacial reconstruction these operations should be performed in a sequence conducive to the best end result. For example it would be inadvisable to make a plastic repair on a collapsed jaw and thus render it more difficult for the oral surgeon to restore masticatory function. Conversely, it would be equally inadvisable to attempt immobilization of the jaws in the presence of severe systemic disorders requiring precedence in treatment.

Experience gained from World War I demonstrated the need for maxillofacial teams composed of various specialists working closely together to serve the best interests of the patient. Reports indicate that these teams, as used in the Services, have made a substantial contribution to improved treatment in World War II. However it is believed that even better results are possible of attainment when the various specialists making up these teams have a broad understanding and some training in mutual fields of endeavor. The establishment of treatment centers staffed by competent co-operative maxillofacial teams seems to be the solution to the problem of providing the best possible attention and care for the more complicated cases of face and jaw injuries.

The time of treatment for maxillofacial cases is frequently as important as the nature of the treatment rendered. Indeed it may be said that favorable prognosis for these cases is dependent upon two factors: the time of treatment as well as the nature of the treatment. With the passage of time if no treatment or simply symptomatic treatment is rendered, the prognosis becomes progressively more unfavorable. It is obvious that definitive treatment for these cases is considerably handicapped by the formation of cicatricial tissue by bony consolidation in malunion and by the inception of avoidable infection.

This article is divided into four parts with emphasis upon the oral surgeon's responsibilities at the time that maxillofacial cases come under his care.

Four cases are presented with many photographs and detailed descriptions of the management of each case.

JOHN F. DEXTER, M.D.

Bernier, J. L., and Thompson, H. C.: The Histogenesis of the Cementoma. *Am J Orthodont.*, 1946, 32: 543.

Fifteen cases of cementoma are reported and discussed. This material is presented with the suggestion that the reaction of the periodontal membrane in the production of the cementoma may be

essentially similar to the process resulting in the formation of ossifying fibromas fibrous osteomas, and fibrous dysplasia of bone.

If this analogy is true, then one is not entirely justified in assuming that the cementoma is a rare tumor. It likewise becomes important then, to place more stress on the histological analysis of such lesions if an accurate diagnosis is to be forthcoming.

NOAH D. FARRICANT, M.D.

## PHARYNX

Reeves, E.: Hemostasis after Adenoid Operations. *Laryngoscope* 1946 56 616

Formerly there was a greater percentage of tonsil bleeding than of adenoid bleeding than at present following a tonsillectomy-adenoidectomy operation. The greater incidence of adenoid bleeding today may be explained by the fact that greater care is now made to stop tonsillar fossa bleeding completely while bleeding from the adenoid fossa is somewhat neglected. Postoperative bleeding from the adenoid fossa can be very serious and difficult to control. Therefore, more care should be taken to stop completely all bleeding before the patient leaves the operating room.

Care should also be taken before operation to rule out any blood or infectious disease which may cause bleeding. It is better to avoid adenoidectomy in any case of elevated fever during the menstrual period in the presence of secondary anemia or during the treatment of syphilis by arsenic or bismuth. It is advisable to determine the bleeding and coagulation times of all patients prior to operation.

There are 5 generally accepted methods of hemostasis after adenoidectomy and tonsillectomy: the plain ligature, the suture ligature, packing, electrocoagulation and infiltration of the tissues with novocaine and adrenalin.

Reeves gives a detailed description of the anatomy of the nasopharynx and distribution of the pharyngeal tonsils. The blood supply and venous drainage is briefly discussed.

There are several methods of doing an adenoidectomy. Reeves uses the method described by Fetterolf with slight modification. This consists of removing the adenoids with a LaForce adenotome following the tonsillectomy. A curette is then used, if necessary. A Tlemann elevator is then introduced to obtain a view of the fornix and a punch of the Myles type is used to remove any remnant of adenoid tissue, loose mucosal tags, and the thick infiltrated mucosa of the posterior wall.

Following this, any bleeding from the tonsillar fossa is stopped and the adenoid fossa again examined. If any bleeding is present, it is usually from the edge of the cut mucosa. The author describes in some detail the application of a modified Conkley slipknot of No. 1 plain catgut to stop this bleeding. If bleeding is present from an area where a plain ligature cannot be used, a suture ligature may be of value, but care must be taken not to injure the im-

portant levator veli and salpingopharyngeal muscles. The method of injection and the technique of retronasal packing is discussed. Electrocoagulation may be necessary but Reeves does not often use that method.

When secondary bleeding occurs from the adenoid fossa an attempt should be made to find the cause. Several causes are mentioned. Control of this type of bleeding is similar to that mentioned but it is usually accomplished by removal of the clot and dropping adrenalin into the nose to reach the bleeding area. Supportive treatment is frequently necessary as is the use of drugs to increase the clotting of the blood.

WILLIAM A. AHROON, M.D.

### NECK

Lerman, J., Jones, H. W. and Calkins, E.: Studies on 2 Sporadic Cretinous Brothers with Goiter together with Some Remarks on the Relation of Hyperplasia to Neoplasia. *Ann. Int. M.* 1946 25 677.

The results of studies made on 2 cretinous brothers are presented in detail, along with brief clinical histories. The records of 2 other cretins with goiter seen previously were re-examined. The relationship between hyperplasia and neoplasia is discussed. Experimental findings in cases in which thyroid carcinoma was produced by thiouracil in the treatment of hyperthyroidism are considered. It was suggested that thiouracil be used only as a preliminary medication in preparing the patient for thyroidectomy.

RICHARD J. BENNETT, JR., M.D.

Beierwaltes, W. H., and Sturgis, C. C.: Complications following the Administration of Thiouracil. *Am. J. M. Sc.*, 1946 212 513.

The author after reviewing 7 fatalities from agranulocytosis following the administration of thiouracil, concludes that the most effective therapy for

this condition is the early administration of penicillin. Also the symptoms of fever malaise or sore throat occurring in a patient under treatment with thiouracil if properly evaluated will lead to earlier recognition of the agranulocytosis and earlier stoppage of the offending drug. The author also concludes that thiouracil should be stopped when the white blood cell count drops below 2,000 per cubic millimeter.

A series of 80 patients was treated with thiouracil. Five patients (8 per cent of the group) developed neutropenic leucopenia or agranulocytosis. The author believes that often in cases of neutropenic leucopenia after temporary stopping of the thiouracil it may again be administered with satisfactory results. However 1 of the 2 patients in this series that developed agranulocytosis developed a recurrence when the drug was resumed. There were no fatalities from agranulocytosis in this series. In only 1 of the 80 patients was it necessary to discontinue thiouracil because of a febrile reaction. In 2 of the 80 patients the results of thiouracil therapy were thought to be only moderately successful and thyroidectomy was performed. This was done in spite of the fact that the basal metabolic rate was reduced to within normal limits in both cases. Because of the incidence of carcinoma in patients with nodular goiter thiouracil is used only as a preoperative measure in these cases. In the 1 case of dermatitis which appeared in this series the drug was successfully readministered following the disappearance of the rash. Leg edema and jaundice were not observed in this series.

The author does not believe that there is a higher incidence of progressive exophthalmos in patients treated with thiouracil than in those in whom a thyroidectomy is performed. He now uses thiouracil plus desiccated thyroid to treat malignant exophthalmos. He believes that thiouracil is superior to iodine for preoperative preparation of patients with hyperthyroidism.

F. J. LESEMARK, JR., M.D.



# SURGERY OF THE NERVOUS SYSTEM

## BRAIN AND ITS COVERINGS CRANIAL NERVES

Lysholm E.: Experiences in Ventriculography of Tumors below the Tentorium *B u J Radiol* 1946, 19 437

This memorial lecture was delivered in April 1946 to honor Mackenzie Davidson, the well known British radiologist. The subject matter has to do with

467 infratentorial lesions examined by ventriculography from 1930 to 1946. One hundred and four cases had previously been discussed in an article published in 1935 to which the author refers us in regard to his technique. This technique has not changed in any essential detail, neither laminography nor terroscopy are used for it has always been possible to visualize the aqueduct and the third and fourth ventricles. The anatomy of the structures to

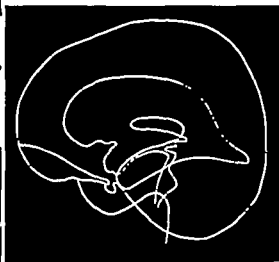


Fig. 1.

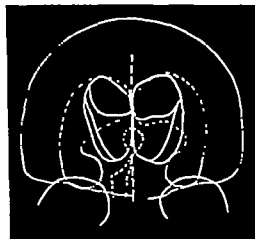


Fig. 2.

(Legends on opposite page)



Fig. 1 (Lysholm) Left, Pathological specimen of supra-tentorial midline tumor (Vermis). Note kink; right, drawing of supra-tentorial midline tumor.

Fig. 2 Left, Drawing of typical hemisphere tumor showing displacement of aqueduct and fourth ventricle (frontal); right, frontal roentgenogram of hemisphere abscess. Right hemisphere expanding process (verified abscess). Moderate symmetrical hydrocephalus. Kink in middle of aqueduct. Fourth ventricle and aqueduct displaced forward and slightly to the left.



Fig. 3.

Fig. 3 Left, Frontal roentgenogram. Lateral displacement of aqueduct and fourth ventricle; right, lateral roentgenogram of same case. Cerebellopontine angle glioma (medulloblastoma verified). Symmetrical moderate hydrocephalus. Aqueduct and fourth ventricle displaced to the right. Aqueduct displaced somewhat backward. At operation the tumor was found in the right cerebellopontine angle growing in the pons and right cerebellar hemisphere.

TABLE I — VERIFIED CASES OF INFRATENTORIAL LESIONS INVESTIGATED BY VENTRICULOGRAPHY FROM 1930 TO 1946

	No. of cases
Expanding lesions in the posterior part of the third ventricle (mostly pinealomas)	62
Aqueduct stenosis	63
Corpora quadrigemina	23
Pons region	24
Cerebello-pontine angle (21 of these = acoustic tumors)	36
Vermis and fourth ventricle, above fastigium	77
Vermis and fourth ventricle, below fastigium	110
Cerebellar hemispheres	100
Arachnoiditis	35
Total infratentorial lesions	467
Borderline cases between the medulla and cord	3

be examined is stressed and three projections, in different planes, are taken in any one position of the head.

The presentation is really a series of 56 pictures of pathological specimens, special views of the head with air or oxygen in the ventricular systems, and diagrams. Table I is descriptive of the material that forms the basis of the demonstration.

Although the series shows great accuracy in the localization of tumors below the tentorium, it was

pointed out that this method must be used in conjunction with careful general and neurological examinations. Certain errors managed to creep in. For instance, there were 42 negative ventriculographies for suspected expanding lesions of the posterior fossa of which 36 were never explored. Of the remaining 6 cases, 5 were explored with the following verified results: 1 stem tumor, 2 meningiomas, 1 acoustic tumor and 1 fourth ventricle tumor. The sixth case was diagnosed clinically as a pons tumor and x-ray treatment was given. The patient died 3 months later but an autopsy was not obtained.

ADRIEN VIER BRUGHEM, M.D.

Gramer, F. J.: Surgical Treatment of Syringobulbia and Syringomyelia; Report of 2 Cases. *Arch. Neur. Psychiat., Chic.* 1946, 56: 442.

The author has presented 3 cases of syringobulbia and syringomyelia which were treated surgically with the belief that they are the first so reported in the literature. The indications for operation in cases of these disorders were listed as being identical with those for syringomyelia, namely: rapid progression of the symptoms, increase of the intracranial pressure, cerebrospinal fluid block and accurate neurological localization.

Syringomyelic types of lesions have been known to occur with the Arnold-Chiari syndrome. The author observed in the first case that the cerebellar tonsils were herniated into the spinal canal but since this area was not explored it was impossible to say

whether the tonsils were attached to the cord. However the fact that the medulla and the fourth ventricle were in their usual position without any traction exerted upon them, and the fact that there were no bony defects found in the skull indicated that the cavitation did not result from an extra-axial cause.

Likewise it has been reported by other observers that arachnoidal adhesions have occurred in certain cases of Arnold-Chiari deformity with associated underlying syringomyelic lesions. The author stated that in spite of the fact that there was a thickening of the arachnoid membrane with vascularization of the syrinx there was no possible etiological relationship between the two for the cyst was primarily in the medulla and the adhesions were atlanto-occipital. Adhesions can be regarded as a causative factor only when they are bandlike and constricting in character.

The pathological process involved in syringomyelia and the associated conditions was discussed. These congenital anomalies are developed from ectopic glial cells which undergo both growth and degeneration. Symptoms are produced (1) by direct involvement of the cranial nerve nuclei and the fiber tracts, (2) by disturbance of the vascular supply to normal neural tissue and (3) by direct increased pressure of the fluid and degenerated products within the syrinx upon the surrounding tissues.

The problem of obliterating the cavity or maintaining the communication between it and the subarachnoid space was considered. It was the opinion of the author that the production of fluid within the syrinx is on the basis of degeneration of abnormal cells and not due to the secretion of new material. The final stages of this destruction of tissue was regarded as being present in most cases which required operation and it was believed that recurrence of the cyst would not take place at the point where operation had been performed.

Postoperatively the 2 patients whose cases were presented showed a definite relief of increased intracranial pressure and no further advance of the pathological process 14 and 18 months after operation respectively. On the contrary the second case even had some regression of symptoms because the signs were on the basis of edema, which subsided and the patient was able to return to work. These factors suggest that operation should be undertaken in these conditions when the above mentioned criteria for operation are noted. RICHARD C. SCHWEIDER, M.D.

Van Wageningen, W. P.: Observations on Changes in States of Mental Depression and Tension following Surgical Section of Certain Frontal Lobe Pathways. *Surgery* 94, 20 656

The author reports 4 cases in which various surgical sections have been undertaken in the treatment of severe mental depression.

The first case was that of a male with mental depression sufficient to incapacitate him for work. A bilateral prefrontal lobotomy as described by Free man and Watts was performed and a satisfactory result was obtained. The patient returned to work

The second patient a sister of the first patient, also with marked mental depression, was treated first by preliminary burr holes over the coronal sutures on both sides and opening of the dura however no section of the white matter was carried out, and the patient's condition remained unchanged. Nine days later through an osteoplastic flap, the anterior portion of the corpus callosum was divided as well as the anterior commissure and the right limb of the fornix. An incision was made into the white matter anterior to the caudate nucleus on both sides and an estimated area of from 1 inch to 1½ inches square was sectioned. A completely satisfactory result was obtained following this procedure.

The third patient a male aged 44 also with severe mental depression and ideas of persecution, was operated upon with essentially the same procedure as that described in case 2. Again a satisfactory result was obtained.

The fourth patient a female aged 50, with extreme nervousness and emotional instability and depression was treated by a left prefrontal lobotomy (Watts technique). No essential change in her mental state resulted. Three weeks later the anterior half of the corpus callosum was divided, and a section of the right prefrontal white fibers anterior to the caudate nucleus was planned but could not be carried out because of technical difficulties. The patient showed only slight improvement in mood there was no other change.

The author believes that the results obtained in these cases support the belief that bilateral division of the white fiber pathways between the basal ganglia and the frontal lobe cortex is sufficient to secure relief from states of mental depression and tension. Section of more white fibers may be unnecessary. He also points out that prefrontal lobotomy, as described by Watts is a more practical procedure and is attended by less surgery and considerably less risk than the section described. He concludes that division of the white fibers in the corpus callosum is not followed by any change in states of mental depression or tension. HOWARD A. BROWN, M.D.

Horvath, G.: Experiences with Cortical Excisions for the Relief of Intractable Pain in the Extremities. *Surgery* 1946, 20 393

The author reports the cases of 4 patients with intractable pain in the extremities, who were treated by excision of the postcentral sensory cortex.

The first patient had had both arms amputated above the wrists, and in this case bilateral excision of the sensory cortex was done in two stages. Temporary relief of pain resulted following each excision, but the pain factors began to return at the end of a week, and within 2 weeks the pain was as severe as it had been before operation.

The second patient suffered intractable pain in the right hand and arm. The pain was thought to be due to some pathological condition involving the cervical roots, which had failed to respond to two laminectomies. Excision of the postcentral sensory

cortex resulted in very little temporary benefit but the patient was addicted to morphine which presented an added problem. The author considered this case also essentially a failure.

The third case was that of a patient with intractable pain involving the right arm and leg secondary to a deep-seated tumor. Removal of the tumor and x-ray therapy gave relief for a time. Upon the return of pain excision of the sensory cortex was done with relief of the pain although with considerable increase in motor disturbance and transient aplasia. The pain returned in the arm area after 5 months, although the leg and foot were still comfortable.

The fourth patient had severe pain in the right hand and arm secondary to a tumor which had been previously removed in part. Following excision of the sensory cortex, there was paralysis of the arm and weakness of the leg but relief from pain was had for almost a year at which time the patient succumbed as a result of the tumor and a pontine hemorrhage.

In each case the sensory area was mapped out by electrical stimulation and the author reports that by j out of 4 patients pain could be produced by stimulation of the cortical sensory areas.

The first 2 cases were considered failures, while the results in the last 2 were considered relatively successful.

Norden A. Peripheral Injuries to the Spinal Accessory Nerve. *Ida chir scand* 1946 94 515

A review of 16 cases of peripheral injury to the spinal accessory nerve calls attention to an apparently completely overlooked condition of incapacity, tingling pain and weakness in the involved arm and shoulder.

Both the sternomastoid and trapezius muscles are doubly innervated the former by the second and third cervical and the latter by the third and fourth cervical nerves, as well as by the spinal accessory nerve. The anatomical course of the eleventh nerve is noted and its susceptibility to injury is pointed out—in cases of surgical intervention for the removal of tuberculous lymphomas, in biopsies, in direct contact with blunt instruments, and in trauma from gunshot wounds.

The symptoms consist of a feeling of heaviness in the arm, inability to lift the shoulder and pains of a dull aching type originating in the shoulder and radiating down the medial border of the scapula into the arm. The latter may be present on either the radial or ulnar side of the arm.

In 7 cases there were paresthesias in the form of numbness, prickling or throbbing sensations in the shoulder, arm or hand. On exertion, both pain and paresthesias in the extremity were increased in all cases.

Objectively there is paresis of the sternomastoid and trapezius muscles with associated atrophy. In the case of the latter muscle, this is not complete because of the double innervation of the muscle. Re-

flexes of the arm are normal and in no case is variation of the radial pulse noted however only 6 of the cases were observed for this factor.

Pains are of two varieties: (1) those due to depression of the shoulder with tension on the brachial plexus which tend to disappear upon supporting the extremity (apparently no part of the plexus is routinely involved because numbness may be present in part or all of the extremity) and (2) those due to periarthritis and peritendinitis secondary to disuse of the extremity.

Two of the 16 patients were without any pain but had pronounced paresis the remainder a majority of the patients, had pain in varying degrees, which more or less interfered with their ability to earn a livelihood.

The most satisfactory method of treatment, of course is prophylaxis. For operations in this area, it is believed that the spinal accessory nerve should first be sought and identified before any tissue is excised. A less risky zone should be selected for biopsy and if this is not possible the procedure should be carried out on the left side of the neck in right hand individuals where bilateral nodes are available. In cases of paralysis of the seventh nerve in which anastomosis operations are necessary it is suggested that the twelfth nerve be used instead of the spinal accessory nerve thereby causing less discomfort to the patient.

Once the injury has been sustained active treatment consists in suture of the nerve within 2 to 3 weeks. Orthopedic bandages have been suggested but are believed to be unsatisfactory. Muscle and fascial plastic procedures are of avail in some cases for support of the scapula. X-ray therapy and exercise are advocated for associated periarthritis and peritendinitis.

RICHARD C. SCHWARTZ, M.D.

## SPINAL CORD AND ITS COVERINGS

Fincher E. F.: The Differential Diagnosis of Intervertebral Cartilage Ruptures and Intraspinal Tumors within the Lumbar Sacral Canal. *South Surg* 1946 12 392

The increasing notoriety and popularity of the ruptured disc has served to focus diagnostic attention on the fact that radiating nerve root pain is more likely to be of mechanical origin than the result of so-called inflammatory or other intrinsic changes in the nerve structures. The disc possibility as a cause for a lumbago-sciatica syndrome has had its influence in bringing about earlier recognition of spinal cord tumors. The differential diagnosis of these two groups is by no means always easy. In the full-blown late developments of spinal cord tumor the diagnosis is not difficult and can be accurately made from a neurological examination. With the history of a specific initiating low back trauma and a subsequent radiating low back pain is quite likely the accurate diagnosis, a "disc" rupture may indicate an intraspinal tumor within the lumbar spinal canal.

In a large series of patients with clinically diagnosed ruptured lumbar intervertebral cartilages, who were incapacitated by their sciatic pain which conservative treatment had failed to relieve it was found that approximately 1 per cent of the group had intraspinal tumors. It was learned further from a study of clinically diagnosed tumors, that a higher percentage had completely herniated (either a full annulus or a nucleus pulposus, or both into the lumbar spinal canal) to produce a complete obstruction. These two groups, (1) the tumors diagnosed as discs and (2) the discs suspected as being tumors, form the basis of the present communication.

The subjective symptoms of these two groups of patients may serve to be very misleading in the clinical diagnosis. The history of trauma may be elicited in approximately 85 per cent of the cases of intervertebral disc.

In about one-third of the cases a history of exacerbations and remissions of symptoms was obtained. The remission of symptoms usually following bed rest. In the cases of intraspinal tumors there was no frank evidence that prolonged bed rest of the patients contributed to the alleviation of nerve root pain. The author points out that a general clinical rule might be that "disc patients lie and tumor patients walk" for relief of their nerve root pressure symptoms.

Intensification of sciatic pain on coughing and sneezing has been stressed as an important clinical sign of a ruptured disc. Occasionally this is true of tumor patients. Activities that entail low back bending are more likely to intensify the symptoms of ruptured disc, than those of tumors. In the case of ruptured discs, there is a tendency for a "list" to the non painful side. Subjective motor handicaps are infrequent in both tumors and ruptured discs. An acute complete rupture of a disc may precipitate a frank paralysis of dorsiflexion of the feet. A footdrop in a tumor patient develops instantly and is rather a latent manifestation of nerve root damage. Patients with ruptured disc are more prone to notice calf atrophy than are patients with tumor. In general, parasthesias of a ruptured disc are referable to one lower extremity whereas, in cases of tumor they are referable to both lower extremities. Muscle spasm of the lumbar erector group is strikingly absent in cases of tumor and a rather constant finding in cases of ruptured disc.

The author discusses the investigative procedures which are roentgenography of the lumbosacral vertebra, spinal puncture with manometric determination and fluid studies, and occasionally contrast media visualization of the spinal canal. He states that there is no necessity to make these procedures a routine in clear-cut cases of ruptured disc, but they are used when necessary for the making of a differential diagnosis. He also calls attention to the use of the exploratory operation for cases in which the diagnosis is in question. As a general rule, this is also a therapeutic procedure.

PAUL MERRILL, M.D.

## PERIPHERAL NERVES

D Aubigné, R. M.: The Treatment of Loss of Substance in Nerves (A propos du traitement des pertes de substance nerveuse) *Mém Acad. chir. Par.* 1946 73 409.

Since October 1945 100 peripheral nerve lesions, of which 59 had loss of substance, were treated at a surgical center. Because nerve grafts were considered unsatisfactory every effort was made to obtain end-to-end suture and it was found that unexpectedly large gaps could be closed. For instance 10 cm. in the median nerve 10 cm. in the ulnar 8 cm. in the radial, 10 cm. in the sciatic and 7 cm. in the common peroneal nerve. It is true that these long distances were covered in only single cases except in the instance of the radial nerve in which it was possible to gain 8 cm. on 2 occasions. Every available method was used to obtain closure of the gap including extensive mobilization of the nerve, transposition of the nerve flexion of the joints, and in 4 cases, shortening of the long bones. Only 30 cases could be followed up and among these there were 12 regenerations and 8 failures. As would be expected the length of the gap that must be bridged bears some relation to the result. In 5 cases in which the gap was 4 cm. or under there were 5 cures, but when the distance was over 4 cm. the results deteriorated by 50 per cent. The following table is a summary.

TABLE I.—LENGTH OF LOSS OF SUBSTANCE

	Cure	Failure
Less than 4 cm.	5	0
4 to 6 cm.	3	1
6 to 8 cm.	1	3
8 to 10 cm.		1
over 10 cm.	1	
	11	5

In some cases a graft has to be used, and on experimental grounds the autograft should be the most useful. This was proved to be the case clinically. The author's results with autografts and auto-cable grafts are not given. *ANNON VAN BUREN, M.D.*

D Aubigné, M.: The Treatment of Loss of Substance of the Peripheral Nerves (Traitement des pertes de substance des nerfs périphériques) *J. chir. Par.* 1946, 63 391.

The ideal goal of all treatment of loss of substance of the peripheral nerves is the complete restoration of the function which had been interrupted by the trauma. This can be reached only if the axons growing from the central stump are permitted to enter into the Schwann tubes of the peripheral stump and to reach their sensitive or motor end-organs.

If it is ever possible the direct end-to-end suture is preferable to grafting. Even if there is a considerable gap between the two ends, they can be approximated by different procedures.

1. Dissection of the nerve to a great length. By this technique alone from 3 to 6 cm. of length can be

gained in dissection of the median nerve. It is true that by very extensive dissection the vascularization of the nerve and consequently its function and regeneration may be jeopardized however experience shows that because of a network of intraneural anastomoses the resistance of the nerve to ischemia is remarkable. In any case a dissected nerve will be always better vascularized than a graft.

2 Further length can be won by transposition i.e., by changing the normal course of the nerve. This is true particularly for the ulnar nerve. Here the transposition of the nerve anterior to the epicondyle combined with flexion of the elbow permits end-to-end suture even in losses of up to 10 cm of nerve substance.

3 Additional length can be gained by appropriate position of the limb. In the upper extremity adduction of the shoulder and flexion of the elbow permit repair in lesions of the median, radial and ulnar nerves.

4 Suture in two stages has been suggested when approximation is impossible with the afore described methods however the results are not satisfactory and the method has been given up by the majority of French and British surgeons.

These mechanical devices for lengthening the nerve make end-to-end suture possible if the loss of nerve substance does not exceed 12 cm. in the sciatic radial nerve and 10 cm. in the popliteal nerve. If none of these methods is applicable there is finally the possibility of shortening the limb by resection of the bones. The applicability of this heroic method is, however quite limited it is justified only for the humerus if there is delay in union of the fractured bone in addition to the nerve injury.

The suture should not be made immediately after the injury. Statistical papers as well as histological examinations have proved definitely that the early secondary suture is much superior to the primary suture. The best time for the intervention is between the nineteenth and twenty fifth days after the injury this being the period of maximal proliferation of the Schwann cells.

If direct suture is definitely impossible, grafting is indicated. Three kinds of graft are possible: hetero-grafts i.e. replacement by animal nerves (dog cat or rabbit), homografts in which nerves from the amputated limbs of other patients are used and finally autografts in which cutaneous nerves of the patient are transplanted to the injured nerve. The results of the heterograft method have been rather disappointing and it has been condemned practically unanimously by American and British authors. In contradistinction to this negative attitude European authors report partial or complete regeneration in about 30 per cent of the cases. It seems to be important that the grafted nerve is living tissue (fresh dog nerve). In any case the heterograft method is reserved for cases in which no other method is possible.

The results of the homograft method have been equally disappointing as the transplanted nerve usually becomes necrotic and is replaced by bands of fibrous tissue.

The results of the autograft method have been much more encouraging. French, as well as American, authors reported success with autografts of the radial and median nerves up to a length of 15 cm. Here the main problem is to find a sufficient amount of material for the transplantation without causing functional damage. In most cases the internal cutaneous brachial or the external saphenous nerves are employed. As these nerves are of small diameter they have to be tripled or quadrupled to replace loss of substance in larger nerves (cable technique). The smaller the diameter of the transplanted nerves the better is the prospect. Small nerves are supplied with nutrient by the environmental tissue whereas large nerves when grafted, necrotize in the center. As suture material either human hair or thread of tantalum seems to give the best results. The most difficult problem is presented by the sciatic nerve because of its large caliber.

It is essential to resect the stumps especially the distal one before suture or graft is made to make sure that the operation is performed in healthy tissue. Most failures are caused by insufficient excision of the sclerotic tissue at the distal stump. Some men prefer to glue the stumps together with plasma or to apply cuffs of metal or other material rather than to suture. In case of failure to restore the nerve function palliative treatment must be applied. Motor paralyses can be compensated for in many cases by tendon operations arthrodeses and arthromy.

WEINER M. SOLMITZ, M.D.

Wertheimer and Mathieu: Results of Surgical Treatment in Wounds of Peripheral Nerves with Loss of Substance (Résultats de la chirurgie des lésions chirurgicales dans les plaies des nerfs périphériques avec perte de substance). *Mém. Acad. chir. Paris*, 1946, 72, 398.

This is the first group of cases reported by a French author concerning patients seen in a 1939-40 campaign and that of 1944-45 who received surgical treatment for wounds of the peripheral nerves with loss of substance. All patients were operated on under the direct supervision of one person and therefore present a group treated in a uniform manner. Follow up reports of some of the cases were unobtainable because of transfers in North Africa and return of the patients to their country. Some cases are too recent to be of value.

In all, 61 observations were made and a comparison was made between direct suture by mobilizing the nerve and flexing the joints over which it runs with immobilization and the results obtained by various forms of nerve grafts. The types of nerve grafts used were: heterografts with the spinal cord of the rabbit or cat, 11 cases; autografts usually with the medial cutaneous nerve of the arm, 10 cases; and homografts from amputated limbs 9 cases. Only

TABLE I.—THE TIME FACTOR IN RESULTS

Immediate suture	Cases 100% successful
During the first month	3 Cases 33% successful
During the second and third month	7 Cases 43% successful
During the fourth and fifth month	1 Case 7% successful
During the sixth and seventh month	4 Cases 35% successful
From seven months to a year	8 Cases 0% successful
After a year	3 Cases 0% successful

1 autograft was a success and it was used on the ulnar nerve in the arm 35 months after operation the patient had only some weakness in the abductor digiti quinti. One other autograft and 2 homografts showed slight evidence of regeneration.

In direct suture of nerves, in contrast to nerve grafting the results depend on the wounding agent and the time of suture. For instance the same author states that in civil practice there were failures in 45 per cent of the cases whereas in military practice there were failures in 60 per cent.

ADRIEN VER BROEGHEM, M.D.

### MISCELLANEOUS

Van Rijssel T. G.: Circulation of the Cerebrospinal Fluid in *Carassius Gibelio*. *Arch. Nerv. Psychiat. Chic.*, 1946, 56: 523

Controversial opinions regarding the origin, movement, pathways, absorption and function of the cerebrospinal fluid are prevalent in the literature. To determine the extent of the perivascular spaces and circulation of the cerebrospinal fluid in these areas the following experiments were undertaken. A species of carp *Carassius gibelio*, was selected

because its anatomical features facilitated such a study. Eight fish were allowed to swim in solutions of trypan blue. Subsequent examination revealed that dye failed to enter the central nervous system. Thus, a blood-cerebrospinal fluid barrier exists for trypan blue.

To trace the flow of cerebrospinal fluid dye (trypan blue or India ink) was injected into the pericerebral spaces of these fish and microscopic examination of serial sections was made. The fish were killed at varying intervals of time following the injection. The significant facts revealed were:

1 Perivascular spaces occur in the brain of *Carassius gibelio* and these are in open communication with the meningeal spaces and the ventricles.

2 Particles of trypan blue or India ink pass through these routes from the meningeal or ventricular spaces into the perivascular spaces.

3 Movement within the perivascular spaces occurs in the same direction as that in which the blood flows and is attributed to the vessel pulsations.

4 An extensive interchange of cerebrospinal fluid takes place between the ventricular fluid or internal cerebrospinal fluid and the external fluid, or that surrounding the brain in the meshes and chambers of the meningeal tissues. This exchange occurs through the thin roof of the third ventricle and the perivascular spaces of the vessels reaching the surface of the brain from the ventricle.

5 The choroid plexus of the fourth ventricle absorbs colloidal suspended particles from the ventricular fluid.

6 There is a strong blood-cerebrospinal-fluid barrier and a less absolute cerebrospinal fluid-parenchymal barrier for trypan blue. The latter of these barriers is stronger with respect to India ink.

C. FARRERICK KITTLE, M.D.

# SURGERY OF THE THORAX

## CHEST WALL AND BREAST

Aiken, D. Brodie's Disease of the Breast. *Brit J Surg.* 1946, 34 87

Unusually large noncancerous breast tumors were recognized early in the nineteenth century. Brodie, in 1846 and his contemporary Cooper regarded the neoplasm as an advanced stage of cystic disease of the breast. Brodie's penetrating observations and gift of graphic description earned him the deserved honor of the eponym. There have been only 125 cases recorded to date in the medical literature.

The term "Brodie's tumor" should be reserved for large, excessively cellular and long neglected fibroadenomas. The history of a pre-existing breast tumor of many years' duration which at first grows slowly or not at all and, finally in late middle age increases rapidly in size is the outstanding feature of this tumor. Commencing as a fibroadenoma, it maintains the characteristics of an innocent lesion throughout. The skin overlying the tumor is mobile; there is no fixation to the deep structures and the lymph nodes are not usually involved, apart from the hyperplasia due to inflammatory changes. Enlargement may be so great that ulceration of the skin results from pressure necrosis and the foul fungating mass in a patient past middle life at once suggests a carcinoma. Sometimes the correct diagnosis of an innocent large tumor is impossible until the breast is removed. One striking clinical feature in typical cases is the excellent general condition of the patient.

Local recurrence following excision of the tumor has been reported on rare occasions, especially by the earlier writers, and convincing evidence of malignancy is even rarer.

The cut surface of a Brodie's tumor reveals an encapsulated mass showing white whorled areas, deep clefts, and translucent lobules, some of which degenerate into cysts. Microscopically its structure is that of an intracanalicular fibroadenoma which has become very cellular and shows degeneration and even cystic softening. In the cellular areas of the fibroblast dividing cells may be found but the mitoses are regular. It is this appearance which may lead to the diagnosis of sarcoma.

The best treatment of Brodie's tumor appears to be simple mastectomy rather than local excision for care must be taken not to leave any breast tissue behind in the skin flaps. It is possible that recurrence of the tumor may take place from a fragment remaining *in situ* as in simple tumors of the parotid gland. It has been suggested that the rapid growth of these fibroadenomas in late middle life may be associated with diminished estrogenic activity.

The author reports a case of a 68 year old woman who presented the described picture. A simple mastectomy was done. One year later there was no evidence of recurrence.

LEX PULLEN M.D.

Ragnell A.: Operative Correction of Hypertrophy and Ptosis of the Female Breast: 500 Cases. *Acta chir scand.* 1946, 94 Supp 113.

Plastic surgical procedures for the correction of hypertrophy and ptosis of the female breast are presented in a complete and detailed monograph. The subject matter is presented in four parts and a comprehensive bibliography greatly enhances the value of the report. Results and criticisms of the author's methods, evolved over a series of 300 cases in the past 9 years, are forthrightly presented.

Part 1 is devoted to embryology, physiology and anatomy. The circulatory system of the breast, both blood and lymph, receives the greatest attention. From an analysis of the investigations of numerous anatomists, it appears that the individual breast may have a variable blood supply with the internal mammary and long thoracic arteries always present and the third to seventh intercostal arteries usually present, but supplying blood in a somewhat different degree. The areola and nipple usually form a splendid anastomosis from the first two arteries with the aid of the intercostal arteries in some instances. In some breasts, however, this area is supplied by end arteries, and as there is no way of determining such a condition in advance, due caution is always necessary. There are no universal laws for circulation in the mamilla. Nerve supply, lymph circulation and the physiology of lactation are discussed.

In part 2 a classification of breast deformities is attempted. The groupings of various authors are presented, and the author suggests the following classification, which he uses:

1. Bilateral overdeveloped breasts with and without ptosis.
  2. Breasts of normal size with ptosis.
  3. Bilateral underdeveloped breasts with and without ptosis.
  4. Asymmetrical breasts over or under developed with and without ptosis.
- Causative factors of the different types of breast deformity are discussed.

With regard to the indications and contraindications for plastic surgical procedures, consideration should be given to (1) the symptoms complained of by the patient (as often mental as physical) and (2) the skill and experience of the surgeon.

A thorough discussion, with excellent illustrations of the several more or less classical procedures of Passot, Biesenberger, Gilles-McIndoe, and Malinjak, and criticisms of each procedure follow. Once again great emphasis is placed on circulatory considerations. Loss of the nipple and areola is of course the paramount apprehension in reconstructive procedures of the breast. Practically all authors agree that venous stasis is the predominant cause of necrosis of the nipple. The innervation and lactation of breasts following surgery are briefly discussed.



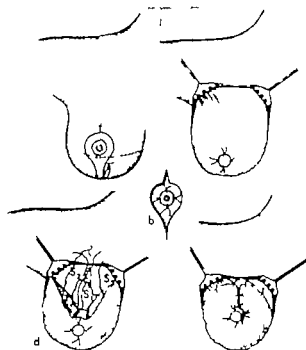


Fig. (Ragnell)

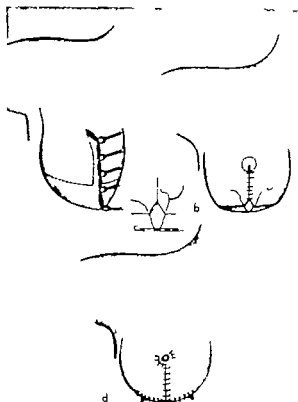


Fig. 3.

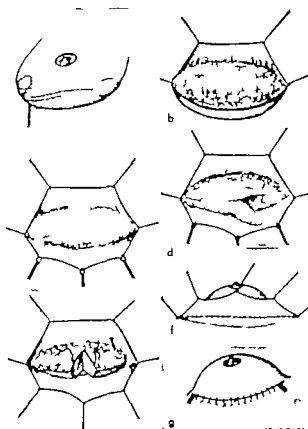


Fig. 2.

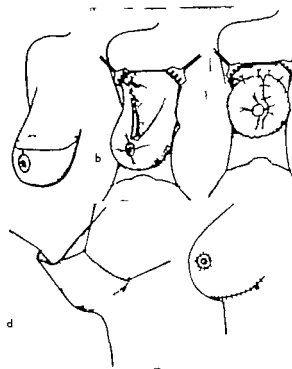


Fig. 4.

## LEGENDS

Fig. 1 (Ragnell) Method I (one stage) a, Skin incisions marked. b, Periareolar skin removed temporary fixation sutures inserted. c, Skin retracted, the gland prior to reduction. d, Sector shaped resection from the gland, fixation sutures with a lifting action inserted. e, Reconstruction of gland.

Fig. 2 Method II (two stages) Stage 1 a, Skin incisions marked. b, Upper skin flap retracted. c, Upper and lower skin flaps retracted. d, Crescent shaped resection of gland. e, Sector shaped resection of gland one of sutures inserted. f, Skin covering replaced resection from lower skin flap. g, Final skin suture.

Fig. 3 Method I (one stage) a, Skin covering replaced preparatory to shaping and reduction. b, Skin covering reduced and sutured. c, Detail of suturing. d, Final skin suture.

Fig. 4 Method II (two stages) Stage I a, Skin incisions marked. b, Skin retracted, sector shaped resection from gland. c, Reconstruction of gland. d, Skin covering preparatory to reduction of lower skin flap. e, Final skin suture.

In part 3 the operative techniques used by the author and their evolution from the methods of others are presented. Preoperative and postoperative care are considered. The author uses both a single stage procedure in cases of breasts without enlargement or with only moderate hypertrophy and a two stage procedure for long and pendulous breasts and those with more marked hypertrophy.

In the final section the author criticizes his method as to its anatomical and clinical aspects. Tables pertaining to symptoms weights of resected tissues diagnosis complications etc. are presented and anatomical and physiological results are tabulated.

This monograph is worthy of study by anyone interested in plastic or reconstructive surgery on the female breast.

EARL H. KLABUNDZ, M.D.

## TRACHEA LUNGS, AND PLEURA

Geland, G.: Traumatic Pulmonary Edema Treated with Concentrated Plasma. *Lancet* Lond. 1946 1: 667

Pulmonary edema due to trauma carries a grave prognosis. It was observed frequently in battle casualties, and its causes included blast petrol explosions, chest wounds, fat embolism and accidental overtransfusions with either blood or saline solution. In civilian accidents it is observed in burns due to underground explosions, in petrol explosions in accidental inhalation of noxious gases in industry, and in accidental overtransfusions. Pulmonary edema is characterized by severe respiratory distress and pronounced cyanosis. Large quantities of frothy mucus are thrown up into the trachea and well up through the larynx. According to the degree of consciousness present, attempts are made by the patient to cough up the frothy mucus. Auscultation of the chest detects coarse crepitations which sound very close to the stethoscope. Danger to life lies in drowning from vast quantities of mucus in the alveoli and bronchial tree.

The author states that he has observed on many occasions that concentrated plasma administered intravenously reduces edema in second degree burns apparently by its direct action in raising the osmotic pressure in the capillaries. If this can be done in traumatic edema in other parts of the body it should be possible in pulmonary edema due to trauma. The author outlines his method of treatment for pulmonary edema of traumatic origin.

1 Atropine (gr 1/50) is administered intravenously to diminish bronchial secretion to a minimum as soon as possible.

2 As much of the mucus in the bronchial tree as possible must be removed. This is accomplished by postural drainage, aspiration and injection of the drugs which tend to produce a temporary return of the cough reflex.

3 Oxygen is given continuously by a method which insures maximal concentration of that gas in the nasopharynx.

4. Concentrated plasma is administered intravenously. Originally double strength plasma was used later triple strength plasma has been used. The plasma is administered at a rate of 80 drops a minute, and little difficulty is experienced in maintaining the flow if slight pressure is used. A dose of 400 c.c. is usually adequate but occasionally up to 800 c.c. are required.

5 Other fluid intake is regulated to a minimum to obtain the maximal benefit from the increased protein concentration in the circulating blood.

The author gives 5 case reports in which this procedure was used and summarizes his article as follows.

Intravenous administration of concentrated plasma has seemed to be a valuable addition to recognized methods in the treatment of pulmonary edema due to trauma. Illustrative cases are described.

There has been no tendency for the pulmonary edema to recur after this treatment in the types of cases described. Apart from the risk of reactions to the plasma, the method is dangerous only if applied without preliminary venesection in cases of pulmonary edema due to overtransfusion.

PAUL MERRELL, M.D.

Brock, R. C.: Studies in Lung Abscess. *Guy's Hosp Rep* Lond. 1946 95 40.

Abscess of the lung due to infection with Friedlaender's bacillus is a rarely like staphylococcal lung abscesses, it serves as a characteristic example of an abscess due to a specific infection. This is in contrast to the much larger group in which the primary cause is some form of bronchial embolism. In the case of a Friedlaender's infection the primary event is a specific pneumonia and the abscess follows this pneumonia. The condition is indeed 'pneumonia with abscess formation'. The statement that lung abscess usually follows pneumonia is largely incorrect. In nearly 75 per cent of cases it is possible to identify the primary cause as other than a primary acute pneumonia.

## INTERNATIONAL ABSTRACTS OF SURGERY

The acute pneumonia caused by Friedländer's bacillus is notorious for its gravity and its high mortality. Usually the clinical course is short none of the earlier reports describes a chronic form of the disease. The scanty literature reveals that 18 cases have been pneumonia caused by Friedländer's bacillus did not end fatally but broke down to form abscesses, and assumed a chronic suppurative course. The condition in some of the patients resolved with fibrosis some patients ultimately succumbed.

The bacillus of Friedländer must always be thought of as the possible causal organism when abscess formation appears in a gravely ill patient. It must also be borne in mind if such a suppurative process becomes chronic, and particularly if the persistence of thin walled cavities with metastatic lesions elsewhere in the lung stimulates chronic pulmonary tuberculosis, but the sputum is consistently negative for tubercle bacilli.

Two additional cases are reported, which brings the total to 20.  
Sauer, Karm M.D.  
Pulmonary Adenoma

Paul, L. W., and Ritchie, G. Pulmonary Adenoma. *Radiology* 1946, 47: 354.

Pulmonary adenomatosis in man is a rare pulmonary disease characterized by the development of multiple nodular adenomatous tumors or by diffuse hyperplasia of the pulmonary alveolar lining. The disease is bilateral and interferes greatly with the gaseous exchange. Metastases do not occur elsewhere in the body and patients usually succumb from terminal pneumonia. Pathologists speculate on its close histological resemblance to an infectious disease of the lungs, called jaagsiekte in sheep and other animals. This disease is endemic in many areas of the world it is believed to be of infectious origin and possibly due to a virus. Just what relationship exists between jaagsiekte and pulmonary adenoma in man remains to be determined.

Bonne in 1939 first described this condition in man and called attention to its close resemblance to jaagsiekte in sheep. He suggested calling this condition carcinoma rather than adenoma. Numerous cases of a similar nature have been recorded in the literature, but they vary chiefly in the bronchial metastases have been found either in the bronchial lymph nodes or scattered widespread throughout the body. The disease has been referred to as alveolar cell carcinoma and shows the characteristics of a malignancy. The metastases often influence the clinical symptoms and progress to a considerable degree.

The authors limit their discussion to cases in which metastases do not occur and which resemble more closely Bonne's original description.

Investigations to determine the infectiousness and the presence of a virus in pulmonary adenomatosis are few and thus far have been fruitless.

The pathological lesion consists typically of scattered nodules of consolidation on the cut surfaces of

the lungs. These are usually mistaken for patches of gray pneumonia until microscopically they are identified as localized occurrences of abnormal lining in the alveoli. The lining is made up of either low or moderately high cuboidal epithelium, the cells of which tend to be slightly pear shaped and form papillary projections into the alveolar spaces. These cells are believed by some to have arisen from alveolar covering cells although there is some evidence that they come from bronchial epithelium. The alveolar walls in these nodules are thickened and edematous, with increased connective tissue.

The authors present 5 cases of pulmonary adenomatosis, illustrated by x-rays and photomicrographs. A study of the histology in these cases seems to show (1) that the abnormal epithelium of adenomatosis is derived in some cases at least, from bronchial epithelium and (2) that in certain cases adenomatosis constitutes a transitional form between normal lung and carcinoma and must be regarded as a potentially precancerous lesion.

The onset of pulmonary adenomatosis is usually insidious, although in several of the authors' cases it was accompanied by symptoms of an acute respiratory infection. Dyspnea and cough were the most common symptoms. The dyspnea is due to the placement of the alveolar cell lining with abnormal secretions in the alveoli and bronchi also cause dyspnea. The dyspnea may be far out of proportion to the extent of the pulmonary involvement that can be demonstrated roentgenographically.

The cough is usually productive of thin, watery frothy mucoid sputum. The sputum may be abundant early or late in the disease. Hemoptysis does not occur and blood-streaked sputum is usually seen only in a terminal phase. This watery sputum is accounted for by the tendency of the abnormal cells to produce mucin.

The remaining symptoms of weight and strength loss, fever and anorexia are not of diagnostic importance. In the majority of cases the condition occurs at the usual age period for carcinoma. The duration of the disease is for months or years, 4 months, and 2 years, respectively.

A review of roentgenograms shows a main type of lesion neither of which is in any way characteristic. One group of lesions is manifested by an area of consolidation. They are often bilateral and extensive. Another group of lesions is manifested by bronchogenic atelectasis is not a prominent feature. The roentgen diagnosis is usually pneumonia or bronchogenic carcinoma. A second form of the disease is manifested by nodular or patchy infiltrative shadows, often widely disseminated throughout both lungs, and likely to be confused with carcinomatous metastases. Since the shadows produced can be caused by a sarcoid Hodgkin's disease silicosis, or tuberculosis, a number of other conditions, the outlook for even a fully establishing definite roentgen diagnostic criteria seems remote.

The diagnosis is purely of academic interest since all cases of the disease have been fatal. The possibility of lobectomy or pneumonectomy has been suggested if the disease can be recognized early enough before it has spread widely.

It is hoped that with the accumulation of additional cases in the future a better understanding of the clinical and roentgen aspects of the disease may be obtained.

ROBERT R. BIRLOW, M.D.

**Mastakallio, S.** The Result of Roentgen Therapy in Histologically Verified Cases of Pulmonary Cancer. *Ann. med. int. fenn.* 1946 35 109

This investigation is based on 51 histologically verified cases of pulmonary cancer. The patients included 47 men and 4 women. The cases were divided into two groups according to treatment. The first included those who were given radical roentgen therapy (over 10,000 r on the skin) and the second, those who were not treated or who were treated insufficiently (under 10,000 r on the skin). The patients in the former group have lived on an average of 1 year, 2 months, and 11 days after the beginning of the treatment and 1 year and 9 months after the onset of symptoms. Two patients are still alive and well, one after 6 years and 10 months and the other after 3 years and 7 months following treatment. Metastases were found in the clavicular region and in the neck of the former patient. These metastases were treated and cured. This shows that in some cases cure can be obtained with roentgen rays but not with surgical treatment.

In the group of untreated patients the average survival time after diagnosis is 3 months and 5 days and from onset of the symptoms, 5 months and 9 days. The inflammatory processes around the carcinomas in the lungs have a disturbing effect on the roentgen treatment. Chiefly because of that fact only 21 of 51 patients have tolerated the radical roentgen therapy.

Roentgen treatment must be tried in all cases of pulmonary cancer if the general condition of the patient permits the trial of this very often strenuous therapy. If the patient tolerates this treatment, it must be continued until the tumor dosage of 6,000 r is reached.

JOHN E. KIRKPATRICK, M.D.

#### HEART AND PERICARDIUM

**Welln, S., Hamberger, C. A. and Crafoord, C.:** Surgically Removed Foreign Body Embolus in the Pulmonary Artery. *J. Thorac. Surg.* 1946 15 302

In this case reported by the authors a metallic object 1 cm in length over 1 mm. in thickness and from 7 to 8 mm. in breadth had entered the femoral vein and had been thrown by the blood stream into the pulmonary artery.

There is no mention in the medical literature of a case in which a foreign body had entered a vessel so far toward the periphery as in this instance. From a diagnostic viewpoint this case was of the greatest

interest. Only by the combined use of the x rays and bronchoscopy could the exact diagnosis be made.

So far as the authors were aware, this was the first case in which the diagnosis of foreign body embolus in the pulmonary artery had been made prior to operation and in which the foreign body had afterward been extracted by thoracotomy plus arteriotomy followed by vascular suture.

The case report and operative procedure are given in detail.

JOHN J. MALONEY, M.D.

#### ESOPHAGUS AND MEDIASTINUM

**Morton, D. R. and Brunschwig, A.** Peptic Ulcer of the Esophagus. Report of a Patient with 10 Year Follow Up. *Gastroenterology* 1946 7 314

The purpose of this report is to record the history of a patient seen in 1935 with a lesion which was at first thought to be malignant but which eventually proved to be a benign ulcer. The patient has subsisted principally by gastrostomy feedings until the



Fig. 1 (Morton and Brunschwig) Roentgenogram taken in 1935 showing constriction and deformity of lower thoracic esophagus which gave clinical impression of carcinoma.



Fig. 2. Photomicrograph (X50) of biopsy of esophageal ulceration secured in 1935 typical appearance of peptic ulceration.

present time (1945) a period of 10 years. When first observed in 1935 the question of resection was not seriously considered inasmuch as the technique for such a procedure had not been well defined and few attempts at such excision had been made. The patient, a 65 year old widow entered the Medical Service of Billings Hospital for the first time on June 16 1935 with the following story

One year prior to admission she noted burning epigastric pain an hour postprandially. Her local physician made a diagnosis of duodenal ulcer without the aid of x rays or gastric analysis. She was treated with powders and a bland diet and obtained complete relief. There was a weight gain of 3 pounds on this regime.

Two months prior to admission she began to vomit recently ingested food. At first this occurred 3 or 4 times a week. The vomitus was not bitter and contained no evidence of blood. The vomiting progressively became more severe. It occurred after every meal and began to be associated with sharp substernal pain which frequently radiated through to the back at a point between the shoulder blades. This pain was also noted upon swallowing food.

The patient stated "it felt as though there were an obstruction." At first, solids could be ingested, and then only fluids and finally during the 3 weeks before entry nothing could be retained. There was a weight loss of 45 pounds.

On physical examination she appeared emaciated and dehydrated and there was obvious evidence of recent weight loss. There were no remarkable findings pertaining to her condition other than changes associated with senility. The abdomen was scaphoid, not tender and presented no masses. Laboratory data were all within normal limits.

A provisional diagnosis of carcinoma of the terminal esophagus was made. The patient received parenteral fluids and roentgenographic study revealed that the esophagus was narrowed to approximately 3 or 4 mm for a distance of 9 or 10 cm. at the level of the seventh thoracic vertebra. The margins of the constricted area were somewhat irregular (Fig. 14). The mucosal folds were not completely destroyed and the segment of narrowing tended to change shape. Small peristaltic waves were seen passing through this area. There was no evidence of a "beak" or protrusion suggestive of ulcer or diverticulum. The mucosal pattern of the stomach appeared normal. It was decided to repeat the procedure described after the patient had inhaled amyl nitrite. Following this, there being no change the radiologist believed that the stricture was an organic lesion probably scirrhous carcinoma.

The patient was transferred to the surgical service with a preoperative diagnosis of carcinoma of the terminal esophagus. On July 2 1935 under local and ethylene anesthesia a high midline abdominal incision was made. There was no evidence of carcinoma within the abdominal cavity. The gall bladder wall was thick and contained many stones. The operative procedure consisted of a cholecystectomy and a Pezzer catheter gastrostomy (Brunschwig). The postoperative course was uneventful. Within 10 days she was tolerating a full gastrostomy diet, gaining weight, and appearing cheerful.

Esophagoscopy with biopsy was performed on 3 occasions, July 21 1935 November 12 1935 and December 16 1935. All 3 examinations revealed a narrowing to 4 mm. of the midportion of the esophagus. The right lateral wall was pale flat and showed an ulceration with well demarcated borders. The surrounding mucosa was red and granular. The granulations bled easily and the lumen was dilated. All esophagoscopic examinations gave the impression of carcinoma, but the 3 biopsies revealed chronic ulceration (Fig. 2). On none of the biopsy specimens was there epithelial lining.

The patient was discharged and followed up in the out patient clinic. Other than having to return every 6 to 8 months for replacement of the Pezzer catheter gastrostomy which became eroded from the gastric juice the patient enjoyed excellent health. She gained 30 pounds in weight on the gastrostomy diet, and gradually was able to take a pint of milk and a soft boiled egg by mouth each

day. However the main part of her nourishment was taken through the gastrostomy catheter. Roentgenographic study was repeated on November 16, 1937 and the stricture was found to occlude the esophageal lumen almost completely.

In 1939 she moved away from the vicinity of Chicago and was not heard from until she was readmitted to Billings Hospital on November 29, 1945. She was now 75 years of age and had been well until the previous June at which time she developed intermittent attacks of vomiting. The first attack continued for 3 days and the vomitus contained brown digested blood according to her physician. Roentgenological studies performed elsewhere were said to show advanced carcinoma of the terminal esophagus and the pylorus. She was advised to return to her original physician for treatment. Physical examination revealed an elderly female in comparatively good health. There were no findings of significance other than a slight excoriation of the skin about the gastrostomy tube which because of erosion was spilling gastric juice about its entrance into the abdomen.

The catheter was replaced under general anesthesia. Repeat roentgenographic studies (Fig 1B) revealed no change in the esophageal lesion except irregularity of the lumen in the constricted segment. A crater 3 mm. in diameter was found in the duodenal bulb. There was no associated obstruction in this area.

Esophagoscopy revealed that the esophagus was normal to within 2 cm. of the constricted area. The posterior wall at this point was red. Anteriorly there was a tough rim (fibrous) which narrowed the lumen and prevented passage of the instrument. The No. 15 and No. 20 bougies were passed the former without resistance.

She was allowed no feeding by mouth, no phenobarbital and no tincture of belladonna. Gradually she was placed on milk and cream by gastrostomy catheter and she showed improvement rapidly. She was discharged on December 21, 1945 in good general condition.

The active duodenal ulcer might be associated with the presence of the Pezzer catheter in the stomach for 10 years although this is not certain.

Since resection of the esophagus entails much risk, the diagnosis of carcinoma should be confirmed by biopsy in any questionable case before such a procedure is attempted. The relatively satisfactory course in the case described even though subsistence by gastrostomy was necessary supplies information as to the course of the disease in cases of severe peptic ulceration of the esophagus. Possibly more efficient medical management might have alleviated the degree of stenosis that occurred.

JOHN J. MALONEY, M.D.

Lewis, I: *The Surgical Treatment of Carcinoma of the Esophagus*. *Brill J Surg* 1946 34: 18.

The esophagus is a difficult surgical field for three reasons—its inaccessibility, its lack of a serous coat

and its enclosure in structures in which infection is especially dangerous and rapid. In the case of carcinoma of this viscus surgery is still more difficult for several reasons. It involves an extensive resection in a part of the alimentary canal which not only has no serous covering but also has no slack. It threatens the surgeon with having both pleurae open during the operation. Because of the loosely knit muscle anastomosis of its walls has with some reason been described as suturing the unsuturable.

It seems that in radiation therapy of the esophagus for carcinoma the upper third of this organ is occasionally cured in the middle third the growths are frequently of a radiosensitive type but they cannot be effectively treated because of their depth while in the lower third the adenocarcinomas are both relatively inaccessible and relatively insensitive. The author believes that direct irradiation of an inoperable growth through the operative wound combined with lateral anastomosis (esophagogastrostomy) is a treatment well worth trying.

The aims of radical cancer surgery are (1) to cure the disease while (2) rendering the patient's life useful and enjoyable or at least bearable.

Judged by this criteria the present position with reference to carcinoma of the lower part is very satisfactory. Not only does the resection with esophagogastrostomy satisfy the postulates of Halstead for the removal of cancer, but it also produces the best possible alleviation of symptoms. For growths of the lower part of the esophagus the left thorax is freely opened through the bed of the eighth rib. The phrenic nerve is paralyzed. The esophagus is mobilized and the diaphragm freely slit from the hiatus outward. The upper half of the stomach is mobilized and brought up into the pleural cavity.

The following are essential:

- 1 Adequate resection en bloc.
- 2 Removal of all tension from the suture line.
- 3 Avoidance of the least soiling.
- 4 An anastomosis which is end-to-side, two-layered, precisely stitched with interrupted sutures.
- 5 Just as the sheet anchor in abdominal anastomoses is the serous coat in the esophageal anastomoses it is the mucosa. This is thick and comparatively strong.
- 6 Water sealed drainage and early expansion of the lung.

For growths of the midesophagus also most surgeons have used the left transpleural approach. However the advantages of the right transpleural approach are:

- 1 A far better accessibility of the upper two-thirds of the thoracic esophagus.
- 2 Only the vena azygos major has to be divided to lay bare its whole course.
- 3 The aortic arch (and to an extent, the descending aorta) instead of being an obstacle becomes a safety barrier between the surgeon and the other pleural cavity. Instead of separating the growth bluntly and blindly from behind the arch it can be dissected under full vision.

The side chosen for the operation should be that giving the better exposure. Therefore to operate on the midesophagus through the left pleura is as unanatomical as it would be to operate on the lower end through the right pleura. By adoption of the method to be described, the question of lymphatic spread in no way affects this general proposition.

**Stage 1:** An upper left paramedian laparotomy is done. The abdomen is carefully explored. If there are no metastases, the greater curvature of the stomach is freed in its upper half. The vasa brevia, left gastroepiploic artery and the omentum are divided well away from the stomach to leave a vascular arch attached to the greater curve. The gastrohepatic omentum is then divided again well away from the lesser curve, and the left gastric artery is tied and divided near its origin. To reduce inflammatory reaction and adhesions, fine silk should be used throughout and the most careful hemostasis secured. Finally a loop of gut about a foot down the jejunum is chosen and a size 10 catheter inserted by Witzel's method. This is brought out, surrounded by omentum, through the lower end of the wound. If metastases are present, all that is done is a Janeway gastrostomy.

For 10 or 15 days after the first stage every effort is made to improve the patient's nutrition by a high carbohydrate high protein diet with extra vitamins. The jejunostomy makes this possible.

**Stage 2:** With the patient in the left lateral position and a sandbag under the chest the whole of the right sixth rib from the neck to its cartilage is removed and the chest entered through its bed. If after careful examination the growth seems removable the lung is packed forward and the vena azygos major divided between ligatures. The mediastinal pleura is then incised and just above and below the growth, pieces of tape are passed around the gullet to be used as guide ropes. The involved segment, together with any glands, is then slowly dissected free. Care must be taken to avoid opening the left pleura—a serious complication. There is no need to paralyze the phrenic nerve. The lower end of the esophagus is gradually freed by retracting the diaphragm dividing the branches of the vagi and keeping it on a stretch with spongeholders. The part in the esophageal hiatus is then freed with the index finger. A specially devised sickle-shaped retractor is now introduced into the hiatus. This instrument not only retracts and stretches the hiatus with its tapering end, but holds the diaphragm and under drawn up through the hiatus, the peritoneum is opened and then severed all around the circumferance. By steady drawing on the cardia, the fundus and eventually the body of the stomach are brought up into the pleural cavity. Adhesions of varying strength will have formed in the interval since the first operation; these are separated. When the stomach is sufficiently mobilized so that the fundus reaches well above the growth the esophagus with a wedge of cardia is severed and the gap sutured and invaginated.

If any enlarged glands have now become evident along the upper part of the lesser omentum, it is probably safe to extend the excision to include part of the lesser curvature and still leave the fundus viable as the vascularity of the stomach is remarkable. The next step of the operation is to prepare the gastric bed on which the esophagus will lie. The upper end of the stomach is fixed in the angle between the vertebral bodies and mediastinum. Five or 6 interrupted silk sutures are placed along each edge to fix the stomach posteriorly on the anterior spinal ligaments and anteriorly to the anterior cut edge of the mediastinal pleura. The esophagus is then laid upon the stomach and the posterior layer of interrupted sutures is put in before cutting of the growth. A transverse incision is made in the stomach. Three points are mentioned: (a) the incision should be on the short side as it can easily be lengthened but once it is too long it will make for a faulty joint; (b) any bleeding point should be tied before proceeding as the time spent will be amply repaid by a clean field and accurate suturing; and (c) a small sucker with a hooked point should be kept just inside the stomach incision. The through-and-through layer should be sutured with a fine needle and fine silk the close interrupted sutures each carefully including the esophageal mucosa. All knots are placed on the inside. The anterior seromuscular sutures are then placed. Finally if it can be done easily the stomach edges or omental fringes are folded over in front of the anastomosis and sutured. The enlarged hiatus does not need stitching up it is only about the circumference of a wrist 3 or 4 sutures are, however placed between the stomach and its rim to prevent the small gut from passing through. Sixty thousand units of penicillin are sprinkled around the anastomosis. A No. 14 catheter is placed alongside the anastomosis with a second hole cut lower down to be just inside the pleura. This is brought out through the ninth intercostal space laterally to drain under water.

The chest wall is sutured in layers. During the stitching up the anesthetist endeavors to get the lung well expanded. Any air left is drawn out forthwith by suction to the catheter. Blood transfusion is given to the patient throughout the operation.

If there is an appreciable amount of bronchial secretion a careful bronchoscopic cleansing is done before the patient leaves the table.

Postoperative care consisted of blood transfusions, nourishment via the jejunostomy tube, oxygen daily stomach washings, and frequent roentgenograms of chest and stomach with barium. The blood protein should be estimated on the third day. Concentrated serum is given intravenously for edema of the bases of the lungs. Culture is made from the intercostal catheter after 3 days. The patient is out of bed and on a full soft diet in about 3 weeks.

The author reports 7 cases of esophagectomy with 5 recoveries.

The practical criterion is that the degree of malignancy to the patient, is the length of time the disease takes to kill him to the pathologist it is an opinion based on the postmortem findings and the appearance of the cells. For the surgeon it may be deemed as the liability to recurrence after apparently adequate removal.

LEE PULLMAN M.D.

## MISCELLANEOUS

Dickson J. A., Clagett O. T. and McDonald, J. R.: Intrathoracic Gastric Cyst. *J. Thorac. Surg.* 1946, 15: 318.

A white girl, 10 years of age, had a long history of repeated 'pneumonic' attacks. Physical examination revealed diminished resonance, tubular breathing, and increased conduction of voice sounds on the left side of the thorax. A roentgenogram showed massive atelectasis involving at least the lower lobe of the left lung and possibly part of the upper lobe. On bronchoscopy a great deal of purulent secretion was aspirated from the left side, but no evidence of a foreign body was found. However there was a definite narrowing especially of the posterior branch of the left lower lobe bronchus. Studies in which radiopaque oil was used confirmed this. At operation a primary left posterolateral incision as made and a long segment of the seventh rib was resected and the pleura opened. The entire surface of the left lung was densely adherent to the thoracic wall. A line of cleavage was established between the visceral and parietal pleura and a good fissure was found between the upper and lower lobes. It was possible to carry out hilar resection with individual ligation of the hilar structures. A large cystic mass which extended down into the diaphragm posteriorly was found in the medial portion of the lower left side of the thorax. The cystic mass was very adherent to the mesial and under surface of the lung. It was first thought to be a cyst of the lung. It proved to be a congenital mediastinal gastric cyst which had become infected and established bronchial communication. Chronic suppurative disease was present in the bronchus of the lower lobe. Dissection was carried out down through the diaphragm with some difficulty. The entire cyst was removed. Ten

porary closed intercostal drainage was instituted and bronchoscopy was performed postoperatively.

Several unusual features about this case of intrathoracic gastric cyst are worthy of consideration. The first of these was its partial extension below the diaphragm. Reports of other gastric cysts indicate that they have been attached to the diaphragm or embedded in it but the authors believe that none of the intrathoracic cysts has extended below the diaphragm. In the author's case this extension was of considerable surgical importance because removal of it necessitated repair of the diaphragm following removal of the cyst.

The associated bronchiectasis in the left lower lobe was a second unusual feature. The cyst had apparently established bronchial communication. It is impossible to determine in this case what part peptic ulceration played in the establishment of such a bronchial communication. Unfortunately studies were not carried out to determine whether the contents of the cyst contained enzymes or acid. Because of the types of mucosal linings present including the mucoid character of the contents of the cyst it does not seem unreasonable to assume that such a cyst was producing acid and peptic enzymes.

A third feature was that the cyst contained the esophageal as well as gastric type of mucosa as has been the situation in a few of the reported cases. A large number of parietal cells were found in the gastric type of mucosa. The wall of the cyst was composed of three distinct layers.

There was no intimate attachment of the cyst wall to the esophagus nor did the cyst and the esophagus have a common musculature. The latter situation was important because it permitted primary removal of the cyst in one stage. This is not feasible in many cases because of the intimate attachment to the esophagus. The firm attachment of the lower lobe of the left lung to the lateral portion of the lower wall did increase the difficulty of resection. As far as can be determined this is the first case in which an intrathoracic gastric cyst was associated with bronchiectasis had a portion of its wall extending below the diaphragm and was treated successfully by removal of the cyst and lower lobe of the left lung in one stage.



# SURGERY OF THE ABDOMEN

## ABDOMINAL WALL AND PERITONEUM

Brandon, W J M: Inguinal Hernia: The Unpredictable Result. *Brit. J Surg* 1946 34 13

It is becoming increasingly evident that the inguinal muscular mechanism is now regarded as the key to the problem of oblique inguinal hernia. We must therefore, obtain an accurate conception of the anatomy and function of this mechanism before turning to the problem itself.

It is not the presence of a patent process of peritoneum that accounts for the frequency of hernia in man, but a weakness in the groin which has resulted from his upright posture. The most potent factor in the production of an oblique hernia, certainly of the acquired type, is a prolapse of the cord. This prolapse may be due to a defect primarily affecting the valvular mechanism or may be secondary to an ineffective cremasteric recoil.

Simple shutter action provides complete protection to the posterior wall against the outward thrust of intra-abdominal pressure. When it fails two types of direct hernia occur: a saucer-shaped bulge due to the stretching of the entire posterior wall or a funicular sac which appears to the lateral side of the insertion of the conjoint tendon and is associated with a localized congenital weakness or defect in the transversalis fascia.

Any breakdown or malfunction of the inguinal mechanism leads ultimately to a prolapse of the cord. If a preformed sac is present, it is bound to prolapse with the cord so that its well defined anatomical neck comes to be distal to the internal ring. The full force of the intra-abdominal pressure through the incompetent valve mechanism against the anatomical neck sooner or later dilates the new neck of the sac and results in a congenital hernia.

In an acquired hernia, once the posterior wall has been torn, the fundus of the sac comes to lie outside the infundibuliform fascia and no longer meeting with any resistance, is able to accompany the cord as an oblique sac with all the known characteristics of an acquired hernia. Frequently the sac fails to disrupt the infundibuliform fascia and, therefore, lies within it, but in all other respects it remains characteristic of the type.

The main point at issue in considering the repair of an oblique inguinal hernia is how much reliance can be placed on a repaired inguinal mechanism. The presence of a sac is an essential component of hernia in childhood; a second factor is the undeveloped state of the inguinal canal. If the surgeon attends to the first, nature looks after the second and success is assured. The author makes the following comment:

"When we consider the multiplicity of repairs, including simple herniotomy, we are struck by the fact that the only repair which provides a certain cure in adult life is complete closure of the inguinal canal

after removal of the cord and testis. It was on this fact that I based my solution, for every repair (with the exception of Schmieden's operation and my own modification of Ogilvie's method of mobilizing the cord in the lateral direction to allow complete closure of the inguinal canal) preserves the inguinal mechanism in some degree, and it is the preservation of this mechanism either wholly or in part that has made the repair of any given oblique inguinal hernia an unpredictable result." **LEE PUTZKE M.D.**

Dantlo, R.: Transplantation of Dermis in the Treatment of Eventrations (Transplantation de derme pour la cure des événtrations). *Presse med* 1946, 54 680.

Simple closure of eventrations by suturing the various layers of the abdominal wall over them is often followed by recurrence. A method which prevents such recurrence is the suture of dermis over the opening. The dermis becomes transformed into true tendon tissue as shown by experiments on dogs. The stimulation of the graft is not only hormonal but functional. The stimulus is furnished by the muscle tonus of the tissue into which the dermis is grafted.

Before transplantation, the epidermis must be removed from the dermis by curettage or with a Thiersch knife. The latter method is probably preferable as infection has never been seen in such cases. If there is enough excess skin above the eventration it is removed and used for the transplant. Skin from the thigh may be used. The grafted dermis must be stretched tightly like a drumhead and this tension must be kept up during healing.

The only contraindication is an enormous hernia lying outside of the abdomen, which would require so much force to replace it that failure of the circulation would be brought about. In large eventrations with plenty of skin above them a double-T incision may be made to produce two flaps, one of these is freed from its lateral connections with the abdominal wall but its connection with the subcutaneous tissue is left. This flap is then sutured to the aponeurosis and the other is turned over it like a double breasted coat. This double covering is not ordinarily necessary, however, as a single layer resists the pressure of the abdominal contents.

This method should become the classical one for the treatment of eventrations and large hernias. The operation is illustrated. **AUDREY G. MORGAN M.D.**

## GASTROINTESTINAL TRACT

Renshaw, R. J. F., Kiskadden, R. M., and Templeton, F. E.: Gastrocolic Fistula; A Clinical and Experimental Study. *Gastroenterology* 1946 7 5

When gastrocolic fistula complicates the treatment of peptic ulcer, a devastating syndrome results which is characterized chiefly by diarrhea.

steatorrhea, weight loss, anemia and malnutrition. Previous reports in the literature indicate that these symptoms develop because food is shunted from the stomach through the fistula into the colon. The authors' experience with dogs and humans indicates that a shunt is not the major factor.

Gastrocolic or enterocolic anastomoses were produced in 7 dogs. Roentgenological studies revealed that all or a major part of the barium meal passed from the stomach into the upper small intestine in all dogs, although in 4 dogs a small or minor portion of the barium passed into the colon through the fistula. Similar studies in 10 human patients with gastrocolic, gastrojejunal, or enterocolic fistula revealed that the barium meal was passed from the stomach into the upper small intestine. In one dog the barium meal was observed to pass from the stomach into the small intestine, then into the colon, finally the barium meal regurgitated through the fistula back into the stomach, from which it passed again into the upper small intestine. This same process was observed in one human patient. On postmortem examination of the dogs the small intestine, especially the upper third, revealed a striking subacute to chronic type of inflammatory infiltration limited almost exclusively to the mucosa of the papillae.

The development of anemia follows a definite pattern, although the authors admit that their studies are inadequate to describe this pattern in detail. The first change is to hypochromic microcytic anemia and if the animal survives long enough the anemia tends to become macrocytic hyperchromic.

It is suggested that the deranged digestive and absorptive functions of the small intestine may cause the clinical syndrome ascribed to gastrocolic fistula. Derangement of function of the small intestine is probably the result of damage to the intestinal mucosa caused by the passage of colonic contents through the small intestine. HAROLD LAUTMAN, M.D.

Kristenson, A.: The Pathogenesis of Ulcer (Zur Kenntnis der ulkuspäthogenese). *Acta. med. scand.* 1946, Supp. 170 p. 31.

Since Virchow first assumed a vascular genesis for peptic ulcer, many attempts have been made to prove that this condition is the result of a local disturbance in the circulation. The results hitherto have been contradictory.

The author points out that the chief source of blood to the first portion of the duodenum and the lesser curvature side of the pyloric antrum is the right gastric artery. This vessel is small and runs in the opposite direction to the hepatic artery, the flow of which it originates. The small opening of the gastric branch is often further narrowed by changes in the media or the intima of the hepatic artery at the site of origin of the former. These arterial lesions may be the result of changes in the position of the pylorus and proximal duodenum as the patient goes from a prone to a standing position. The upright position would seem to diminish the circulation through the right gastric artery.

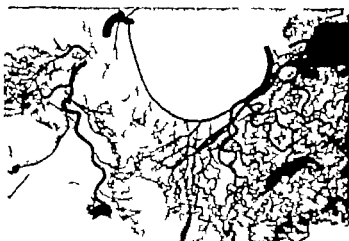


Fig. 1 (Kristenson) Roentgen picture of the stomach injected with contrast medium. Note the poor circulation to the pyloric region.

Injection preparations were made of the stomach and duodenum. These were x-rayed and showed that the circulation to the pyloric antrum and first portion of the duodenum is decidedly less abundant than to the rest of the stomach and intestine. This poor circulation is further embarrassed in the upright position, especially in individuals with marked gastroparesis.

The author concludes with his findings in regard to therapy. Small feedings are preferable to large ones since the former are less likely to disturb the stomach and duodenum, hence less harmful to the circulation around the pylorus. Rest in a horizontal position is advised after each meal. Finally, it is suggested that ulcer is the result of the upright position of the human race.

THEODORE B. MARSHALL, M.D.

Wilkinson, S. A. and Tracey, M. L.: The History of Hemorrhage in Peptic Ulcer. *Gastroenterology* 1946 7: 450.

The mortality and significance of a first hemorrhage and of later hemorrhages vary widely in published reports.

This study concerns 140 proved cases of peptic ulcer admitted to the clinic which necessarily had a selective effect upon the series. Of the patients 125 were males, the average age of the patients was 41.3 years and the average follow-up was 4.3 years. The over-all mortality was 3.5 per cent (5 deaths). Of the 140 cases only 2 were operated upon without previous medical management and 14 were operated upon after medical management prior to admission. One hundred and twenty-four had medical management at the clinic and 41 of these, had eventual surgery.

There were 70 cases in which hemorrhage was the first symptom of the ulcer and there was only 1 death (1.4%) from the first hemorrhage. Twenty-nine of these patients were more than 45 years of age at the time of their first hemorrhage.

The results of medical treatment were best in the 66 patients with only 1 hemorrhage prior to ad-

mission. Sixty-four of these were treated medically and 78 per cent responded satisfactorily. In this group there was a total recurrence of 35 per cent. Surgery was necessary in 11 cases (17%).

Seventy-four patients had more than 1 hemorrhage prior to admission. Seventy three were treated medically and 33 per cent responded satisfactorily. Operation was necessary in the cases of 45 patients (61%) and of these patients, one third had recurrent hemorrhages subsequent to radical operation.

Of the 140 cases, 41 were subjected to subtotal gastrectomy and recurrent hemorrhage appeared in 24%. Of 124 receiving medical treatment 30 per cent had subsequent hemorrhage.

In this series the first hemorrhage was not more serious than the later ones, and medical management offers a good chance of preventing further hemorrhage.

Patients with multiple hemorrhage do not respond well to any form of medical management and even radical surgery is not very satisfactory.

FREDERICK C. HOSKEL, M.D.

Tuovinen, P. I.: On the Relation Between Appendiceal Carcinoid and Appendicitis. *Ann. Chir. Gyn. Fenn.* 1946, 35: 60.

Carcinoid occurs in the stomach and gastroenteric tract, preferably in the appendix. It is closely related to true carcinoma, 30 per cent of the cases showing invasion in the neighboring tissues and metastases in the mesenteric lymph nodes and in the liver. Clinically and histologically however the disease presents many features of appendicitis: tumor cells are mixed with inflammatory cells (polymorphonuclear plasma cells, and lymphocytes). The growth originates in the deeper epithelium cells of the crypts.

The author discusses 3 cases of carcinoid which showed the clinical picture of acute appendicitis. He

believes that carcinoid may sometimes be an etiological factor of acute appendicitis.

WALTER M. SOLARZ, M.D.

Scott, W. J. M., and Serenati, O. J.: Megacolon: Mechanisms and Choice of Treatment. *Surg.* 1946, 30: 603.

Among the last 250,000 admissions to the Stree Memorial Hospital, Rochester, New York, the authors found 31 cases of megacolon. Because so few cases are seen, there exists in the literature a conflict of ideas about both the etiology and the method of treating the condition. It is believed by the authors that megacolon is a syndrome rather than a disease entity and that at least 4 different causative mechanisms can be delineated. These are (a) organic obstruction of congenital origin (b) neurogenic dysfunction (c) functional obstruction from extreme redundancy (dolichocolon) and (d) metabolic factors extrinsic to the colon (hypothyroidism, avitaminosis, malnutrition, etc.).

When a patient with megacolon appears for treatment, the following plan of combined diagnostic classification and clinical management is followed:

1. Examination is carried out to exclude organic obstruction of congenital origin. A tremendous dilatation of the colon may in the presence of normal innervation, musculature, and mucosa, be associated with congenital anomalies in the development or fusion of the proctodeum, which causes a high grade but incomplete obstruction of the lower large bowel. After several years of such obstruction, secondary changes due to dilatation, erosion, and fibrosis may supervene and affect bowel function. It is surprising how such a bowel will retain good emptying power.

2. Factors depressing the metabolic effectiveness of the smooth muscle of the colon are searched for and treated if found. The authors are unable to state whether such cases can be considered as definite clinical entities.

3. These two causes of disturbance in the emptying of the colon account for only a small minority of the cases. The remainder are then classified as idiopathic megacolon and the patients are put on a medical regime consisting of repeated colonic irrigation, mineral oil, occasional very mild cathartics, vitamin supplements, low roughage diet, and parasympathomimetic drugs. This regimen usually produces some improvement in symptoms which may be sufficient to warrant its continuation as the only form of therapy.

4. If conservative treatment fails to relieve symptoms after a thorough trial then on 2 courses is taken: (a) the use of a spinal anesthetic motor test (anesthesia, at least to the costal margin, has to be achieved if the test is to be considered adequate) in cases in which the x-ray evidence is not strongly suggestive of dolichocolon, if, within a few minutes after induction of the anesthetic, the colon vigorously expels most of its contents, which the patient was unable to do voluntarily; the megacolon then is considered to be due to neurogenic dysfunction (b) im-



Fig. 1. (Tuovinen) The tumor fills the appendiceal lumen. Strong proliferation of the connective tissue (38).

mediate exploration and resection of the colon in cases in which the x ray evidence of a functional obstruction from redundancy (dolichocolon) is convincing.

5. When satisfactory spinal anesthesia is ineffective then the case is classified as dolichocolon and resection is carried out as under (b) even though the evidence from the routine barium enema may not be sufficiently clear cut to make the differentiation between neurogenic and dolichocolon types. In the cases of the latter type it was found that the fundamental mechanism in production of the megacolon was a functional obstruction apparently due to an abnormal increase in the length of the sigmoid. When this abnormally long loop is filled it causes a kinking just proximal to its fixed point namely just above the rectosigmoid.

6. When spinal anesthesia is effective then the previous conservative régime is continued for at least 3 months more and may be repeated if gradual improvement in symptoms does not appear.

7. Lumbar sympathectomy is advised only for the small number of patients who respond dramatically to spinal anesthesia but who fail to obtain relief of symptoms after one or more such inductions.

8. The authors' experience has recently led them to advise early operation in certain young children in whom a marked obstipation has been present since birth, and whose barium enema shows extreme redundancy of the colon with kinking just proximal to the rectosigmoid. In these cases it has been found that conservative measures and parasympathetic drugs are usually ineffective. In such instances when in addition to the previously mentioned findings, haustral markings are absent in the left colon resection of the redundant colon has been combined with left lumbar sympathectomy without a spinal anesthetic motor test being carried out. Whether this combination offers more than resection alone is not yet proved.

9. In any case when resection of the colon is carried out for dolichocolon, utmost care must be taken to prevent the subsequent development of any obstructive sequelae. It is believed that a long side-to-side anastomosis placed between the taeniae is the preferable type of reconstruction under the circumstances although ordinarily the authors choose an end-to-end anastomosis, usually of the aseptic type, for most resections of the colon.

Included in the discussion are illustrative cases and reproductions of roentgenograms.

EUGENE J. AUDI, M.D.

Herrmann, L. G.: The Management of Megacolon (Hirschsprung's Disease). *Surg Clin N Amer* 12, 1946, 26-1170.

Before discussing the treatment of megacolon the author briefly reviews certain theories concerning the genesis of megacolon, pathologicophysiological considerations, the diagnosis of the condition, and the pathological changes in megacolon. Under the last heading are included statistics which indicate that

about 33 per cent of the patients have involvement of the sigmoid colon alone. Figures compiled by the Mayo clinic reveal that 42.3 per cent of cases seen at the Clinic have had involvement of the rectum and 11.5 per cent have had involvement of the cecum. The parts of the colon proximal to the hepatic flexure were involved in 26.9 per cent of their cases. In all of the author's cases there was involvement of the sigmoid colon and of the portions of the large bowel immediately adjacent and proximal to the sigmoid colon.

Examination of these patients on admission often reveals that the distal part of the colon is packed with feces causing subacute colonic obstruction with marked gaseous distention of the entire colon. If at this time rectal examination reveals the presence of congenital strictures of the rectum they must be treated by regular dilatation with the finger or with soft rubber bougies, before any other form of treatment is instituted. Adolescent children and young adults have reported weeks of relief following a single manual dilatation. Overstretching of the sphincter muscles usually leads to a short period of fecal incontinence. The age of the patient and the extent of involvement of the colon usually serve as valuable guides for therapy since young children should always have the benefit of prolonged medical treatment and those children over 5 years of age with extensive involvement of the colon should have the benefit of properly planned and executed surgery. In the medical management of megacolon, acetyl-beta-methylcholine (mecholy) has been used. Experience has shown that the optimum times for its administration are (1) 30 to 60 minutes after breakfast (2) in the midafternoon or (3) at any juncture to parallel and enhance an observed daily intestinal rhythm. Nausea, vomiting, and abdominal pain result if the drug is given before breakfast. It should be administered for a 5 to 10 day period if it is expected to correct an autonomic imbalance with the establishment of new reflexes which are necessary to regulate intestinal function. An average initial dose of acetyl-beta-methylcholine bromide for patients with megacolon is 0.1 gm. increased if necessary, to 0.2 gm. within 2 to 3 days. Then after several more days with this daily dose, if bowel function is still not well established, an additional dose of 0.1 or 0.2 gm. in midafternoon may be prescribed. As the drug becomes effective in bringing about more normal function of the bowel daily enemas are discontinued but the oral administration of mineral oil is continued because of its lubricating action in the colon. 0.2 gm., given each morning and in midafternoon is sometimes required to initiate bowel movements. If this quantity of the drug produces diarrhea, the dose is then reduced to 0.1 gm. When the patient becomes stabilized on a dose of the drug which produces one or two stools daily he is usually discharged from the hospital with instructions to take 0.2 gm. of acetyl-beta-methylcholine bromide each morning about 30 minutes after breakfast and 1 or 2 tablespoonfuls of mineral oil each evening. He is seen again in 2 weeks.

An occasional enema is used if the patient becomes constipated or is troubled with gaseous distention of the colon.

The author is convinced that medical management of megacolon must be vigorously employed to minimize distention of the colon and to prevent nutritional changes in children at least up to the age of 5 years. Medical management should be continued after that age especially when the child continues to grow normally and continues to have satisfactory evacuations of the bowel. Proper preoperative medical management is frequently overlooked so that patients come to operation unprepared for an extensive surgical procedure.

The surgical measures used in the management of megacolon are (1) emergency procedures after some acute surgical catastrophe such as volvulus, complete intestinal obstruction, gangrene of the obstructed loop of bowel or peritonitis from perforation of the colon has occurred (2) elective procedures such as sympathectomy or colectomy, either of which may be done alone or in combination.

Of 117 cases of megacolon subjected to sympathectomy (collected from the literature) complete relief was reported in 38 cases, and improvement in 64, there was failure to obtain benefit in 12 patients and 3 died. In the author's series of 10 patients with congenital megacolon with an age distribution from 2 months to 30 years, 14 patients were subjected to sympathectomy. Only 1 of these failed to obtain satisfactory function of the bowel following operation together with many months of intensive medical management.

Sympathectomy will not produce satisfactory results in cases in which the muscle power of the colon has been lost. It has been observed that patients who showed hypertrophy of the colon and visible peristalsis did well following sympathectomy. When hypertrophy of the colon was absent, the improvement which followed the sympathectomy was minimal in those patients in whom the disturbances of the colon had progressed to the stage of marked dilatation with thin weak musculature of the colon, the results following sympathectomy were completely unsatisfactory. These patients were in constant danger of great gaseous distention of the bowel and kinking of the sigmoid loop.

Technically the author believes that the operation of abdominal sympathectomy should be performed by the transperitoneal route since that approach also affords an excellent opportunity for the surgeon to examine the entire colon. By this route, both lumbar sympathetic trunks and their ganglia can be removed at the same operation. In the more advanced cases of megacolon, the author and his associates have utilized the abdominal sympathectomy operation by way of the transperitoneal route and have removed most of the preaortic plexus of sympathetic nerves together with the inferior mesenteric plexus and its ganglia, the superior hypogastric plexus, and both lumbar sympathetic trunks with the second and third lumbar sympathetic ganglia.

The operation of sympathectomy does not always immediately restore the involved bowel to normal functional activity. It is sometimes necessary to use daily enemas, mineral oil, and even mild laxatives for several weeks before the habit of spontaneous evacuation of the bowel is established.

It is believed that partial colectomy is indicated in the segmental type of megacolon when only a small portion of the colon is hypertrophied and dilated, and the adjoining segments of the colon are relatively normal. The mortality in this type of operation is much lower than in those wherein extensive resection of the colon is necessary. The disturbing feature about the operation of segmental resection of the colon is not the immediate mortality but the fact that progressive dilatation of the segment of the colon proximal to the portion which had been resected frequently takes place. Usually however the resection of segments of the colon gives excellent end-results and removes the danger of volvulus which develops all too frequently after sympathectomy. Patients with megacolon who have not been benefited by the combination of good medical management and sympathectomy should be subjected to partial or total colectomy if they can no longer be benefited by less drastic measures. In addition, those cases of megacolon which are due to low grade mechanical obstruction of many years standing, and not relieved by surgical removal of the obstructing lesion should be subjected to colectomy. Subtotal colectomy should be done also on those patients with megacolon who show no contraction of the bowel or evacuation of feces following spinal anesthesia, and for whom intensive drug therapy fails to reduce the size of the involved colon or to re-establish peristaltic activity.

The removal of a greatly dilated and thickened portion of colon is a somewhat different surgical procedure than the resection of a diseased portion of an otherwise normal colon. It is suggested that all of the involved colon should be resected by a one stage aseptic procedure, and, when possible, a temporary double-barrel colectomy should be constructed. This colectomy can be closed any time from a few weeks to several months, but not until the patient has shown definite general improvement. If the caliber of the entire colon is greatly increased it is wisest to remove it entirely or at least to the upper part of the rectum. The proximal end of the rectum and the distal end of the terminal portion of the ileum are brought to the outside of the abdomen, the final anastomosis should be made as a second stage procedure at some later date. The above described method of approach allows the saving of some portions of the colon which may be showing only secondary changes that might be reversible.

It has been found that a liberal left rectus incision is satisfactory for it affords adequate exposure of the splenic flexure of the colon which occasionally is very difficult to mobilize adequately. There is usually elongation of the mesentery of both the sigmoid and the descending colon making easier the mobilization

of an enlarged colon. The anal sphincter muscles should be forcefully dilated at the completion of the colectomy and when the colostomy is closed.

Because of the poor healing qualities of the enlarged bowel, the result of long-standing distention and lymphatic stasis in the tissues, the single stage resection of a part of the colon in megacolon and an immediate anastomosis between the proximal and distal segments of the bowel is fraught with danger of serious complications. This one stage procedure is not recommended in the management of the more advanced types of megacolon.

EUGENE J. AUDI, M.D.

### LIVER, GALL BLADDER, PANCREAS AND SPLEEN

Colp, R.: The Treatment of Postoperative Biliary Dyakinesia. *Gastroenterology* 1946 7:414.

A review of some of the studies of cholecystectomy series shows symptomatic cure or improvement in approximately 80 per cent of the cases of cholelithiasis and a much lower and more variable figure for cases of noncalculous cholecystitis. The patients with recurrent symptoms respond in a fairly high percentage to medical management but in all of the series a few cases because of persistence or intensity of postoperative symptoms, again needed surgical exploration. In this latter group the surgical findings varied and included such findings as calculi in the stump of the cystic duct, calculi in the common duct, acute pancreatitis, cholangitis, stricture of the papilla and pancreatic cyst. However, in the majority explored no gross pathological findings were found. The absence of organic findings upon which to base an explanation for colic in these cases leads to consideration of a functional factor or dyskinesia of the sphincter mechanism to explain not only recurrent or persistent symptoms following cholecystectomy but the pathological physiology of gall bladder disease.

The author recommends that the treatment of biliary dyskinesia at first be directed along a conservative medical course. Reflex or emotional factors should be sought. In the latter reassurance and mild sedation may be effective. In menopause or difficulties in menstruation proper hormone therapy may be effective in relieving the symptomatology. Constipation may be the reflex cause of the symptoms which may consequently be relieved by bile salts, mineral oil, magnesium sulfate, or daily sodium carboxate enemas. In patients with recurrent attacks of colic, elimination of biliary stagnation is attempted by frequent small feedings for each period of gastric digestion is followed by a discharge of bile into the duodenum. Gastric acidity, if high, is controlled by antacids and a bland nonirritating diet to prevent flow of free acid into the duodenum which causes sphincter spasm. Sodium nitrate or trinitroglycerol controls the colic in some cases but more often morphine sulfate may be necessary to relieve the pain. Persistent or increasingly severe symptoms make

surgical exploration mandatory to rule out an organic cause, or as in the 8 cases presented by the author to eliminate surgically intractable dyskinesia of the sphincter mechanism.

Surgical exploration should be meticulous and special attention should be given to the retroduodenal and papillary portions of the choledochus, a common hiding place for residual calculi. If organic exploration is totally absent it is then reasonable to consider intractable dyskinesia of the sphincter mechanism and this may be primary or secondary to a hypertrophy, stenosis or inflammation of the papilla. Stenosis of the sphincter is best circumvented by choledochoduodenostomy. A spastic sphincter may be dilated by sounds or other means but these do not guarantee lasting relief. Sphincterotomy offers a more direct and definitive approach to the problem of spastic sphincter but has not been widely practiced either because surgeons did not believe dyskinesia of the sphincter was responsible for the symptoms or because they did not wish to use such a formidable procedure for a functional disease. The author submits the results in 8 cases in which he divided the sphincter without opening the duodenum, by means of an instrument first described by him in 1938 and which he calls a sphincterotome. This instrument sections the sphincter endocholedochally. Following the procedure the common duct is drained by a T tube and by this means manometric readings of the intraductal pressure, lipoidal studies, and x ray studies may be made.

Seven of the 8 patients in whom the sphincter was divided had had recurrent symptoms of pain, chills, fever or jaundice. Of these 6 experienced relief over a period of observation from 2 to 8 years following sphincterotomy. One of them had the retained stump of the gall bladder fixed to the side of the common duct which was dilated and thickened so relief may have been caused by its removal. One patient with recurrence of jaundice may possibly have passed a stone just prior to the operation which may have accounted for relief of the symptoms. In the remaining 4 no organic pathology was found. In 1 case the sphincter was divided at the time of the cholecystectomy, because there were only a few stones in a gall bladder showing little change but the patient had had an attack of jaundice with colic. The common duct was normal and did not contain stones. The patient was free from discomfort 5 years after operation.

FREDERICK C. HORNEL, M.D.

Kaljeer, R.: Clinical and Pathohistological Aspect of Acute Cholecystitis. A Comparative Investigation. *Upsala läk fören förh* 1946 51:313.

The clinical classification of acute gall bladder disease as acute cholecystitis or as noncomplicated stone colic has been based chiefly on the presence or absence of hypernormal temperature and as a rule no pathohistological evidence has been brought forth to support this division. A nonselected series of 176 surgically resected gall bladders were studied histologically, sections from various parts of

the gall bladders having been taken for purposes of examination and the findings were correlated with the temperature at operation or during the last attack.

From 21 patients who at the time of operation, ran a minimum temperature of  $38^{\circ}\text{C}$  there were only 3 specimens that showed no material signs of acute inflammation histologically. From a group of 82 patients who, during the last attack, had had a rise of temperature to a minimum of  $38^{\circ}\text{C}$  but at the time of operation had a maximum of  $37.9^{\circ}\text{C}$  there were 46 specimens (55 per cent) showing plain signs of acute inflammation and 12 showing slight signs of acute inflammation. It is difficult to gauge the remainder of these cases because of the possibility that an acute inflammatory process had subsided between the time of the attack and that of surgical removal of the gall bladder. However there were only 4 patients operated upon within a reasonably short time after an acute attack with a temperature of over  $38^{\circ}\text{C}$  whose specimens showed no acute inflammatory changes. From a group of 70 patients who during the last attack, did not have temperatures exceeding  $37.9^{\circ}\text{C}$  there were 48 specimens showing no evidence of acute inflammatory change whatever. In the remainder of this group there were only 6 specimens in which an acute cellular infiltration of trivial appearance had occurred, not causing a rise of temperature beyond  $37.9^{\circ}\text{C}$ .

The conclusion to be drawn from this study is that the classification of a clinical series of cases of gall bladder disease into the groups "acute cholecystitis" and "noncomplicated stone colic," with division at the temperature level of  $38^{\circ}\text{C}$ , is fairly well substantiated by the pathoanatomical picture. Although there are patients running temperatures below  $38^{\circ}\text{C}$  with pronounced acute changes in the gall bladder as well as those with temperatures above that level having no acute changes these divergences are not particularly frequent.

JOHN L. LINCOLN, M.D.

Lasala, A., and Uribe, J. V. Jr.: The Common Bile Duct. Surgery of the Pancreatic Portion. Technique of Finocchietto. (Colédoco. Cirugía de la porción pancreática. Técnica de Ricardo Finocchietto) *Pres. méd. argent.* 945 31:149

Gall stones fixed in the pancreatic and preangular portions of the common bile duct are always of surgical importance. If they are firmly attached, they cannot be mobilized upward with finger maneuvers, nor grasped with clamps as there is always the danger of duct lesions.

To remove such stones, the transpancreatic or transduodenal approach is employed. Moynihan advises sectioning of the pancreas with the thermocautery or separating it by blunt dissection. Wabek Kehr and others advocate transduodenal cholecystotomy. The transpancreatic approach has often been criticized for there is always the danger of sectioning this gland which sometimes lies like a

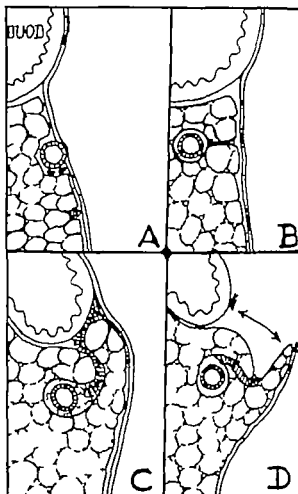


Fig. (Lasala and Uribe) Locations of the common bile duct.

broad coat upon the choledochus. R. Finocchietto proposed the interpancreatic approach after many anatomic studies on the pancreatic choledochus. This method was used for 6 years with excellent success.

Modern anatomic studies of Chylivich and Kozinverter, Belou, Zuckerkandl, and others, show that the choledochus is not intraglandular as was thought some time ago, for it is only partially engulfed by the gland. Actually it lies in a channel more or less deep at the posterior side of the gland and separated from it by loose connective tissue. This level must be found and the connective tissue removed in order to separate the pancreas and reach the choledochus without injury of the gland.

The following results have been observed by Finocchietto in 100 dissections.

In 7 cases the choledochus was situated in a small depression covered exclusively by the lamina of Treitz and the pancreaticoduodenal vessels (Fig. 1 A). In 4 cases the choledochus was in a slightly deep depression but covered in a small extension by

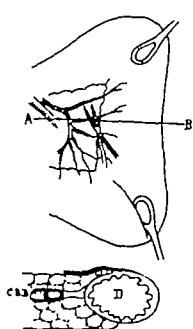


Fig. 2

Fig. 2 The duodenum and pancreas have been released and drawn to the right side. D duodenum C.B.D. common bile duct.

Fig. 3. Some of the pancreaticoduodenal vessels have been cut, as well as the fascia of Treitz which band of tissue

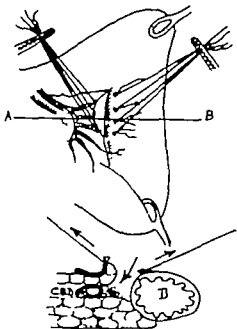


Fig. 3

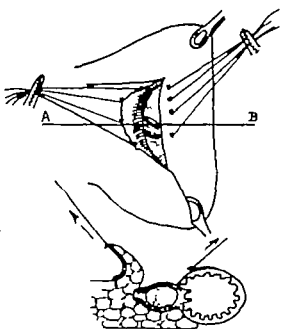


Fig. 4

extends from the pancreas to the duodenum

Fig. 4. One of the flaps of the pancreas has been separated showing the choledochus. The stone is caught at the ampulla of Vater

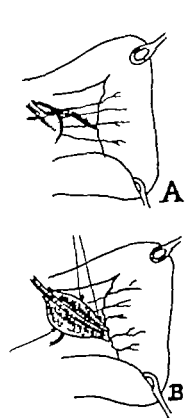


Fig. 5

Fig. 5 The most common case transversal disposition of the pancreatic flaps.

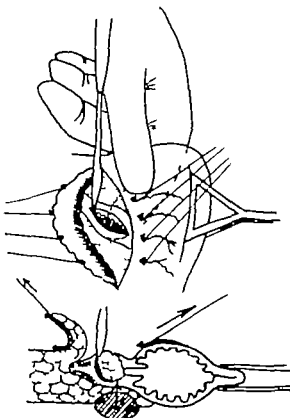


Fig. 6

Fig. 6 Preampullar incision of the choledochus.

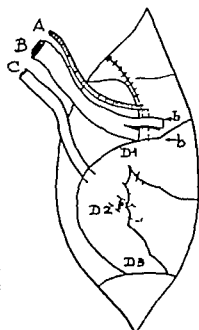


Fig. 7

Fig. 7 Drainage.



a portion of pancreas. In 3 cases it was situated in a deep depression totally covered by two thick flaps of the pancreas (Fig 1 B). In 7 cases the gland covered the choledochus and apparently there was no interstice. The small branches of the pancreaticoduodenal vessels were ligated and the pancreas could be opened in the form of the leaves of a book and another deep layer was seen (Fig 1-C). In 74 dissections after separation of the superior pancreaticoduodenal vessels it was possible to uncover a good portion of the duodenum by opening the pancreatic leaves (Fig 1 D).

In 5 cases the posterior side of the choledochus was overbridged by pancreatic tissue in a thin coat of 1 or 2 mm.

Finocchietto says that therefore in this series of dissections, and according to the anatomists, the choledochus runs in a depression of the posterior side of the pancreas in 11 per cent of the cases, and in a channel in 89 per cent. According to the surgeons, in 84 per cent of these 89 per cent of cases a single furrow of this channel could be made by just ligating and sectioning some little pancreaticoduodenal vessel and the choledochus found without sectioning even the smallest portion of the gland. In only 5 per cent of the cases would it have been necessary to cut the parenchyma to a small depth.

The study of the vessels of this territory described in the classical work of Rio Branco and in the modern one of Pierson is very interesting. The choledochus runs first side by side with the superior or posterosuperior pancreaticoduodenal artery being crossed by these later to join them at the postero-inferior pancreaticoduodenal artery in a bow from which start many small pancreaticoduodenal vessels. The ligation and cutting of these vessels render the pancreatic leaves movable.

In Finocchietto's surgical technique the operating table must be horizontal with no dorsal angulation and a Potter Bucky screen is applied to obtain systematically an operative cholangiography by Mirizzi's method. Once the stone is localized in the pancreatic or presuprapancreatic choledochus, the following operation is performed.

Step 1. Loosening of the duodenum and pancreas through Kocher's maneuver. Gentle pushing upward of the stone can be tried, or it can be grasped by a clamp through a supraduodenal choledochotomy. If it is not possible to remove it an intra-pancreatic choledochotomy is done.

Step 2. Insertion of a Béniqué's probe, size 30, into the supraduodenal choledochotomy to locate the choledochus and determine the thickness of the gland upon it. An interstice has to be looked for. It is commonly covered by areolar tissue and can be separated by disrupting the Treitz lamina.

Step 3. If step 2 is impossible ligation and section of the small pancreaticoduodenal vessels forming a bridge between the pancreas and duodenum must be done (Fig 2). The ends of the ligatures must be left long in order that they may be grasped with forceps. The bridge formed by the fascia of Treitz

will be cut (Fig 3). Once the areolar interstice is found, the choledochus is reached by retraction (Fig. 4). In other cases the pancreatic flap lies crosswise and its retraction is easier (Fig. 5).

Step 4. The surgeon takes the loosened pancreas in his left hand and, with his forefinger pressing on the anterior side of the pancreas, pushes the stone toward the posterior side of the pancreas (Fig. 6). Transversal choledochotomy is performed to avoid section of the sphincteric fibers. The stone is removed.

Step 5. Suture of the inferior choledochotomy by joining of the edges of the pancreatic parenchyma and knotting of the suture ends (left long with a forceps attached).

Step 6. Fastening of the loosened duodenum and pancreas. Rubber dam drainage is left behind the pancreas at the level of the inferior choledochotomy. At the superior choledochotomy a thin Kehr's tube is put in to control postoperative biliary hypertension, because rupture of the sutures of the inferior choledochotomy or an infection could occur. This is also of benefit in postoperative cholangiography. Next to this tube, gauze and rubber dam drainage is placed (Fig. 7).

H. MARINO, M.D.

#### Biegard J D: Pancreatitis as a Cause of Complete Obstruction of the Common Duct. *Ann. Surg.* 94:6 4. 1931.

The author presents in detail the reports of 2 cases of relatively painless extrahepatic obstructive jaundice. In both cases there was chronic cholecystitis without stones and much evidence to support a diagnosis of chronic pancreatitis. Both patients recovered following surface drainage of the common duct.

In both cases the postoperative cholangiograms showed narrowing of the distal end of the common duct suggestive of compression from pancreatic disease. In one case subsequent cholangiograms were made and these showed a progressive increase in the filling of the constricted portion of the duct which was interpreted as evidence of release of compression.

From the evidence, it is suggested that the obstruction of the common duct in these 2 cases probably was caused by chronic pancreatitis. The evidence is offered in support of the hypothesis that on occasion the swelling of the chronic pancreatitis obstructs the intrapancreatic portion of the common duct.

In making the diagnosis of chronic pancreatitis with obstructive jaundice, it is assumed that (1) the jaundice is extrahepatic in origin, (2) chronic pancreatitis exists, and (3) the assumed inflammation of the pancreas is capable of obstructing the common duct.

A diagnosis of chronic pancreatitis can be made with certainty only by histological confirmation. An elevated serum amylase is suggestive. If not indicative, of inflammation of the pancreas.

EMIL C. ROSENBERG, M.D.

## MISCELLANEOUS

Moore, M T : Symptomatic Abdominal Epilepsy  
*Am J Surg* 1946 72 883

Epilepsy according to Hughlings Jackson, is the name for occasional, sudden excessive, rapid and local discharge of gray matter. Its manifestation in the patient depends upon the locus of the brain which discharges.

The more commonly observed motor Jacksonian seizure of isolated muscle groups is often the result of a discrete lesion (tumor, scar or other structural change) in the motor area but should the lesion which initiates paroxysmal cerebral dysrhythmias be situated in another portion of the brain than the motor area the symptoms would logically be reflected in the somatic or visceral component of the body dominated by that part of the central nervous system. Thus the author reasons it is conceivable that focal lesions of any one or all of the areas three, five, and six, of Brodmann of the cerebral cortex or diencephalon could produce, under appropriate conditions, abnormal discharges which would lead to disturbed gastrointestinal activity and resultant abdominal pain. This condition he defines as symptomatic abdominal epilepsy.

Abdominal distress and even pain which according to one investigator is due to abnormal gastrointestinal movements has been observed to be a part of the preconvulsive aura of epilepsy. Wechsler and others have noted the occurrence of abdominal pain variously simulating gall bladder disease, peptic ulcer, appendicitis and renal colic in cases of cerebral lesions.

The author discusses 5 representative cases in support of his contention. Of these, one is a case of brain tumor of area six following the removal of which symptoms of recurrent severe epigastric pain disappeared. The second case is one of tuberous sclerosis with disseminated brain lesions in which one prominent symptom was recurrent attacks of severe abdominal pain. The third case is one of old cerebral trauma with numerous intervals of abdominal pain, nausea and occasional vomiting and diarrhea following the injury. Electroencephalographic studies approximated the pattern seen in idiopathic epilepsy and the patient was free of abdominal complaints following the institution of anticonvulsant medication. The fourth case is one of angioneurotic edema with focal cortical damage. The chief complaint was that of periodic cramping pain of the entire abdomen. On an anticonvulsant regimen this patient was free of pain for a period of 7½ months. On cessation of medication the attacks recurred and were again halted by dilantin sodium. A characteristic abdominal seizure occurred when the sedatives were replaced by sodium chloride without the patient's knowledge and complete relief was again afforded when anticonvulsant medication was resumed. In the last case no cerebral damage was demonstrable however the author believes that the prompt cessation of gnawing abdominal pain and accompanying epileptoid symptoms with anticonvulsants justifies the diagnosis of abdominal epilepsy.

The pathogenesis of abdominal epilepsy is discussed and a routine for the complete study diagnosis and treatment of the condition is listed.

WAYNE CAMERON, M.D.

## GYNECOLOGY

### UTERUS

Mollinengo, L.: Association of Endocervical Carcinoma with Fibromyoma of the Body of the Uterus (Sull'associazione di carcinoma endocervicale con fibromioma del corpo uterino) *Ginecologia* Tor 946, 12 133

The simultaneous occurrence of fibromyoma of the body of the uterus and endocervical carcinoma has been observed by the author in 3 cases. Because of the difficulty in diagnosis which this combination presents, the importance of an endocervical exploration must be stressed. The precise diagnosis is important, as the presence of carcinoma suggests x-ray therapy while fibromyoma requires operative intervention.

This disease was suspected following a menorrhagia or metrorrhagia, and a discharge which varied from yellow rose red coffee-like, and fetid. The endocervical mucosa was curetted and a microscopic examination revealed the diagnosis. With involvement of the pelvic peritoneum, severe local pain was present, although similar pain may be caused by rapid growth or hemorrhage into a fibromyoma.

The treatment advocated by the author is a total hysterectomy either abdominal or vaginal, for carcinoma of the uterus, and a supracervical hysterectomy for fibromyoma. ARTHUR F. CIPOLLA, M.D.

Campbell, Z. B.: A Report of 2 798 Vaginal Hysterectomies. *Am. J. Obst.* 946 5 598

This report covers 2 798 vaginal hysterectomies for benign disease of the uterus performed at the Presbyterian Hospital, Chicago by the attending and resident staff. The mortality is compared with that of 4,483 vaginal and 40 587 abdominal hysterectomies reported in the literature. The mortality rate of the collected cases of abdominal hysterectomy is 7.5 times greater than that of the vaginal hysterectomy.

The author prefers vaginal hysterectomy because (a) it permits a more regular correction of all defects than do other procedures (b) the vaginal route causes less discomfort to the patient (c) no abdominal scar is produced (d) pulmonary complications and emboli are less frequent (e) thrombophlebitis and pelvic abscess are less common (f) trauma to the bowel postoperative adhesions, and flexion and bowel obstruction are infrequent (g) gas pains are less severe (h) it is less radical and safer than irradiation (i) it affords a safe approach to many forms of adnexal pathology (j) peritonealization can be accomplished as accurately as by the abdominal route and (k) stump carcinoma and persistent cervical discharge are prevented.

The author agrees with many who have advocated vaginal hysterectomy rather than abdominal hysterectomy in poor operative risks. It then seems logical

that vaginal hysterectomy is an even safer procedure in patients who are in better operative condition. Previous abdominal surgery need not always contraindicate vaginal removal of the uterus. The technical skill of the operator is of no greater importance than is the choice of method of approach or preoperative preparation of the patient, such as: (a) eradication of foci of infection (b) correction of anemia, and vitamin protein and fluid balance and (c) restoration of the normal vaginal flora. Metabolic hemostasis is vitally important.

Adequate training in vaginal hysterectomy will equip a surgeon with the confidence and ability to treat many other gynecological conditions by vaginal surgery to the great benefit of the patient.

JOHN R. WOLFF, M.D.

Falk, H. C., and Bunkin, I. A.: A Study of 500 Vaginal Hysterectomies. *Am. J. Obst.* 1946, 5 623

The authors report 500 consecutive vaginal hysterectomies with and without anterior and posterior vaginal wall repairs, performed on the gynecologic service at Beth Israel Hospital, New York, over a 5 year period from January 1940 through 1944. A group of 14 operators took part in the work all following a standardized fixation ligature technique.

According to the obstetric standard of morbidity (a rise in temperature to 100.4 degrees on any 3 days after the day of operation) 106 cases, or 21.2 per cent, were morbid. One hundred and ninety-three patients were given sulfonamides prophylactically following operation and 46 or 23 per cent, became morbid. 307 did not receive sulfonamides, and 50, or 16 per cent, were morbid. One hundred and sixteen patients had gross or microscopic cervicitis as reported by the pathologist and 25 or 21 per cent were morbid. Of the 384 patients without cervicitis 77 or 20 per cent showed morbidity. When vaginal hysterectomy alone was performed, the morbidity was 19.4 per cent. When perineal care was added, the morbidity was only 15.5 per cent, but when bladder repair was also done, the morbidity rose to 24.5 per cent. Bladder repair also increased the incidence of voiding difficulties. Of the 500 patients, 73 or 14.6 per cent developed pus in the urine. 34 of these had received sulfonamides prophylactically.

There was 1 death in the series, a mortality rate of 0.2 per cent. This followed a septic course with pelvic peritonitis, abscess and perinephritic abscess.

There were 3 cases of pyelocystitis, 1 case of pelvic phlebitis, 1 of pulmonary infarct, 1 of transient pulmonary edema, 1 of transient auricular flutter, and 3 cases of pneumonia. The bladder was injured twice but immediate suture led to recovery. There were no urethral injuries, injuries to the rectum or fistulas. Postoperative bleeding occurred

twice once from the vaginal cuff, and once from the perineum. Two patients returned with ovarian cysts necessitating removal.

The authors believe that vaginal hysterectomy is an operation associated with a minimum of shock and hemorrhage, low morbidity and low mortality. It is the procedure of choice in the obese and the aged. Nulliparity is not a contraindication. The fixation ligature technique is safe and readily taught and learned.

JOHN R. WOLFE, M.D.

#### ADNEAL AND PERIUTERINE CONDITIONS

Mocquot, P. and Musset, R.: Nongravidic Ovarian Hemorrhages (*Les hémorragies ovariennes non gravidiques*). *Gyn. obst. Par.* 1946 45 337

Hemorrhages of the ovary may be secondary to a systemic or local pathological process. Infectious diseases like typhoid, smallpox, cholera, as well as poisonings with phosphorus or antimony, extensive burns, blood dyscrasias or cardiac failure are among the general processes which may cause ovarian hemorrhage while tumors, torsion of the adnexa and endometriosis are among the local ones.

More frequent but more puzzling as to their etiology and pathogenesis are the primary hemorrhages. These may either occur freely in the peritoneal cavity or form localized hematomas within the ovary. In hemorrhages bleeding into the peritoneum, the gross appearance of the ovary may vary considerably; sometimes it is enormous and of wine red color resembling splenic pulp on the cut surface, other times the volume is increased only in parts revealing hemorrhagic zones and cysts filled with blood. The amount of bleeding may vary from minor seepage to profuse apoplexy of the ovary which calls for immediate surgery. Often adhesions are found, but whether these are the cause or a sequel of the bleeding has not been decided. The histological examination shows that the hemorrhages may originate from a Graafian follicle or from a corpus luteum on the other hand interstitial hemorrhages originating from the stroma seem to be not infrequent.

Very little is known of the pathogenesis and etiology of primary hemorrhages. Clinical and experimental experiences seem to indicate a hormonal origin. The most plausible theory is that a sudden excessive activity of the anterior pituitary lobe leading to hyperproliferation causes the syndrome but nothing definite is known yet of the mechanism. The hormonal theory is supported by the clinical picture: the hemorrhages have never been observed before the menarche or after the menopause, more than half of the cases occur in virgins only a short time after the menarche, other cases occur during lactation or in women with irregular menstruation. All this indicates a disturbance in the hormonal equilibrium. In the acute cases, the symptoms are dramatic, resembling those of ectopic pregnancy or acute appendicitis. On the other hand there are women who suffer from these crises more or less reg-

ularly between the twelfth and eighteenth days of the menstrual cycle, i.e. synchronously with ovulation. These crises are often violent, and are accompanied by vomiting and even syncope. Vaginal examination during the attack often reveals doughy swelling of one ovary with extreme tenderness. This sign clears up after a few days only to be repeated after 1 or 2 months.

The treatment should be surgical in the acute cases and conservative and symptomatic in the chronic ones.

WERNER M. SOLMITSZ, M.D.

#### MISCELLANEOUS

Scott, W. W., and Ekas, W. L.: An Operative Procedure for the Repair of the Urethrodiverticulovaginal Fistula. *Surgery* 1946 20 645

Urethrodiverticulovaginal fistula is an uncommon lesion. A review of much of the literature on diverticulum of the female urethra and the urethrodiverticulovaginal fistula revealed but two cases.

From the location and character of the urethrodiverticulovaginal fistula, it is reasonable to assume that it can be classified as an acquired rather than a congenital lesion. Furthermore, it would seem that the identical conditions which play a role in the development of the urethral diverticulum are the essential factors in its causation.

The authors state that while our knowledge of the symptoms of this disease is quite limited because of our meager personal observations and the scarcity of information on the subject in the literature, it seems safe to assume that for the most part these symptoms will be quite similar to those of the urethral diverticulum. In addition, in most of these cases there will be urinary incontinence concomitant with vaginal irritation and dyspareunia. In a case in which the tumor was present for some time before drainage was established, the patients were quite sick, having chills, fever, nausea and vomiting and low back pain. All of the patients had frequency, urgency, dysuria and urinary obstruction in varying degree.

The diagnosis of this condition is not difficult once the possibility of a ureterovaginal or vesicovaginal fistula has been ruled out and the presence of an urethral diverticulum proved.

The successful repair of this condition, as in the case of the vesicovaginal fistula, depends in no small measure upon the preoperative preparation and most especially upon meticulous care following operation.

The authors have presented an operative procedure used successfully in the repair of 2 of these cases.

HARRY W. FINE, M.D.

Beecham, C. T.: Conservative Surgery in Endometriosis. *Am. J. Obst.* 1946 53 707

Conservative surgery in the treatment of endometriosis is the predilection of all gynecologists. To the author, conservative gynecological surgery means the removal of the least possible tissue to obtain the

desired result. Hence every attempt is made to preserve ovarian function to the age of 45 years or beyond if the lesion permits, and in previously sterile women, to preserve the childbearing capacity to the age of 40 years. A patient with endometriosis who has her family obviously minimizes the latter consideration.

The author surveys 80 conservative cases encountered in the past 6 years. By means of conservative methods, such as removal of endometrial implants, resection of diseased ovaries, and the correction of a retrodisplaced uterus, he has been able to salvage the childbearing capacity in 32 cases, or 53 per cent. Ovarian tissue was salvaged in whole or in part in 14 patients (55%) but this was impossible in 15 instances (24.5%). Nineteen of the patients were more than 45 years of age and radical surgery was employed in all but 3. In the 6 years, only 2 of the conservatively treated patients had recurrent complaints.

Since 42 per cent of the patients had a retrodisplaced uterus, the author believes that there is a close relationship between this condition and endometriosis. Beecham recommends that women with nonpathological retrodisplaced uteri be observed at regular intervals for signs of fixation indicating a surgical need for treatment of probable endometriosis.

The author concludes that conservative surgery is definitely worth while and should be the major consideration when operating upon endometriosis.

JOSIE R. WOLFE, M.D.

Tellum, G.: Arrhenoblastoma—Androblastoma. *Acta path. microbiol. scand.* 946: 23, 52.

The author here describes a series of homologous tumors of the ovary and testis which he calls the arrhenoblastoma-androblastoma series.

He states that in studies of ovarian tumors made during the past 25 years, histogenesis was the basis for classification. Classification however is still uncertain in some tumor forms because of the highly variable histological pattern.

He refers first to the ovarian arrhenoblastoma which is characterized clinically by a more or less pronounced masculinizing effect and, according to Robert Meyer originates from testicular elements remaining from the early stages of gonadogenesis. There is the one extreme represented by the testicular adenoma of the ovary and the other extreme which is a diffuse blastema often with sarcomalike differentiation and a more or less pronounced tendency toward epithelioid differentiation. He makes the observation, as others already have, that the strongest virilizing effect is noted in patients with the least differentiated forms of tumor. The clear cut tubular adenoma shows hardly any hormonal effects.

He reviews Robert Meyer's concept of the origin of the ovarian arrhenoblastoma—the view which is now widely accepted, namely the arrhenoblastoma originates from the undifferentiated germ cells that

have kept their germinal potency throughout the period of development. Thus, if part of the rete blastema with its medullary cords remains undifferentiated and later for some unknown reason, commences to grow a tumor of masculine germinal epithelium may develop in the rete ovary.

The author points to the morphological congruity between certain testicular tumors and ovarian arrhenoblastomas apart from the clear cut tubular adenoma. He refers to these homologous tumors as the androblastoma series.

He describes a feminizing testicular tumor which has the same structure as an ovarian arrhenoblastoma. The patient from whom it was removed presented himself with increasing gynecomastia, a loss of libido and a testicular tumor. The tumor showed all the stages of differentiation seen in the typical virilizing arrhenoblastoma of the ovary. The author shows the microscopic pictures of this tumor and points to its close similarity to an ovarian arrhenoblastoma. He likewise shows photomicrographs of 7 other testicular tumors and similar microscopic pictures from ovarian tumors. The morphological likenesses noted in this feminizing tumor and in the virilizing arrhenoblastoma along with the gradual transition in some parts to a structure like that of a clear cut lipid cell tumor allows the author to elucidate on several points.

He says that it proves Meyer's view that the ovarian arrhenoblastoma also originates from a particular testicular anlage. One can follow the continuity of various stages of differentiation in this male tumor as in the ovarian tumor described by Meyer. This gradual transition from tumor tissue of the arrhenoblastoma type to a clear cut lipid-cell tumor is taken to prove that the latter represents a particular form or variant of the androblastoma series. In the ovary we meet with virilizing or defeminizing tumors rich in lipid the histogenesis of which has been disputed. It is said that they arise from aberrant adrenal cortex (ovarian hypernephroma) or they have been taken to be luteal cell tumors (luteoma) luteinized granulosa cell tumors, or the neutral masculinovoblastoma. The author believes that these tumors in the ovary are particular form of the arrhenoblastoma series originating through one-sided differentiation of lipid cells within the blastema.

The tumor described in this paper with its gradual transition from tumor tissue of the androblastoma type to lipidoid cell tumor—which histologically corresponds to the tumors described in the ovary as luteoma and adrenal tumor—affords a definite proof of such a histogenesis. In other words, most of the cases described as luteoma adrenal, or hypernephroid tumors have to be looked upon as representing a particularly lipidoid form of the ovarian arrhenoblastoma.

It is a peculiar fact, he states that tumors of this series which are virilizing in women may have feminizing effects in men. This corresponds to the effect described for certain tumors of the adrenal cortex. In men occasionally feminization with gynecomast-

the testicular atrophy and increased estrin values in the urine are noted. The paradoxical hormonal effect in men is thus common to all these tumors, including the androblastoma which he describes.

The author presents one chart showing the homologous tumors of this series together with similar but not homologous tumors of the granulosa group.

HENRY C. FALK, M.D.

Vaccaro H, Cabezas J and Berrios, H: The Importance of Lysozym In Gynecology and Obstetrics (Factores inespecificos de defensa en ginecología y obstetricia. Importancia del lisozima) *Bol Soc chilena obst gin* 1945 10 233

The importance of lysozym as a defense factor in gynecological and obstetrical patients was evident in the following observations. In gynecologically normal women the vaginal flow contained a high lysozym titer while the cervical flow although containing lysozym contained a lower titer or in some cases none at all. No constant parallel was found between the lysozym content of the cervix and that of the vaginal wall. Lytic inhibitory power was found in dilutions of 1:800 in 6 hours of contact while in the same length of time the highest dilution in which the cervical content showed action was 1:400. The vaginal flow without previous dilution had its lytic inhibitory action after 5 minutes while the cervical flow under the same conditions showed its power after an hour.

In gynecologically affected women under identical conditions as those shown above, there was an appreciable diminution of the lytic inhibitory power

while the maximum effective dilutions were half of those in the normal group. The lysozym contents of the cervix and vagina were similar to those of the normal group and were predominant at the vaginal wall level.

Pregnant women revealed an increased lysozym content in the genital flow however, the stage of pregnancy has no influence on the lysozym titer. The difference between cervical and vaginal concentration was similar to that in the previous groups.

In puerperal women the lochia had a lower lysozym content than that of pregnant women of the normal group and of those with gynecological diseases. The lysozym content was nil in most of the cases.

Amniotic fluid contained practically no lysozym.

The following procedure was used in determining the lysozym titer. 10 c.c. of sterile serum were washed against the cervix or vagina and this specimen was diluted with 10 c.c. of sterile physiological serum. This mixture was placed in a water bath at 60 degrees for  $\frac{1}{4}$  hour 3 times, with an interval of 24 hours each. The resulting solution was sterile having a total lysozym content. One cubic centimeter of the above solution is added to 0.1 c.c. of a bacterium emulsion of *Bacterium Sarcina* and incubated at 37 degrees for 24 hours. One cubic centimeter is removed placed in a test tube containing agar at 42 degrees, and this mixture is then placed in a petri dish and incubated at 37 degrees for 24 hours. It is then examined at 24, 48 and 72 hours and compared with the serum from 3 controls.

ARTHUR F. CIPOLLA, M.D.

# OBSTETRICS

## PREGNANCY AND ITS COMPLICATIONS

Mayer C.: The Quantitative Analysis of Urinary Estrone in the Course of Pregnancy (Le dosage de l'œstrone urinaire au cours de la grossesse) *Brazzaville méd.* 946 26 8

Estradiol is the fundamental estrogenic substance elaborated by the ovary. Two derivatives of this substance occur in human urine, estrone and estriol. It is the former however which is chiefly responsible for the estrogenic activity of female urine.

Two methods are utilized for the quantitative analysis of urinary estrone. The biologic method is based on establishment of the minimal dose of extract capable of provoking keratinization of the vaginal cells in the spayed mouse and rat. The colorimetric method is based on the fact that pure estrone reacts with betanaphthol sulfuric acid to form a rose color. This reaction is quantitative and the intensity of color change may be measured by comparison with standard solutions. Other substances present in the urinary extract will also produce a color but the color due to estrone is destroyed by the addition of hydrogen peroxide. Hence accurate estimation involves a determination of the difference in color before and after the addition of peroxide.

A review of the variations reported by other investigators is confusing because of different unit measures. To eliminate this confusion the author has proposed the following arbitrary classification:

- 1 mouse unit equals 8 international units
- 1 rat unit equals 32 international units.
- 1 international unit equals 1/10 gamma unit.
- 1 gamma unit equals 1/1000 milligram

Colorimetric quantitative analyses were made of urinary estrone during the course of pregnancy for 10 women. As early as the sixth week the urinary estrone level was found to be at least twice the highest level found in nonpregnant women. Large individual variations occurred but in general the highest figures were obtained when the placenta was very large and was associated with a large baby. A prompt fall of the level followed childbirth and expulsion of the placenta.

These studies are interpreted as supporting the contention that considerable augmentation of urinary estrone occurs in the course of pregnancy and that this augmentation is due to the secretory activity of the placenta. *Edward W. Gantt, M.D.*

O'Connor, C. T., and Bradley J. J. Retroperitoneal Hemorrhage Complicating Pregnancy *N. England J. M.* 946 35 648.

Retroperitoneal hemorrhage complicating pregnancy is extremely rare but probably occurs more frequently than reports indicate.

One type is characterized by severe abdominal pain and shock as a result of massive retroperitoneal hemorrhage in the upper abdomen. The most frequent source of the hemorrhage is disease in the kidney and its vessels. The condition is usually fatal.

The other type, reported here for the first time, is retroperitoneal hemorrhage occurring chiefly in the true pelvis and resulting in a tumor causing dystocia and necessitating cesarean section.

The source of the hemorrhage in the case reported was probably one of the hemorrhoidal veins. Such a hemorrhage should not be evacuated; its complete absorption may take months.

*Charles Rarow, M.D.*

Keller M.: Ovarian Hemorrhages Caused by Nidation of the Fertilized Ovum at the Level of the Ovary (Les hémorragies d'origine ovarienne déterminées par la nidation au niveau de l'ovaire de l'œuf secondé) *Gyn. obst., Par.* 946 45 359.

Hemorrhages due to implantation in the ovary may cause hematomas in different parts of ovarian tissue. They may be interstitial, parenchymatous, subcapsular, periovarian or in preformed cysts. They are of different age and varied extent; on rare occasions they may rupture and cause a secondary intraperitoneal hemorrhage. The intraovarian hemorrhages are due to the invasion of the chorionic villi into the capillaries and small veins of the maternal circulation; in rare cases bleeding may occur also by diapedesis in abnormal permeability of the capillary wall. If on the other hand nidation occurs on the surface of the ovary in a groove of the albuginea, intraperitoneal hemorrhage ensues. Small and repeated hemorrhages are likely to form a hematocoele in the cul-de-sac of Douglas, while more extensive hemorrhages spread in the abdominal cavity. The amount of bleeding varies considerably. It may be almost nil but often reaches 400 or 500 c.c. and in rare cases it may be as high as 2,000 c.c.

Histological studies reveal the most significant disturbances at the point where the fetal tissue is contiguous to the maternal. Here the Langhans cells attack the ovarian tissue, invading the walls of the capillaries and small veins and forming the intervillous spaces, which are filled with blood. Close to the points of invasion by ectodermal cells, extravasations of blood can be observed as the first stages of the intraovarian hematomas. Sometimes a considerable periovarian hematoma is formed which causes detachment and death of the ovum. A true decidua is not formed in ovarian pregnancy. The absence of a decidua vera makes the nidation precarious and predisposes to intraovarian or intraperitoneal hemorrhages.

In the later stages of pregnancy, i.e., after the fifth month, hemorrhages into the ovary and the fetal sac are rare occurrences and the pregnancy

may continue until term on the other hand in this stage of development there is grave danger of severe hemorrhages during surgical intervention, especially in the attempt to separate the placenta.

It has never been possible to diagnose ovarian pregnancy preoperatively all we can do is to diagnose an ectopic pregnancy in general and leave the correct diagnosis of ovarian pregnancy to the time of operation. If the operation has to be done in advanced stages of pregnancy or close to term the technical difficulties can become very serious in the attempt to separate the placenta, hemorrhages may occur which may endanger the life of the patient. In these cases marsupialization is sometimes the only safe procedure.

WERNER M. SOLMITZ, M.D.

Socias, G.: Fetal Survival in Premature Separation of the Normally Inserted Placenta (Supervivencia fetal en el desprendimiento prematuro de la placenta normalmente inserta) *Bol Soc chilena obst gín* 1946 11 102

In premature separation of the normally inserted placenta, fetal survival is an exceptional occurrence. However the problem of survival of the fetus in these cases is secondary because the severity of the condition does not warrant favoring of the fetus. Among 32 cases observed from 1941 to 1946 only 12.5 per cent of the fetuses survived.

Evaluation of the viability of the fetus may be explained by a comparison of the area of separation to the total area of the placenta. If the site of separation is near the great vessels the possibility of survival is small. Measurement of the weight of the clot is of no value as the clot not only forms on the placenta but also outside of the site of the separation.

One theory of fetal death is attributed to shock produced by histamine liberated from the traumatized placental tissue. The histamine is absorbed by the fetus and produces death mostly in premature or defective fetuses which explains death in the cases with small separation.

ARTHUR F. CIPOLLA, M.D.

Thadall, L. H.: The Present Status of Transfusion of Whole Blood and Its Derivatives in Obstetrics and Gynecology *A. J. Obst* 1946 52 788

Blood transfusions are an essential form of obstetric and gynecologic therapy. In view of the recent advances in our knowledge of this subject, obstetricians and gynecologists have a threefold responsibility.

1 To have an ample supply of whole blood and plasma available. This can be assured by the establishment of a community blood bank such as has been suggested by the Red Cross.

2 To demand that the collection, preservation and administration of whole blood and plasma conform to the best technical standards. The adoption of the closed system vacuum technique and the use of the ACD preserving solution will meet such criteria.

3 To insure that blood or plasma administered to patients must be beneficial without reaction, and to

avoid antibody stimulation which may subsequently cause difficulties in later pregnancies or transfusions. This can be accomplished under a pyrogen free technique by the use of group and Rh compatible blood for routine transfusions of Rh negative group O blood with a low titer of isoagglutinins for emergency transfusions and of a compatible group or group O plasma with a low isoagglutinin titer when plasma is indicated.

JOHN R. VOLLEY, M.D.

## LABOR AND ITS COMPLICATIONS

Snoeck, J. and Rocmans, M.: The Management of the So-called 'Normal' Delivery by the Obstetrician. *Obstetrical Analgesia* (Quelle doit être la conduite de l'accoucheur pendant l'accouchement dit normal.) *L'analyse obstétricale* *Gyn obst., Par* 1946 45 257

This article gives a comprehensive account of all aspects of obstetrical anesthesia and analgesia. It includes an excellent detailed description of the anatomy of the central and autonomous nervous systems in their relations to the innervation and function of the uterus and to obstetrical anesthesia. Instructive illustrations are added.

The authors discuss the advantages and drawbacks of all known methods and drugs used for analgesia and anesthesia in obstetrics. Of special interest is the discussion of the different methods of producing peripheral anesthesia. This chapter includes epidural, paravertebral, and continuous caudal anesthesia, as well as the blocking of the lumbar sympathetic nerve by injection into the paravertebral ganglia, the superior or inferior hypogastric plexus, and the internal pudendal nerve.

The conclusions at which the authors arrive differ considerably from the consensus in the United States. This difference of opinion may be due partly to the fact that in France there are fewer highly and specifically trained anesthetists than in this country. In the category of inhalation anesthetics, the authors consider nitrous oxide as the only agent without any toxic side effects for mother and child. It demands a minimum of supervision and does not inhibit the uterine contractions. However it does not produce complete anesthesia, often the pain is only attenuated. Cyclopropane is quite satisfactory but it demands a highly trained and experienced anesthetist and a complicated and expensive apparatus. All other inhalation anesthetics are considered too dangerous for mother or child or both.

The groups of opium derivatives and barbiturates should be rejected altogether as they are too ineffective in small doses and too dangerous in large ones.

As to the different methods of anesthesia by blocking pain conduction either in the spinal medulla or in the peripheral nerves, the authors believe that these are still in the experimental stage and should be studied further before they are accepted as safe and effective. Of the different methods of this kind the authors prefer the infiltration of the lumbar sympathetic nerve whereas caudal anesthesia



(little known in France) seems to them to be complicated in its technique and not without risks (convulsions or circulatory collapse).

The details of this very interesting article should be read in the original. WILKINSON M. SOLARZ, M.D.

Gosselin, O: The Management of the So-called "Normal" Delivery by the Obstetrician Not Including Analgesia and Anesthesia (Quelle doit être la conduite de l'accoucheur pendant l'accouchement dit normal. Analgésie et anesthésie exceptées) G) *ibid* Par 946, 45 35

Even if there is no anatomical obstacle or other condition which demands intervention in the interest of the mother or child a delivery can no longer be considered normal if the duration of labor exceeds a certain time limit. 'The sun should not rise twice over a woman in labor' (Doederlein). It is no longer justifiable to maintain an attitude of purely passive expectancy in prolonged labor. The danger is twofold. Infection after the membranes are ruptured, and asphyxia of the child by tetanic contractions of the uterus. No delivery should be termed "normal" which has not been completed within 10 or 12 hours after rupture of membranes. The main reason for prolonged labor in "normal" cases is disturbance of uterine contraction and dilatation of the cervix, caused either by spasticity and hypertony of the cervix, or by weakness and inertia of the uterine muscle. The dilatation of the cervix is not a passive phenomenon due to the pressure of the bag of waters on the cervix, but rather an active process caused by the traction of the spiral fibers of the corpus on the fibers of the cervix. The "physiologic delivery" is due to the harmonious interaction between contraction of the upper and relaxation of the lower part of the uterus.

Prolonged labor due to spasm of the cervix should be treated by rupture of the membranes and with antispasmodic drugs. A number of outstanding French obstetricians rupture the membranes routinely in all cases when the cervix is dilated to 2 cm. and others at a dilatation of 4 or 6 cm. Objections against this routine can be made for two reasons, i.e., increased danger of bacterial invasion, and danger of prolapse of the cord. However these dangers seem to be negligible as the saprophytic germs of the vagina seldom cause infection and prolapse of the cord is of rare incidence (34% in a series of 375 cases).

The antispasmodic generally used in France is called spasalgine. It is a mixture containing pantopon (0.05 gm.), papaverine (0.02 gm.) and atropine (1 mgm). Many outstanding men (Kreiss, Voron, Pigeaud) give it routinely in all cases. If necessary it can be given several times in intervals of 30 minutes without danger to the mother and child.

Prolonged labor due to the opposite disturbance, namely weak contractions, should be treated by oxytocin. In contrast to the opinion prevailing in the United States, the French authors deem it permissible to use pituitrin also in the second stage of labor provided that it is given in very small doses (a inter-

national units) and under close supervision. In some cases, it is advisable to combine the pituitrin with an antispasmodic. WILKINSON M. SOLARZ, M.D.

Lévy-Solal: Anomalies of Uterine Contraction (Anomalies de la contraction utérine) *Rev. fr. gyn. obst.* 1946 41 225.

Extreme prolongation or even arrest of labor is often seen in cases of functional uterine dystocia. In the studies of uterine contraction, particularly by means of external hystero-graphy, a great deal may be learned in the cases of hypercontractility one sees either (1) inertia or functional insufficiency of the uterus or (2) an excess of contractions, either intermittent or tonic contractions.

The hystero-graph is composed essentially of a large pneumatic tube and an oscillograph. The tube held in place by an inextensible belt is inflated under a known pressure, the excursions transmitted from the tube are recorded on a drum which revolves at a known rate of speed. Normal contraction appears as a line ascending sharply then a plateau more or less notched and then a line descending slowly to the base line. The height of the peak is a measure of the maximal power of the contraction (or uterine tones) and the line its duration. Labor contractions are represented by the area bounded by the base line and the arc.

Intermittent and involuntary uterine contractions become painful during labor. The pain appears somewhat in advance of the contraction and disappears shortly after it. It is only perceptible above a certain threshold this explains why the mild contractions, such as those which follow immediately after the expulsion of the fetus, pass unperceived both by the woman herself and the obstetrician.

The duration of the contractions is from 10 to 30 seconds. The contractions follow a rhythm which varies not only from one patient to another but also in the same patient starting with a duration of 10 minutes and ending with a duration of 3 minutes. Each contraction is followed by a period of repose, the state of tension of the uterus or its absence being designated by either an arc or a horizontal line (Graph 1). Physiologically, the uterine tones are always the same, varying only if the uterine capacity is suddenly changed as, for example, by the rupture of the membranes. Pathological variations of tones are observed chiefly in the hyperkinetic uterus. The persistence of pain during the period between contractions is a sign of poor muscular relaxation. In cases of inertia or functional uterine insufficiency one sees undulations and shortening of the base line, and the intervals are very long, lasting from 15 minutes to even several hours (Graph 2). Intermittent contractions show up as a successive series of similar waves with the common characteristic of a constant return of the peak to its base line of departure as long as the contraction retains its forcefulness (Graph 3). One sometimes sees a series of unremitting ineffective contractions (Graph 4) this state of contraction can evolve following two eventualities (1) after a

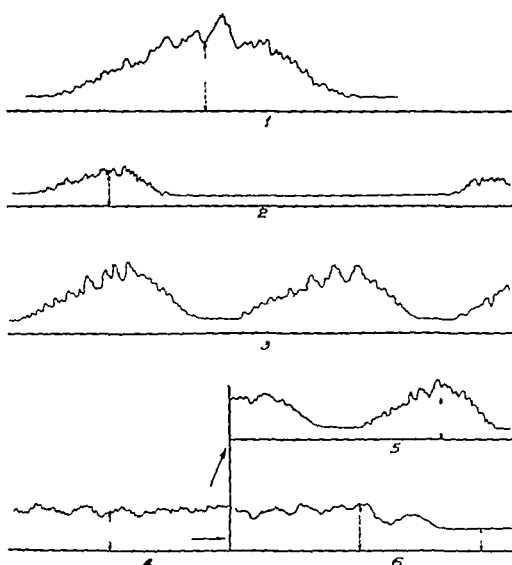


Fig. 1. (Levy Solal)

more or less protracted period of successive spikes (Graph 5) as may be observed following the administration of barbiturates and (2) between maximal contractions irregularly placed when the intervening quiet period is represented by a horizontal line at the lowest point. In this case the decrease in the severity of labor is due not to a state of inertia or to the effacement of the contractile wave but to an elevation of the tonus (Graph 6). This latter state, due to muscular overwork provokes an arrest of labor. It does not represent uterine inertia and oxytocics should not be employed. Rather antispasmodics or even morphine should be used to diminish the resistance due to muscular hypertonicity to give each contraction its full value. When the tracing discloses a permanent elevation of the muscular tone then spinal anesthesia is indicated thus the contractility is abolished and the retraction of the uterine body and its tonicity are augmented.

These anomalies, i.e. functional insufficiency or excess of contractions, may be due to various causes there may be congenital central or autonomic nervous system derangements or there may be fibrosis

or sclerosis of the uterine musculature which breaks up the contractile wave before it reaches the base of the uterus. In general, however the neuromuscular system is normal and the contraction is vitiated secondarily. This is not only a reaction of the uterine muscle. It may also be due to an abuse of hypophyseal extracts, or to repeated and prolonged mechanical excitations by obstacles difficult to overcome. Also these difficulties follow more or less tardily after a phase of regular contractions.

The obstacle may be due to either (1) resistance of the soft tissue the inferior segment or the uterine collar or (2) fetal disproportion. The inferior segment may be either rigid or supple. The neck can be the site of diverse alterations which add to the complication of anatomic malformations or inflammation involving the normal course of effacement and dilatation often produced by scar tissue secondary to the intemperate use of caustics. As for the fetal head it may be imperfectly adapted even to the shape of the uterus and cannot descend without distending the inferior segment. This is seen particularly in forehead and shoulder presentations. An undis-

closed osseous dystocia may also condition a poor presentation. In these secondary anomalies the reaction by inhibition or true atony is rare. It is the contracture that one sees most often.

However all of these anomalies of contraction due to various mechanisms have the same result: extremely slow progression and even arrest of dilatation—in inertia because of weakness, infrequency of contraction, lengthening of intervals. In the states of contracture, because of constriction and stretching of all the uterine fibers and finally in the states of hypertonicity because of uterine retraction which constricts the fetus.

Physiopathological difficulties are manifest clinically in the following forms:

1. Functional insufficiency. This occasionally persists from the start to the finish of labor; it generally is modified in a eutonic sense or it is complicated by difficulties of malcontraction. This can be determined clinically or by graphic exploration. Indeed, when inertia exists in a pure state one sees labor desperately prolonged. The contractions are feeble of short duration, painful, placed far apart even in spite of perfect engagement of the head and perfect conformation to the inferior segment. Labor can sometimes last for days if means for establishing a normal pace are not employed.

2. True muscular dystocia in labor. This is due to contracture. It can be mild or severe; it can involve the whole organ or can be localized in certain zones.

The states of mild contracture are observed in only particular circumstances: the membranes are generally intact and the uterine body struggles against the inferior segment which resists more or less. But little by little the weak musculature of the inferior segment and the neck give way before the pressure of the uterine body. The cervical canal opens passively either by pressure from the bag of waters or from the fetal prominence. That is the rule. But these are rare cases which one cannot foresee in which the muscular elements of the cervical region resist longer and more abnormally in the course of the period of dilatation.

The clinical syndrome which indicates this struggle is also typical. The woman essentially has lumbar pain. On palpation the uterus is uniformly hard and this hardness persists a long time without relief. The heart sounds are muffled and the uterine souffle is exaggerated to auscultation. On touch the inferior segment is tight resistant, and painful often it is poorly formed. The neck can either remain thick when the presenting part is high or on the contrary soft when it comes in direct contact with the outlet, but at the moment of a contraction this is checked and it seems as though it were bounded by an iron band. This syndrome has received various interpretations, the most current one being an active contraction of the uterine neck during labor.

Hystero-graphic films have shown that this cervical rigidity corresponds, in fact, to a state of uterine subcontraction. Indeed a uterus does not contract except when it reacts in coming up against an ob-

stacle to its dilatation. It is this obstacle often not apparent that one should look for.

In the cases of strong contracture the cause of arrest can be found in factors which alter the normal functioning of the neck or of the lower portion of the uterus. This can perhaps be an abnormal adherence of the membranous pole around the uterine outlet which prevents the normal progress of ablation of the inferior segment. A relatively simple procedure is to break these adhesions with the fingers or better to rupture the membranes. The inferior segment regains its elasticity and dilatation progresses rapidly. This condition may be called *agglutination of the neck*, the origin of which one frequently finds to be an alteration of the neck by therapeutic caustics or endometrial inflammation. One recognizes this anomaly when it is difficult on vaginal examination to outline the orifice of the neck, especially when the thinness of the inferior segment, pressed tightly on the presenting part, reveals the existence of a complete dilatation. It is important to search carefully for the site of the depression (more or less distinct) which discloses the presence of the external orifice of the neck, then to introduce the tip of the index finger or a catheter so that the cervical obstacle can be lifted and the dilatation can progress rapidly.

There are indeed cases in which an excess of liquid, important because of the extreme distention that it can produce at the base of the uterus, deprives the inferior segment and the collar of all its pliancy. The artificial rupture of the membranes permits the uterine muscle to regain its normal contractility.

Sometimes one can find no apparent cause for the phenomenon of contracture and authorities have shown the influence of antispasmodics which, administered at the onset of accidents, are capable of cutting down the cervical resistance and regulating the contractions. These ideas are significant from the point of view of treatment.

In addition to these phenomena of contracture due to a cervicosegmental obstacle easy to correct, there are others in which the obstacle is more serious and the contracture if let alone, can assume a very grave character. The difficulties coincide generally with the onset of premature rupture of the membranes, but it is not this rupture which causes the difficulty. This anomaly of contracture is revealed by the clinical pace of labor. The pains are lumbar and unremitting continuing even through the intervals between contractions. The woman is seen to suffer even when the uterus is apparently relaxed. This impression corresponds, as was shown in the hystero-graphic curves, to an elevation of tones to the level of the pain threshold in the intervening period.

However, the general syndrome which accompanies the painful phenomena is perhaps as typical as the pain itself. The women are agitated, complain constantly vomit, and present a rapid pulse.

On palpation two syndromes can be observed: 1. Following sufficient labor the presentation which was high has descended into the inferior segment. It strikes an obstacle there and progression

ceases. The uterus is contracted on the superior part of the fetus and presses itself upon it, it stretches the inferior segment. The permanent hardness of the muscle due to the contracture contrasts with the thinning by distention of the inferior segment.

2 The uterus contracted from the outset, tightly bands the fetus over which it is molded. The inferior segment is malformed the presenting part is high. The fetal head which is the agent of the transmission of forces, instead of progressing remains completely imprisoned in the interior of the uterine cavity. The state of the uterine neck is variable to touch sometimes the dilatation is very advanced at other times it remains stationary at about 2 to 5 francs. When the fetus is entirely trapped in the contracted uterus there is anywhere from a finger tip to 10 cm. of the external orifice and one can perceive the presenting part above the ring of stricture which marks the inferior limit of the corpus uteri.

When the head reaches the ring it appears like a pendulum in the inferior segment which it does not touch and the shoulders are supported above the zone of strangulation a sensation of unusual resistance occurs when one attempts a forceps extraction or an extraction with a basiotribe.

This state of contraction does not always persist at a given moment the uterus may appear to relax. However this relaxation is not much better for it denotes muscular fatigue. In fact the hysterograph discloses a permanent elevation of uterine tonicity. If treatment is not given immediately the condition becomes much worse—in addition to hypertonicity capable of responding to agents modifying the uterine muscle fibers there is a state of irreducible retraction corresponding to histological lesions which in extreme cases appear as interstitial edema. This infiltration occurs not only at the neck but also more or less throughout the entire inferior segment. It is an edema which at first is soft and appears to harden somewhat as the syndrome evolves. On palpation it gives the sensation of leather filled with fat. Couvelaire has shown that the element of infection plays a considerable role not only in the appearance but also in the persistence of these cervical alterations. The contamination of frequent examinations, the suppression of the anti-infection barrier set up by the bag of waters, and the abnormal duration of labor after arrest of the presenting part explain the state of these alterations easily confirmed by microscopic examination of specimens of the neck which show all stages from the leucocytic infiltration to microbic penetration. These anatomic lesions explain the almost absolute impossibility of the neck to dilate by normal mechanisms. The neck does not dilate—it ruptures. It is in these conditions that one sees transverse fissures or even a spontaneous circular amputation, and these accidents can progress to the point of uterine rupture or at least to favor serious amniotic infection.

The difficulties are inherent in the general etiologic conditions that have been studied. Indeed behind these same contractures one usually sees two fre-

quent causes the congenital malformation and the irritation of the uterus provoked by a bad position or even by an irregularity of the fetal head or some times by untimely intervention.

This irritability has been studied on a fresh specimen which was removed en bloc by hysterectomy. Uterine contraction is dependent on an autonomic intrauterine system as well as on the lumbar spine. In looking over the specimen the authors noted the presence of spontaneous intermittent contractile rings. The idea of opening the uterus and stimulating it with a stylet was conceived. When the irritation was intermittent it was seen that each time the tip of the stylet was touched to the muscle, circular contractions occurred contractile rings starting at the periphery and converging toward the point of irritation. When the stimulus was continued the uterine muscle froze as it were into a solid contraction (tetanic) which relaxed almost immediately on withdrawal of the stimulus.

The constriction rings occur at various levels of the body of the uterus. One sees them most often at the junction of the body and the inferior segment, more from autonomic than functional causes. In the habitual cephalic presentation this region corresponds to the furrow of the neck of the fetus.

In breech presentations the muscular constriction forms preferably at the level of the popliteal fold. In transverse presentations, when the head and shoulders are in the inferior segment, the ring can pass as a sling on the neck and the thorax of the fetus.

Clinically the essential signs of the preceding form are the same as those found after premature rupture of the membranes the same permanent character of the pain radiating to the lumbar region and as in total contracture, the extreme slowness of labor with precocious appearance of the fetus.

Several clinical signs permit differentiation of these two forms. By inspection and palpation one can often discover a notch on the uterine margin which persists even during contracture in fact this notch is usually discovered during intervention and the uterine wall forms a cul-de-sac above this notch. Reorientation of the fetal head usually corrects this situation otherwise there is a rigid retraction which is of serious import to both mother and fetus. Two syndromes may be associated with this situation either pure inertia or inertia with contraction.

It is emphasized that uterine atony and rigidity are always secondary and the primary cause should be investigated from the standpoint of the uterus pelvis and fetus. The pelvis may have a narrow superior outlet or there may be a face presentation in these cases a cesarean section is indicated. If dystocia is purely uterine i.e. dynamic, medical management with antispasmodics is indicated. Membranes are ruptured when the dilatation has attained 4 or 5 cm. then quinine or posterior pituitary extract may be used. In this way cervical resistance is abolished and an easy intervention with an engaged head and complete cervical dilatation is possible. Anti

spasmodics have been found to diminish the abnormal duration of hypercontractility and permit normal relaxation between contractions. Thus, severe uterine retraction with rupture, amniotic infection, endometrial gangrene and peritonitis are avoided.

Among 61 cases reported 47 physiological deliveries resulted following the use of antispasmodics. Thirteen cases resulted in intervention 6 were forceps deliveries following cervical incisions anteriorly and posteriorly 2 were spontaneous deliveries following cervical incisions, 2 were cesarean sections and 3 were managed with the bariatric. There were no maternal deaths but 7 fetal deaths. It is concluded that antispasmodics have transformed the management of problems of dystocia. Results might have been better had intervention following the use of antispasmodics in some cases been earlier the optimum time seems to be when the dilatation remains stationary after 2 hours, although fetal distress usually begins after 12 hours. Rupture of the membranes should be carried out when there is a permanent tension when there is adherence of the inferior part of the fetus, or when no other reason for nonengagement has been found and the bag of waters rests on the cervical os. There should always be at least a 5-franc opening of the canal before rupture is attempted.

With regard to the use of antispasmodics, a first series of 2 or 3 injections of spasalgine at one-half hour intervals is employed. This usually suffices to regulate the contractions and abolish uterine tonus without employment of a second series. If dilatation is stationary after ten hours, either cervical incision or section should be done. In primiparas, in the presence of a large fetus or after premature rupture of the membranes, intervention should be done earlier.

PHILIP B. CHASE, M.D.

Reid D. E.: The Treatment of Prolonged Labor with Extract from the Posterior Lobe of the Pituitary Gland. *Am J Obst* 946 52 719.

Prolonged labor dependent on uterine inertia and associated with cervical dystocia, is a syndrome occurring with rare exception only in primiparous women. Such exceptions are not due to cervical dystocia per se, and may occur in the "dangerous multiparas" with definite or borderline cephalopelvic disproportion. The author administered extract from the posterior lobe of the pituitary gland to 1500 patients who exhibited any degree of uterine inertia during their labor. Uterine inertia exists when progress during labor ceases. The initial dose of this drug is usually 1 minim. The dosage is increased up to 4 minims at a single dose at from 30 to 45 minute intervals in an attempt to stimulate uterine contractions. Usually cervical dilatation will ensue with the smaller doses. The total dose in a given labor is usually from 1 to 4 minims, but doses from 5 to 9, 10 to 15, and even of 15 minims plus were administered during a single labor.

However if no effective uterine contractions or progress has been obtained after 1 to 4 minim doses

have been used (which will cover a period of from 2 to 3 hours) it seems reasonable to discontinue the drug and turn to other means of completing labor. Procrastination from that point on will only add further hours of labor and an increased fetal mortality.

With the use of this drug there have been no cases of ruptured uterus or extensive birth canal trauma in this series. The incidence of prolonged labor has been reduced to the low figure of 2 per cent in the clinic patients. The need for midforceps operations in the clinic patients was reduced to 0.5 per cent. The need for Duhrssen's incisions was small. Some degree of intrauterine asphyxia accompanies normal labor. In this series it was 0.33 per cent.

Prolonged labor contributes materially to an increased fetal mortality. This is true particularly if the labor is more than 40 hours in length. Fetal mortality in the clinic patients with prolonged labor was 11.65 per cent a figure which usually accompanies such cases. Intrauterine asphyxia was the most frequent cause of fetal death. JOHN R. WOZNY, M.D.

Mujica, H.: Internal Version in the Angel Custodio Sanhueza Maternity Hospital (La versión interna en la Maternidad Angel Custodio Sanhueza). *Rev Soc chilena obst gín* 946, 57.

Among 1533 deliveries over a 5 year period, internal version was performed in 422 or 27.8 per cent, of the versions, and was 3 times as common in the multiparas as in the primiparas. A comparison between the incidence of versions, forceps deliveries and cesarean sections showed that versions were carried out in 27.8 per cent, forceps in 4.21 per cent, and cesarean sections in 1.24 per cent of the cases. Throughout the 5 year period the use of forceps increased and the use of versions decreased the number of sections remained about the same.

Of the indications for versions, fetal distress accounted for 31.50 per cent, transverse presentation for 27.48 per cent, prolapse of the cord for 12.79 per cent, maternal exhaustion for 10.18 per cent, stoppage of labor mechanism for 4.97 per cent, prolapse of the superior extremity for 3.55 per cent, deflected cephalic presentation for 3.08 per cent, and twins, infection, excessive size of the fetus, dystocia of the cervix, and uterine rupture accounted for the remaining 3.31 per cent.

The complications which were seen following versions were as follows: perineal tears (22.51%) of which 18 per cent were 1 degree 3.79 per cent of 2 degrees, and 0.71 per cent of 3 degrees; cervical tears (20.61%) vaginal tears (6.39%) vulvar tears (0.94%) tears of the lower segment (3.84%) hyper-tonicity of the uterus (6.16%) uterine inertia (4.50%) retained secundines (7.34%), rupture of the cord (1.65%), transverse presentation of a second fetus (0.23%) retention of the aftercoming head (5.68%) locked arm (8.89%) anemia (3.60%) obstetrical shock (0.94%) and anesthetic syncope (0.33%).

The puerperal complications were as follows: simple endometritis (4.73%) purulent endometritis

(4.97%) infection of an episiotomy (3.60%) a febrile puerperium (0.47%) abscess of the abdominal wall (0.23%) putrid endometritis (0.69%), genital gangrene (0.47%) puerperal septicemia (0.47%) phlebitis (0.23%) subinvolution of the uterus (0.93%) anemia (0.47%) and late hemorrhage (0.23%).

Two-fifths of the patients with complications required the following treatment: repair of the canal (27.25%) placenta extraction (9.47%) dilatation and curettage (3.31%) colpotomy (0.23%) blood transfusions (1.65%) suture of the lower segment (1.65%) biopsy of the cervix (0.23%) delivery of the second twin (0.23%) forceps on the aftercoming head (0.23%) craniotomy (3.08%) and tamponade (0.46%).

Ether given by intravenous drip was used in 97.63 per cent of the cases.

The maternal mortality was 2.07 per cent and the infant mortality was 14.22 per cent; the morbidity was 25.35 per cent. ARTHUR F. CIPOLELLA, M.D.

Kahanpää, V.: Cesarean Section with Special Emphasis on the Transverse Transperitoneal Incision (Ueber den Kaiserschnitt mit besonderer Berücksichtigung der queren transperitonealen Schnittführung). *Ann. chir. gyn. fenn.* 1946 35 157.

This is a report on a series of 825 cesarean sections. The indications were contracted pelvis in 49.6 per cent, eclampsia and similar conditions in 19 per cent, placenta previa in 7.5 per cent and others in 23.9 per cent. Three hundred and eleven of the women were subjected to the transverse isthmus section. A comparison of the longitudinal (cervicocorporal or isthmolongitudinal) and the transverse incisions shows that the latter is preferable: it is easier technically, the hemorrhage less and the operation time shorter. There were also fewer postoperative complications. In no instance did uterine rupture occur in subsequent deliveries.

WERNER M. SOLMITS, M.D.

## PUERPERIUM AND ITS COMPLICATIONS

Klein, J.: The Relationship of Maternal Weight Gain to the Weight of the Newborn Infant. *Am. J. Obst.* 1946 52 574.

Most physicians who supervise prenatal care caution their patients against excessive weight gain during pregnancy. Their reasons for doing so are multiple. It is the opinion of many that the size of the fetus may thus be controlled. Prevention of over growth of the baby, especially in the presence of a pelvic contracture, would reduce the incidence of disproportion with its attendant hazards.

A series of 367 cases was studied statistically by the author to determine whether any relationship existed between the maternal weight gain and the weight of the newborn. In this group of cases, 408 primiparas and 159 multiparas were delivered of 282 male and 285 female infants. The heaviest baby

weighed 10 lbs and 7.5 oz at birth; the lightest 5 lb and 4.5 oz. One mother who had lost 3.25 pounds during pregnancy gave birth to a girl weighing 5 lb and 14 oz. The patient who had gained the most weight, 48.25 pounds, was delivered of a girl weighing 6 lb and 5.5 oz. The average maternal weight gain for the series was 21.05 pounds and the average weight of the newborn was 7 lb and 6 oz.

No correlation was noticed between the maternal weight gain during pregnancy and the weight of the baby at birth. The average birth weight of the males exceeded that of the females. There is no relationship between the age of the mother, her weight gain during pregnancy and the weight of the newborn infant. Although the average maternal weight gain and the average weight of the newborn of multiparas were greater than those of primiparas, the differences were slight and of no significance.

JOHN R. WOLFF, M.D.

## NEWBORN

Repetti, M.: Fetal Erythroblastosis (Sull'eritroblastosi fetale). *Fed. gyn.* Genova 1946 41 3.

The author describes 2 cases of fetal hydrops, and 1 case of acute congenital icterus. In fetal hydrops the fetus is born prematurely as a stillbirth or dies immediately after birth. Heredity plays a part and may alternate with successive deliveries of fetuses with icterus. The liver and spleen are enlarged and there is an increased number of immature red blood cells and white blood cells. Foci of hematopoiesis in the liver, spleen, placenta, and other organs are evident. The amniotic fluid is increased in amount and has a yellow color.

Acute congenital icterus is often fatal and is characterized by a marked pallor of the skin with a short continuation of the intense jaundice. The liver and spleen are enlarged and focal embryonal hematopoiesis is revealed by masses of erythroblasts in various states.

Erythroblastosis of the newborn is characterized by an intense anemia, hepatomegaly and splenomegaly with increase of the nucleated red blood cells and reticulocytes. Foci of erythropoiesis are also seen.

Although these processes appear to be different they are related. Fetal hydrops is the gravest, congenital icterus is intermediate and hemolytic anemia of the newborn is the least grave condition. The incidence of these conditions is much higher than was formerly believed.

Other conditions which produce a similar picture and therefore must be considered in the differential diagnosis are as follows: syphilis, sepsis, producing anemia, hemorrhagic disease of the newborn, congenital malformation of the biliary tract, and physiological icterus of the newborn.

Not only has the Rh factor been found as the etiological cause of these conditions, but the placenta is the route by which the antigens pass, although sensitization of the newborn may take place by intra-

muscular injection of Rh positive blood. The iso-anti-Rh antigen is also present in mother's milk and may sensitize the newborn by its ingestion through the intestinal tract therefore this milk is contraindicated.

The treatment is transfusion with Rh positive blood and the administration of Vitamin K.

ARTHUR F. CIPOLLA, M.D.

#### MISCELLANEOUS

Spivack, M: The Anatomic Peculiarities of the Human Umbilical Cord and Their Clinical Significance *Am. J. Obst.*, 946, 53 387

The author reports her observations of the anatomic peculiarities of the human umbilical cord. Twenty five specimens were examined grossly for the presence of 'valves', folds, and other peculiarities. Thirty were studied microscopically with special attention being given to the blood vessels. All these cords were from babies born alive. Cords from dead babies were utilized for the search of nerve tissue.

The umbilical vessels were found to differ anatomically from other blood vessels in several essential ways. True valves were not present. The presence of folds and nodules (nodules of Hoboken) were

noted in the arteries and semilunar folds in the veins. The elastic tissue of the umbilical vessels varies from that seen in other vessels of similar size. The arterial media is strongly developed and its powerful contractions are ascribed by some authors to the spiral and snaillike course of its muscle fibers. Vasa vasorum and adventitia were not present. There is a delicate connective tissue which contributes to the sponginess of the vein.

The author demonstrates for the first time the presence of a nervous apparatus within the umbilical vessels.

Spivack points out the clinical application of the value of not ligating or tying the umbilical cord until its pulsation has ceased. She reviews the reports demonstrating the amount of blood that can be drained from the placenta into the fetus by adopting this dictum, and reasons that this occurs because the anatomic peculiarities of the umbilical vessels are such that the arteries have greater contractile power than the veins and compression of the placental vessels will lead to a contracting, narrowing, and obliteration of the arterial cord, with an increase or dilatation of the umbilical vein. Thus the outflow of the blood from the baby to the placenta is hindered while the return flow is augmented.

JOSEF R. WOLFF, M.D.

# GENITOURINARY SURGERY

## ADRENAL, KIDNEY AND URETER

Söderlund, G. Four Cases of Tuberculosis of the Kidney. *Acta chir. scand.*, 1946 94 470

Four cases of renal tuberculosis are reported by the author because they are interesting from the standpoint of diagnosis. Indications for operation or pathological findings.

A 42 year old man was operated on in 1930 for a rather extensive hydronephrosis of the left side of a horseshoe kidney. Pyelolithotomy was performed. In 1944 an extensive tuberculosis of the right half of the kidney was diagnosed. The involved portion was removed and the patient was discharged cured.

In a 20 year old girl tubercle bacilli and pus were found in the urine, and urographic studies revealed an extensive tuberculous process in the left kidney and also a few irregular cavities in the right kidney considered to be also of a specific character. Two years later the urine from the right kidney appeared to be normal and the cavities in the involved kidneys were no more visible after retrograde pyelography. The tuberculous left kidney was removed and the patient was discharged cured.

In a woman age 45 with cystitis of 3 years duration the urine was found to contain pus and tubercle bacilli. Urography revealed an extensive tuberculosis of the right kidney and a rather large hydronephrosis of the left kidney. The urinary bladder was contracted. The nonprotein nitrogen was 100 mgm per cent. After insertion of a retention catheter the nonprotein nitrogen gradually diminished to 36 mgm. per cent. The tuberculous right kidney was removed and the bladder gradually expanded.

A woman age 35 had had periodic attacks of fever without local symptoms for 10 years. Urography and urine examination failed to disclose any pathology of the urinary tract but 3 years later a congestion of the upper pole of the left kidney and a displacement of this kidney downward and in a lateral direction were found. Nephrectomy was performed and a large cavity was found in the upper half of the removed specimen. Colon bacilli were demonstrated in the pus of the cavity which was not communicating with the renal pelvis. The histological examination disclosed the presence of tuberculosis. The patient made an uneventful recovery.

JOSEPH K. NARAT, M.D.

LeComte R. M.: Perinephritis and Perirenal Abscess. *J. Urol. Balt.*, 1946 56 636.

The author's study is based on records of 28 patients which contain fairly complete data. They have been culled from some 9,600 odd cases of real or suspected urologic disease encountered over a period of 25 years an incidence of about 0.3 per cent.

Eleven of the 28 patients were in the primary or uncomplicated group all of these recovered. Eight of

the 17 patients with secondary or complicated disease died a percentage of 46.5 per cent. The mortality for the entire group was 28.5 per cent. All of those who died had renal infection which in 2 probably originated from prostatic obstruction in 1 patient the abscess probably developed as a result of extension from a ruptured posterior urethra torn in a poorly performed internal urethrotomy in 1 patient there was a left renal stone and acute bilateral pyelonephritis with multiple small abscesses in 1 patient following puerperal sepsis, the condition was discovered at autopsy and a pelvic as well as a perirenal abscess was found in 1 patient had active pulmonary and renal tuberculosis. The 2 other patients who died had acute renal infection of undetermined anatomic origin. The former died from sepsis and shock following the too thorough exploration of an infected kidney in searching for a stone, the latter died from pulmonary tuberculosis. The time intervening between operation and death varied from 1 day to 3 months. All but 2 of the 17 patients with secondary cases (1 with vertebral disease and 1 with appendical abscess) had urinary infection of some sort ranging from hydronephrosis with or without stone and obstruction, to prostatic abscess, urethral strictures etc.

On x ray a mass was observed in 6 of 10 patients. The spine was concave towards the side of the abscess in 7 patients, and convex in 1 of the 10 in whom this finding was set down. The psoas shadow was obliterated on the involved side in 6 patients, on both sides in 1 patient, and was indistinct in 1 of 8 patients. The pyelogram was recorded in 13 cases the kidney was considered to be normal in 6 was reported as deformed without characteristic change in 2 as showing evidence of external pressure in 3 and of hydronephrosis in 2 patients, each of whom had ureteral obstruction. The kidney was displaced laterally in 2 and mesially in 2 of 4 cases. It was fixed in 1 of 2 instances in which this feature was checked.

The multiplicity of possibilities as to pathogenesis and mode of invasion has led to a somewhat confusing classification and terminology based on points that often cannot be determined with certainty even at operation or autopsy. The author's preference is to consider the basic lesion as a perinephritis nonsuppurative or suppurative and to designate the suppurative form with definite abscess formation as perirenal despite the objectionable impure composition of the word (Simeone). This avoids the confusion due to the similarity in spelling and sound of the words, perinephritic and perinephric.

Bacteria may reach the perinephrium by metastasis or as heretofore set forth, by extension from inflamed nearby organs. A perirenal abscess may occur from metastasis, too if a hematoma from traumatism has occurred in the perinephrium and if bacteria circulating in the blood lodge and multiply in it. The point of origin is immaterial if renal or other complicating





ly disturbing the abscess wall. Failure to drain secondary abscesses may lead to delayed healing which will require a second operation.

If no frank pus is encountered and the perirenal fat is found to be hard and hemorrhagic, a thorough exploration of the perinephrium should be done especially behind and at the upper pole of the kidney. If a renal lesion is known to exist beforehand or is found at operation it is generally better to be content with drainage of the abscess especially if the patient is markedly septic, leaving the primary renal difficulty to be cared for later. A secondary nephrectomy is often difficult and somewhat hazardous but is perhaps less dangerous than the spreading of infection from extensive handling of a kidney in the presence of extensive suppurative pyelonephritis.

JOHN A. LOER M.D.

Munger A. D.: Renal Surgery *J Am Med Ass* 1946  
132 675

The author urges greater conservatism in renal surgery. Too often the kidney is sacrificed when it can be readily saved by a conservative procedure. Conditions for which nephrectomy is performed are frequently limited to only a small portion of the kidney substance. Resection of only the diseased portion of the organ is the preferable procedure.

In the hands of many surgeons the only operative procedure for hydronephrosis is nephrectomy. Surgical correction is for the most part a perfectly logical and feasible operation. Protective splinting with adequate and prolonged intrapelvic drainage is an absolutely necessary procedure in plastic correction of the renal pelvis.

Hydronephrosis is not uncommonly a bilateral disease and the removal of a kidney for hydronephrosis is not infrequently followed by the development of a hydronephrosis on the opposite side.

About 70 per cent of diseases requiring surgical intervention and congenital in origin are amenable to conservative surgery. Total nephrectomy for hydronephrosis should be performed only when it has been demonstrated that the drainage system of the kidney is completely destroyed and beyond recovery.

When ischemia occurs in a greatly altered area of renal tissue as a result of ligation of a renal vessel to relieve pyeloureteral obstruction the author recommends resection of the ischemic area to prevent septic necrobiosis.

If the urinary passages are opened in a partial resection prolonged drainage of the pelvis is indicated to prevent fistula formation.

FREDERICK A. LLOYD M.D.

Ortega F. E.: Indications for Nephropexy (Las indicaciones de nefropexia) *Arch esp. urol.*, 1946  
3 174.

The mere existence of an abnormally movable kidney does not constitute an indication for nephropexy unless there is interference with pyeloureteral evacuation. Alterations in the region of the kidney can be easily detected with pyelograms. All authors

generally agree that without a specific indication nephropexy should not be performed as a supplementary operation after pyelotomy or nephrotomy. Pyelograms should be taken in the horizontal as well as in the erect position of the patient. Serial cinematographic pictures may furnish valuable information. Pyeloscopy as advocated by Legueu has not found many adherents.

Even if the kidney can be palpated and the patient complains of pains in the renal region conservative treatment is advisable if pyelographic findings are negative. In some cases the decision is difficult to make. In many instances in which torsion of the ureter by a ptotic kidney is suspected dilatation of the renal pelvis supplemented by proper medication and a dietary regimen may furnish relief. Nephropexy may easily be discredited unless strict indications are observed. JOSEPH K. NARAT M.D.

## BLADDER, URETHRA, AND PENIS

Castro E. P.: Vesicoureteral Reflux (Concepto actual del reflujo vesicoureteral) *Arch esp. urol* 1946  
3 122

Vesicoureteral reflux in the majority of cases must be considered as a phenomenon caused by a defective synergism of ureterovesical dynamic factors. Such conditions may be created by an irritation of the muscular layer of the urinary bladder and an alteration or retardation of the transmission of reflexes which is responsible for alternating tonokinetic phases of the bladder and ureters.

According to extensive questionnaires a reflux is observed in cases of malignant but not benign lesions of the bladder. This may be explained by the assumption that malignant neoplasms create special reflexes. The author's experience does not correspond to that mentioned in the statistics as he observed a vesicoureteral reflux also in cases with non-infiltrating neoplasms.

Hypertrophy of the prostatic gland was not considered as an important factor in the creation of the vesicoureteral reflux until the introduction of cystographic studies. As a matter of fact reflux occurs in from 4.7 to 18 per cent of all cases of prostatic hypertrophy. The mechanism of production of such reflux has not been completely elucidated but the increased intravesical pressure seems to be an important factor. In addition to such passive factors as mechanical obstruction an active factor in the form of a disrupted ureterovesical synergism enters into play.

An obstruction of the neck of the bladder may be responsible for the origin of a diverticulum of the bladder and also for a concomitant reflux.

A frequent coexistence of vesicoureteral reflux and tuberculosis of the excretory organs has been observed. A transurethral resection of the neck of the bladder performed at an early stage of the condition may relieve the reflux accompanying tuberculous cystitis.

The author reports 19 cases of ureterovesical reflux  
JOSEPH K. NARAT M.D.

Molina, L. R. and Estarellas R.: Instrumental Trauma following Cystostomy (Herida instrumental en un cistostomizado) *Rev. argent. urol.* 1944, 3: 441

As the first stage of the surgical treatment of an adenoma of the prostate gland, a cystostomy was done on a 37 year old man. One month after the operation the family physician tried to eliminate an obstruction of the drain. The patient experienced severe pain and the following day was admitted to the hospital. The examination showed that fecal matter not urine was escaping from the drain and between the drain and the wall of the fistula. Three hundred cubic centimeters of clear urine were evacuated through a urethral catheter. The bladder was irrigated with a solution of mercury oxycyanate, but the injected liquid did not escape through the hypogastric drain. This observation proved that the bladder was occluded and that the drain in the hypogastric region was communicating with the intestines and not the bladder. The drain was withdrawn, and a curved probe was introduced through the urethra and brought out through the suprapubic fistula. A retention catheter was placed into the cystostomy opening. An antiseptic solution injected through the urethral catheter escaped through the Pezzer catheter.

After insufflation of the urinary bladder with air and the injection of an opaque medium, the relations between the cystostomy, the bladder and the small intestines were visualized by means of roentgenograms. Apparently an adhesive plastic peritonitis was responsible for the connection between an intestinal loop and the anterior wall of the bladder. The circumscribed peritoneal reaction apparently prevented more serious complications.

JOSEPH K. NARAT, M.D.

Pierini, A.: Traumatism Rupture of the Bladder and Posterior Urethra. Fou Observations (Ruptura traumática de la bula y uretra posterior. A propósito de 4 observaciones) *Bol. Acad. argent. ur.* 1946 30: 584.

The author reports 4 cases. The first was that of a man who sustained a fracture of the left iliopectic and ischiopectic branches of the pelvis which led to a rupture of the posterior urethra. The second was that of a woman with a vertical fracture of Maligne's type with extraperitoneal rupture of the bladder. The third patient was a 15 year old boy with a fracture of the pelvis and signs of an extraperitoneal tear of both the bladder and the posterior urethra. The fourth patient, a man 37 years old, also had an extraperitoneal tear of both organs, which had been caused by a fracture of the pelvis.

Extraperitoneal rupture of the bladder usually involves its anterior aspect but occasionally the trigonum or the posterior portion may be torn. Such injuries are usually the sequelae of a fracture of the iliopectic or ischiopectic bone or separation of the pubes. One of two mechanisms may be responsible for such complications, namely a perforation of the

wall of the bladder by osseous spiculae or a tear caused by violent traction exerted by the pubovesical ligaments. A combination of both mechanisms may take place in some cases causing multiple perforations at times.

Instead of a complete tear of the bladder wall, a partial rupture or so-called contusion of the bladder may occur. A unilateral or bilateral iliopectic or ischiopectic fracture, a double or quadruple vertical fracture of Maligne's type, or a pubic or sacrospinous separation may cause brisk traction on the median aponeurosis of the perineum and a complete section of the urethra in a manner similar to the mechanism of a guillotine. Sometimes a fragment of a bone may pierce the urethra. The accompanying hemorrhage is caused by a tear of Santorini's venous plexus and the deep dorsal veins of the penis. The blood infiltrates the Retzius cavity and the ischiorectal fossa and produces ecchymoses in the perineal zone.

A traction exerted by the pubovesical ligament and the median perineal aponeurosis may cause a simultaneous rupture of the bladder and the posterior urethra as was the case in 2 patients reported by the author.

The injection of air instead of a contrast medium for cystography may be advantageous for diagnostic purposes.

As to treatment, early exploratory laparotomy is indicated whenever a fracture or dislocation of the pelvis is accompanied by hematuria. The majority of authors, including the writer is opposed to Boehler's suggestion to treat intraperitoneal as well as extraperitoneal ruptures of the bladder by complete suture of the tear in the bladder and the skin without drainage. Supposedly the skin suture prevents infection of the extraperitoneal hematoma. The introduction of a retention catheter is the final step of the operation. Although in the author's opinion this procedure may be admissible in certain cases of intraperitoneal rupture which are treated early it is an undesirable method in extraperitoneal rupture of the bladder as it may have grave consequences. Suture of ecchymotic margins of the wound which may appear viable at operation may lead to post-operative disruption. Furthermore occlusion of the retention catheter by a blood coagulum may be followed by urinary infiltration of the soft tissues. The author advocates a cystostomy, the introduction of Pezzer's catheter, and a local application of sulfonamides. A drain may be introduced into the Retzius cavity. The bladder is not attached to the abdominal wall.

Some writers advocate a reconstruction of the posterior urethra in case of rupture as soon after the accident as possible, while others recommend a cystostomy to be followed by a secondary reconstruction of the urethra after the fracture has healed. In selected cases the first method may be acceptable, but as a rule the second is preferable. If a rupture of the urethra is combined with a tear of the bladder a primary cystostomy is the method of choice.

JOSEPH K. NARAT, M.D.

Tabara, G., Lechner, C. and Hess, E.: Acute Interstitial Cystitis. *J. Urol.*, Balt. 1946 56 535

The authors report 3 cases of a new clinical entity which for want of a better name they have called acute interstitial cystitis. Each case presented approximately the same subjective syndrome namely marked urinary frequency, strangury and the passage of bloody urine.

The urograms in each case revealed a contracted bladder and overdistention of the ureters and pelvis of the kidneys. The picture resembled that seen in tuberculosis, malignancy and chronic interstitial cystitis. The condition is inflammatory and can be cured by large doses of penicillin and by arsenicals. The prognosis is good but recurrences have occurred.

FARMER, A. LLOYD, M.D.

Flocks, R. H.: Carcinoma of the Bladder. *Canad. M. Ass. J.* 1946 55 348

From 1930 to 1942, 540 cases of carcinoma of the bladder (0.5 per cent of all cases and 5 per cent of all urological cases) were seen in the University Hospitals, Iowa City, Iowa. The majority of patients were in the age group between 50 and 80 years. Metastases were found in 41 per cent of the total number of cases. The most frequent presenting symptoms were hematuria and bladder irritation.

Tumors were classified into three main types: (1) papillary tumors, (2) infiltrating tumors confined within the bladder wall, and (3) infiltrating tumors extending through the bladder wall. Differentiation was made on the basis of the cystoscopic appearance of the tumor, the microscopic appearance of portions of it, and bimanual palpation under spinal or other anesthesia.

Of 168 patients whose tumors were considered papillary, 167 underwent transurethral resection. Eleven died of the operation. The disease was controlled in 130 patients. Twenty three died or are dying of their disease. Three could not be followed up. One patient who was fulgurated suprapubically died postoperatively of a urinary tract infection.

There were 249 patients with infiltrating tumor which was considered to be confined to the bladder wall. In this group, 126 were treated by transurethral resection alone, with control of the disease in 67. Seventy-four were treated by transurethral resection combined with deep x-ray therapy, with resulting control of the disease in only 23 cases. Forty-nine patients received treatment other than transurethral resection alone or combined with x-ray therapy. Five of 13 cases were controlled by partial cystectomy. One of 16 is known to be controlled by suprapubic fulguration. None of 6 cases receiving x-ray therapy alone was controlled. One patient underwent transurethral implantation of radon seeds without benefit. One underwent suprapubic implantation of radon seeds and is doing well. Two patients underwent total cystectomy and are doing well, however, 3 patients died from complications of urinary diversion procedures preliminary to contemplated total cystectomy.

Transurethral resection was found to have definite palliative value in cases deemed incurable.

The author concludes that transurethral resection is an excellent method of treatment in approximately 50 per cent of cases of carcinoma of the bladder. Earlier diagnosis should increase the percentage of good results. This implies increased awareness on the part of physicians to the possible significance of hematuria and bladder irritation.

In cases not amenable to transurethral resection, i.e. all adenocarcinomas and all tumors with extensive infiltration, total cystectomy offers the greatest chance of cure, but its value is limited by the mortality associated with procedures necessary for urinary diversion. The author proposes a new method soon to be reported by which he believes the mortality can be lowered.

CLARENCE V. HODGINS, M.D.

Gorro, A. P.: Total Cystectomy (La cistectomia total). *Rev. esp. cir.*, 1946 3 197

In the author's opinion total cystectomy represents the only correct method of treatment of cancer of the urinary bladder. In this respect, cystectomy may be compared with gastrectomy, which procedure is not disputed by anybody as the method of choice for the treatment of gastric cancer. The final results of total cystectomy may be even better than those of gastrectomy because a cancer of the bladder can be diagnosed at an earlier stage. On the other hand, from the social point of view, gastrectomy can be tolerated more easily than the mutilating removal of the urinary bladder which necessitates deviation of the urinary flow. Frequently total extirpation of the bladder is not selected by the surgeon because the lesion is circumscribed, but in reality the radical operation gives the best promise at that stage and carries a relatively small risk because of the good general condition of the patient.

There are four methods of diverting the urinary flow after total cystectomy: (1) transplantation of the ureters into the intestines, namely the colon or rectum; (2) implantation of the ureters into the hypogastrium; (3) implantation of the ureters separately into the iliac fossae; and (4) implantation of the ureters into the lumboiliac regions.

Attempts to create a new receptacle for urine out of an isolated loop of the intestines never became popular. The multiplicity of methods for deviation of the urinary flow proves that none is quite satisfactory and applicable in every instance. On the other hand, there is a unanimity of opinion as to the operative procedures concerning the extirpation of the bladder, either the abdominal or the abdominopernical approach is used in accord with the local conditions.

As a rule, implantation of the severed ureters into the skin is preferable to their implantation into the intestines. In many cases it is advisable to perform such an operation as the first stage of the entire procedure in order to improve the renal function and the general condition of the patient. The author does not approve of exploration of the lymph system in

the pelvis, lumbar region and along the aorta in order to extirpate the invaded ganglia, because when the condition is so far advanced extirpation of the bladder is no longer indicated. Symphysiotomy is contraindicated in view of the danger of infection of the bone. As a rule the author employs a low median incision. If the perineal approach is selected the author starts with the perineal incision and detaches the prostatic gland and the seminal vesicles from the rectum.

Every effort should be made to preserve the ureters which can be easily traumatized especially during the separation of the posteroinferior aspect of the bladder. If a considerable portion of the ureters is damaged great difficulties may be encountered in implanting them into the skin.

Trendelenburg's position is used for the operation. The vasa deferentia are ligated and the vascular pedicles are isolated and tied proximal to and in front of, the ureterovesical junction. In women an inverted Y-shaped incision is carried through the anterior vaginal wall surrounding the external meatus of the urethra. The urethra can then be dissected up to the internal meatus. One or two rubber drains are inserted into the perineal wound in men. If the ureters are long enough both are implanted into the skin through a stab wound close to the midline. Each ureter is attached to the skin with four sutures placed through its muscular layer and adventitia. If the ureters are not long enough to reach the midline they are implanted in the iliac fossa in the vicinity of the anterior superior iliac spine.

Forty-eight hours after the operation the gauze sponges are removed from the hypogastric incision, while from the perineal wound they are extracted after 4 or 5 days. The rubber drains are withdrawn from the perineal wound 2 or 3 days later and are replaced by smaller ones. These drains prevent the formation of pelvic cellulitis which represents the most serious complication of the operation.

JOSEPH K. NARAT, M.D.

### GENITAL ORGANS

Fergusson, J. D.: Carcinoma of the Prostate Treated with Estrogens. *Lancet*, Lond., 1946, 55.

Fergusson carried out repeated biopsies on 9 patients with carcinomatous prostates and accessible metastases in suitable cases during continued estrogen therapy and simultaneous estimations of acid phosphatase content of the affected tissues. All the patients had proved prostatic cancer and showed a good clinical response to estrogens. Fergusson used a Thompson resectoscope, and the tissue was removed from behind the posterior quadrant of the urethra above the verumontanum. The biopsy intervals varied from 10 days to 23 months.

The estrogen employed was stilbestrol or dienes-trol in doses of from 2 to 15 mgm. daily. In nearly all of the cases the neoplasm regressed from a glandular

adenocarcinomatous to a less cellular scirrhous form. In some cases a measurement of the nuclear diameter and computation of the tumor units were made and a definite decrease in number and size under therapy was revealed. The fresh biopsy material was stained for acid phosphatase and again the concentration of the enzyme diminished during treatment. There was no intimate connection between the concentration of acid phosphatase in the affected prostate and the amount in the blood serum. The serum value is undoubtedly derived from the quantity elaborated by the meta-tases as well as by the primary growth.

Serial removal of several involved lymph nodes in 1 patient demonstrated regression of the metastases also. The author observed nipple tenderness, mammary swelling and pigmentation of the areola, shrinkage of the testes, changes in complexion, and vertigo in 66 per cent of the treated patients. The average survival period of 23 patients treated with estrogen was longer than that of 27 patients not so treated. About half of the deaths were due to delayed and often sudden reactivation of the tumor as though sensitivity to the estrogen was abruptly lost. In the present state of our knowledge it appears that estrogen treatment should be used early and continuously.

DAVID ROSENBLUM, M.D.

McCrea, L. E.: Carcinoma of the Prostate; A Résumé of Treatment with Ethinyl Estradiol. *J. Urol.* Balt., 1946, 56: 697.

In its chemical structure ethinyl estradiol is closely related to alph estradiol, the natural follicular hormone. It does not lose its potency upon oral administration. It is considered to be the most potent oral estrogen used up to the present time, being 6 times more potent than diethylstilbestrol.

The author makes an attempt to contrast the length of survival period, the disappearance of symptoms, and the end-results for a larger but untreated series, with a smaller but nonetheless typical series in which orchiectomy and estrogenic therapy were instituted.

In his series of 15 cases subjected to the combined therapy of orchiectomy and estrogenic therapy ethinyl estradiol was used instead of diethylstilbestrol. The dosage schedule routinely employed was a 30 day period in which 0.05 mgm. ethinyl estradiol was given once a day alternating with a 3 day rest period. One patient has been on such a regime for 27 months. The results attained were good, and more than favorably compared with the results attained with diethylstilbestrol, and warrant the further use of the drug.

An attempt was made to use the fall of the serum acid phosphatase level as an index of therapeutic efficiency but it was not uncommon to find the original level within normal limits. In these cases the diagnosis was made on clinical interpretations alone. It cannot be stated that a low primary level or a marked regression of the level should be a criterion in estimating the prognosis, extent of metastases, or severity of pain.

The author found regression of the prostate to be remarkable in most instances. In his series of 15 cases

not a single transurethral resection was necessary after the institution of combined therapy although many of the patients were in a state of acute urinary retention when first seen.

The side effects of ethinyl estradiol therapy were similar to, but less intense than those seen following the use of diethylstilbestrol. The use of vitamin B complex is suggested to relieve such side effects as exist. The breasts may become grossly enlarged and are sometimes painful, but this is less marked than with diethylstilbestrol. Edema of the lower extremities was slight in this series and in not a single instance did it become necessary to discontinue the drug.

The author concludes that the side effects of ethinyl estradiol are not as severe as those of diethylstilbestrol and that subjective improvement always followed its use.

JOSEPH E. MACKEK, M.D.

Nixon, N. and Lewis, D. B. Mumps Orchitis. *J. Urol. Balt.* 1946 56 534

Epididymo-orchitis occurring in mumps, is responsible for long periods of hospitalization. Important to the patient is the possibility of atrophy of the involved testicle with subsequent sterility and impotence. Most authors report an incidence of testicular atrophy of between 40 and 60 per cent. Orchitis usually occurs before complete subsidence of mumps parotitis. In rare instances it may precede the parotitis by a number of days and in other cases it may be the only manifestation of mumps.

The temperature usually rises shortly before the patient begins to complain of testicular tenderness. As swelling occurs the fever rises sometimes to 105°F., and the patient complains of chilliness, back ache, malaise, nausea and vomiting. The testicle becomes hard, smooth, exquisitely tender and remains so for at least 4 or 5 days. The fever then drops by lysis and the swelling subsides the usual course of the orchitis taking about 10 days.

The invasion of the glandular tissue by the virus causes an edema of the former which is restrained by the firm, fibrous, tunica albuginea. In fulminating cases, hydrocele fluid accumulates between the tunica albuginea and the tunica vaginalis. This causes pressure necrosis of the seminiferous tubules with subsequent partial atrophy of the testis.

The shift in the blood picture from leucopenia and lymphocytosis to polymorphonuclear leucocytosis is further evidence of necrosis.

The medical treatment of orchitis is symptomatic. Convalescent serum, hot and cold applications and drugs are useless.

The author advocates the treatment of severe orchitis by surgical drainage. An incision 2 cm. long is made over the anterior surface of the scrotum under a per cent procaine infiltration anesthesia and the tunica vaginalis is incised. Usually the hydrocele fluid drains out under considerable pressure. A small Penrose tube is inserted beneath the tunica vaginalis and the wound is closed.

Of 339 soldiers with mumps at an Army Air Base 101 (nearly 30%) developed orchitis. In 68 of these

(67%) the orchitis was sufficient to warrant surgery. In 66 soldiers the above described technique was employed. In 2 the tunica albuginea was also incised by the technique of Wesselhoeft and Vose. Drainage was maintained for at least 24 hours.

Most patients showed almost immediate improvement with relief of pain, nausea, vomiting, and head ache within a few hours and reduction of the swelling within 24 hours. It was possible to follow up 27 of these patients. 26 revealed no evidence of testicular atrophy other than a slight degree of softening of the testicle in comparison with the firmness of its fellow.

FREDERICK A. LLOYD, M.D.

Baker, W. J. and Ragins, A. B.: Actinomycosis of the Testicle. *J. Urol. Balt.* 1946 56 547

A case of actinomycosis of the testicle in a 77 year old man is described as an incidental finding in a bilateral orchiectomy for the treatment of carcinoma of the prostate gland. The tunica vaginalis of the right testicle was loosely adherent to the tunica albuginea, and the testicle measured 5 by 3.5 by 3 cm. The surface made by cutting was brownish gray and studded by numerous abscesses which were filled with a greenish gray purulent material emitting a musty odor. The right epididymis showed no gross abnormal findings.

Since gross examination gave no clue as to the true nature of the condition the specimen was fixed before cultures were taken. The diagnosis of actinomycosis became obvious after microscopic studies. Because of the typical radiating fungus with bulbous mycelia at the periphery the organism may be considered as actinomyces bovis (Wolf Israeli type).

The condition is extremely rare. This represents the fourth case to be reported in the literature.

FREDERICK A. LLOYD, M.D.

Friedman, N. B., and Moore, R. A.: Tumors of the Testis; Report on 922 Cases. *J. Urol. Balt.* 1946 56 373

In a group of 922 cases of tumor of the testis occurring in males of military age who were serving in the Army of the United States the authors found that 96 per cent of these tumors could be classified into 4 fundamental structural patterns. These were seminoma (55%), embryonal carcinoma (10%), teratoma (7%), and teratocarcinoma (35%). Of the remaining 4 per cent, 1 per cent were interstitial cell tumors and the remainder fell into a miscellaneous category.

Seminomas showed mainly a homogeneous mononuclear pattern. They were composed of sharply defined, rounded polyhedral elements the cytoplasm was often clear. The nuclei clearly outlined were centrally placed as were the nucleoli. The nuclear chromatin was evenly dispersed. The cells were remarkably uniform and were usually arranged in an organized masses, separated by trabeculae of connective tissue. Occasionally the arrangements of cords and columns gave the impression of glandular structures but no lumens were formed. Micro-

scopically they appeared relatively benign, which appearance was consistent with the small incidence of regional and distant metastases and the low mortality rate.

Embryonal carcinomas, often confused with seminomas, differed not only in fundamental cell type but in biologic behavior and prognosis. The cells were frankly epithelial, often cuboidal or columnar and frequently formed differentiated glandular or papillary structures. Differentiation was often incomplete so that portions or all of the tumor consisted of unorganized solid epithelial sheets. The obviously anaplastic cells were larger than those of seminomas. The nuclei, which were large, variable and bizarre, showed few traces of the orderly seminomatous pattern; the chromatin was clumped irregularly into large masses which stood out sharply against the clear background. Cellular types showed more variation from tumor to tumor than did seminomas. Significantly trophoblastic tendencies were seen in embryonal carcinomas.

Chorioepitheliomas have customarily been placed in a special category. However histological studies in this series indicated that the trophoblastic tendencies observed in embryonal carcinomas found full expression in the typical chorioepithelioma pattern, that of a combination of compactly grouped cytotrophoblastic cells and giant multinucleated syncytial structures. This, it was believed, justified inclusion of chorioepitheliomas in the embryonal carcinoma group.

The somatic potentialities of testicular tumors were shown in the teratomas, which were characterized by the presence of epithelial masses, glands, and cysts, many of which were organized in combination with undifferentiated or specialized mesenchymal tissues, such as cartilage, into structural units. A teratoma is termed adult if it has no histologically recognizable malignant components

however metastasis of testicular tumors which appeared to be only adult teratomas is reported to have occurred.

The classification of teratocarcinoma was proposed for the large group of pleomorphic tumors in which both differentiated teratoid structures and histologically malignant elements were present. Rather than the conventional belief that the presence of embryonal carcinoma in teratocarcinomas is accounted for by malignant transformation of an adult structural component, the authors hold that the adult structures have differentiated in situ, probably from the carcinomatous cells. This is supported by the intimate association of glands and other differentiated epithelial structures with both carcinomatous epithelium and organized mesenchymal components within the tumor.

A study of mortality rates and incidence of metastases indicated that for seminomas the immediate prognosis is good. In contrast the immediate prognosis is bad for embryonal carcinomas and chorioepitheliomas, and poor for teratomas and teratocarcinomas.

Ninety per cent of embryonal carcinomas metastasized as embryonal carcinomas or chorioepitheliomas. Roughly half of the teratoid neoplasms which metastasized gave rise to growths with teratocarcinomatous structures and half to pure embryonal carcinoma.

The authors state that the architecture of testicular tissue is not reproduced in seminomas and, therefore the term "seminoma" is inappropriate. They conclude that seminomas are probably tumors of primordial germ cells and should be called germinomas. Embryonal carcinomas and teratoid tumors, which are composed of evolving and differentiating somatic and trophoblastic tissues, are neoplastic expressions of the unlimited potencies of embryonic cells.

CLARFAX V. HODGES, M.D.

# SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

## CONDITIONS OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC

Schlumberger H G: Fibrous Dysplasia of Single Bones (Monostotic Fibrous Dysplasia) *Mil Surg.* 1946 99 504.

During the war the Army Institute of Pathology received tissue and records of 66 cases of fibrous dysplasia occurring in Army personnel. This paper reports the study of 67 of these which were monostotic. The ribs were most frequently involved and the small bones of the hands and feet were never involved.

The roentgenogram in this disease is not specific, and diagnosis is made by biopsy. The correct diagnosis was not made in any case by the roentgenologist. Eighteen resected ribs were studied.

The lesion appeared as asymmetrically fusiform or almost spherical swellings ranging up to 6 cm. in diameter. The surface consisted of thin but intact cortical bone. On section the cancellous bone and marrow were found to be replaced by a firm resilient yellow white tissue containing occasional small cysts which were usually filled with amber fluid. This tissue had a gritty character because of the presence of innumerable minute spicules of bone. Histologically the material resembled normal callus. Within the fibrous tissue, and most abundant at its periphery were trabeculae of partly calcified newly formed bone formed by direct metaplasia of the connective tissue.

The author believes that monostotic fibrous dysplasia can be distinguished histologically from neurofibromatosis by failure to find any nerve fibers in the lesion, but that ossifying fibromas and nonosteogenic fibromas are histologically indistinguishable from this disease and should be considered as variants of fibrous dysplasia. Albright's syndrome characterized by osteitis fibrosa disseminata, areas of pigmentation and endocrine dysfunction is a polyostotic fibrous dysplasia and probably has nothing in common with monostotic fibrous dysplasia. It is not a congenital anomaly.

Evidence is presented to suggest that the disease may represent a disturbance of the normal reparative processes following injury to bone.

VERNON C. TURNER, M.D.

Newman, F W: Paget's Disease. A Statistical Study of 83 Cases. *J Bone Surg.* 1946 28 798.

This study covers a 15 year period at the Hospital of the University of Pennsylvania representing an incidence of Paget's disease of over 0.06 per cent of the total of about 127,000 case histories.

The disease was fairly equally distributed between males and females, over 40 years of age in 79 cases among which 79 patients were over 50 years of age. Only 3 cases occurred in individuals under 40 years

of age. In only 48 per cent of the cases were the chief complaints closely related to Paget's disease. In the remainder the Paget's disease was an incidental finding.

The bones involved were chiefly the pelvis, skull, spine, and femur but there were some cases in which the tibia, humerus, radius, fibula and metacarpals were involved.

The calcium (blood serum) varied from 9.4 to 12.2 mgm. per 100 c.c. The serum phosphorus levels ranged from 2.6 to 6.75 mgm. per 100 c.c. The alkaline phosphatase level showed a definite elevation in most cases and is considered by the authors as the most useful of all laboratory procedures. The serum phosphatase levels varied from a low normal of 0.8 Bodansky units to a high of 175 units. The acid phosphatase levels varied from a normal low of 0.1 to 2.0 units. The alkaline-phosphatase levels varied from a low normal of 2.6 to 48.8 units.

The roentgenograms were diagnostic, the differential diagnosis from metastatic carcinoma from the prostate being very important. The complications in the order of their frequency were cranial nerve pressure, fractures, urinary calculi and sarcomatous degeneration. In this series there were only 2 proved cases of sarcoma.

Relief of the presenting symptoms was directed by the respective specialties. Roentgenotherapy was formerly given in an attempt to relieve pain. Magnesium carbonate powder 1 teaspoonful 2 or 3 times daily and a low calcium diet were recommended.

DANIEL H. LEVITSKY, M.D.

Herdner and Malgras: Costotransverse Tuberculous Osteoarthritis (Osteo-arthritis tuberculeuse costo-transversales) *Rev. orthop.*, Par. 1946 32 231.

The authors believe that they have identified a localization of tuberculous osteoarthritis that has never before been described. A few cases of tuberculous osteitis of the transverse processes have been described but this was an osteoarthritis that involved the rib, the transverse process, and the joint which connects them. Two cases are described in women 48 and 37 years of age who for months had suffered agonizing pain. Tuberculosis of this very small joint is more serious than that of larger joints like the knee because relief cannot be procured by immobilization. The slightest movement even that of respiration or coughing causes the most intense pain. In both of these cases when the lesion had been localized operation was performed and the patients were completely relieved.

The point that is most emphasized in the article is the necessity for tomographic examination in these cases. A simple roentgen examination is only the first step in the diagnosis. It must be completed by an extremely careful tomographic examination of the



region in which the lesion is suspected this reveals the lesion by getting away with the shadows of neighboring organs.

The tomograms of these cases are reproduced and a detailed discussion is given of the manner in which the lesions were revealed. Diagrammatic sketches of the involved regions are shown.

AUDREY G MORGAN M.D.

Hamilton J B., Barner J L. Kennedy P C., and McCort, J J.: The Osseous Manifestations of Eosinophilic Granuloma. Report of 9 Cases. *Radiology* 94b 47 445

Case studies of 9 patients with eosinophilic granuloma of bone are presented. All of the patients were seen in an Army General Hospital and were young males. The laboratory findings were normal except as follows: in 2 cases the alkaline phosphatase was increased to 7 and 7.9 Bodansky units, respectively the sedimentation rate was increased significantly in 1 case a sternal marrow puncture was made in 1 case and the smear was normal.

Röntgenologically all lesions tended to be osteolytic. In the skull the lesion had little respect for suture lines and usually involved both tables.

The differential diagnosis included the following: fibrosing osteitis developing after a closed injury to the skull, meningiomas (however these usually show more erosion of the inner than of the outer table), epidermoid cysts (which originate in the diploe and expand through both the inner and outer tables), solitary bone cysts, multiple myeloma, osteitis fibrosa cystica, and low grade osteomyelitis.

There is a long discussion of the relationship of this disease to Hand-Schüller Christian's disease or lipogranulomatosis, and to Letterer-Siwe's disease also called reticulosis or neoplasmic histiocytosis.

In this series, with a relatively short period of follow-up there was no roentgen evidence that roentgen therapy altered the course of the disease, although it did appear to relieve pain.

VERNON C. TURNER, M.D.

Peša, K.: Changes in the Bones of the Wrist in Workers with Pneumatic Tools (Směny na kostech zápěstí při práci pneumatickým nářadím) *Laborská listy* 94b, 249.

The tools included in the workman's compensation law are the pneumatic drill, pneumatic riveter and the pneumatic hammer. They do not include the tools fixed to an immobile base. The intensity of the percussive effect depends upon the weight of the tool (from 7 to 35 kgm.) the rapidity of the strokes (from 250 to 4,000 percussions per minute) and the length of the stroke (from 12 to 350 mm.). The more tightly the instrument is gripped the less is the impact.

The bones most commonly affected are those of the wrist, although the literature also reports effects in the acromioclavicular shoulder and elbow joints, and even spondylitic changes in the spine. The last effects are ascribed to using tools while in the hori-

zontal decubitus which, even if it does not induce the vertebral changes could certainly aggravate a spondylitis already present. In addition, there are also described vague effects on the joints, muscles, blood vessels, and nerves. The law recognizes that the progressive effects should require constant exposure to the percussive effects for a sufficient length of time (at least 2 years).

The author reports 7 cases for the Brno region in Moravia during the years from 1929 to 1943. In 5 cases the shoulder joint was the part involved in 1 the elbow joint, and in 1 instance there was an extensive atrophy of the muscles in the region supplied by the cervical plexus (pectoralis major supraspinatus and trapezius muscles).

The remaining 3 cases were wrist injuries. In 2 of these there were no roentgenological findings and the author a roentgenologist does not attempt to discuss it. The other 2 cases, including the roentgenograms are reported in detail. In 1 patient extension at the wrist was practically nil and the other motions were markedly diminished. The roentgenogram for the year 1939 disclosed a lunatum flattened to half of its normal height with a pathological fracture. In the substance of the bone were cystic areas alternating with areas of condensation. In the other bones of the wrist there was a longitudinal arrangement of the bone prominences and in these bones, as in the ulnar styloid process, cystic changes were visible. In most of the wrist joint surfaces arthritic changes were visible. Six years later the bones were largely reconstituted however the deformities and other arthritic manifestations were unchanged.

The remaining patient presented much the same history, development, roentgen findings, and residual loss of motion in the wrist joint, except that the left wrist was the joint involved. There was an early history of injury to the joint, and 4 years later the cystic changes had not entirely disappeared.

JOHN W. BRIDGMAN M.D.

## SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Marino, H.: Volkmann's Contracture of the Upper Extremity. Technique of the Explorative Operation (Contractura braquial de Volkman de miembro superior. Técnica de la operación exploratoria) *Boletín Acad. argent. Cir.* 1944, 23 0.

The need of surgery in the treatment of Volkman's contracture at the moment of its appearance in order to avoid further development, as well as after it is once established, has been emphasized by Bardenheuer, Leriche, Tavernier and among Argentine surgeons, by Ceballos, Gioia and Fitte. However none of these authors has described a satisfactory technique which will facilitate the approach to the somewhat complex region in an urgent case, and save as many nerves, vessels and muscles as possible.

Because of the ischemic paralysis of the upper limb resulting from fractures or vascular lesions, the operative procedure must ensure a perfect approach to

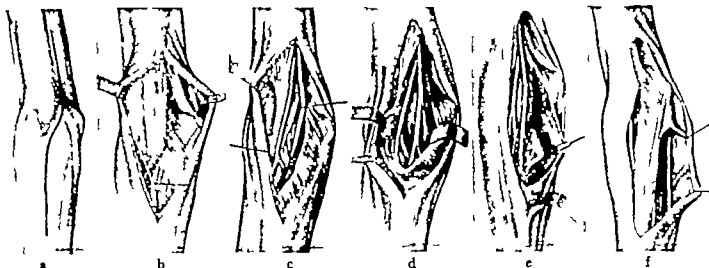


Fig. 1. a, Incision line. b, Aponeurotic layer. c, The incision of the aponeurosis shows the nerves, vessels, and the pronator teres. d, The artery and its branches, and the median nerve covered by loose connective tissue and easy to reach. This is the site where compression lesions begin.

e, The dissection of the pronator teres is followed downward showing the flexor digitorum sublimis and the artery and nerve lying underneath. f, The investigation of the ulnar nerve.

the lower part of the arm and anterior part of the elbow and forearm with good vision of the median and ulnar nerves the brachial artery and its branches, and the radial and ulnar arteries. Incisions have to be wide and easily extendible. Fiolle and Delmas devised a technique which was applied to elbow injuries in World War I this allowed the exploration of the three main arteries of the upper limb although it did not permit the study of the ulnar nerve and the lower portion of the forearm.

The author proposes the following technique: the incision starts at the inner edge of the biceps at the juncture of the middle and lower third of the arm, following that edge downward crossing in front of the elbow bending toward the axis of the limb and following that line as far as necessary.

In early cases the surgeon will find branches of the medial brachio-cutaneous nerve in the subcutaneous tissue and the musculocutaneous nerve below them. Sometimes the superficial vessels have to be cut, but in older cases they will not exist or will be very small. Dissection must be performed even if it is difficult because of infiltration of the tissues.

The first element to be studied is the median nerve which can be seen at the internal edge of the biceps muscle and under the brachial aponeurosis. It is freed with the scalpel and section of the aponeurosis is continued downward following the incision line (b). This incision of the forearm is performed between the pronator teres and supinator longus in the form of a channel in which the nerve lies (c).

Section of the aponeurosis is important in early cases, because it constricts the vessels and nerves after fracture or the development of a hematoma. One can see how the circulation improves after section.

The investigation of the brachial artery is easy: it is found in the arm just lateral to the median nerve

and surrounded by veins. If the artery is of good size, it should be followed upward to a normal area where a periarterial sympathectomy is performed. If the caliber of the artery is very small or the artery does not exist an arterectomy is advised with two ligatures including the injured portion.

The nerve is often only partially injured and a good dissection will permit wrapping it with muscular tissue. If the continuity is lacking it must be re-established by a graft at a second operation.

In this manner the vessels and nerves of the arm elbow and upper part of the forearm are liberated. However sometimes the lesion is in the lower third of the forearm, in which case the investigation must be continued downward. The section of the pronator teres frees the nerve lying under it. The artery must be traced also for it may be that the artery and nerve are pressed under the flexor superficialis at the radial and ulnar insertions, and its section will release them (e).

The ulnar nerve is not always injured as it is better protected than the median. It can be seen through the superficial aponeurosis at the inner edge of the forearm. It is easy to recognize because of its size (f) and if it is followed upward it will be seen that it divides the insertions of the flexor carpi ulnaris. If desired the investigation can be continued upward through the supracondylar groove.

Once the section of aponeurosis and scars is complete and the treatment of nerves and arteries accomplished the wound is sutured that is, only the subcutaneous tissue and the skin. The aponeurosis and injured muscular fibers are left loose to avoid recurrence. Immobilization with a plaster splint is advised during the healing period. Afterward mobilization physical therapy and thermotherapy will complete the treatment aiding the return at least partially of the movements of the limb.

H. MARINO, M.D.

Guilleminet M., Roy J. C. and Andrie G.: Results of Arthroplasty of the Finger Joints (Résultats de l'arthroplastie des articulations digitales) *Rev orthop* Par 1946, 3 277

Little is known of the late effects of arthroplasty of the finger joints. The authors therefore describe and illustrate with photographs 3 cases in which they have operated, the most recent one 6 months ago and the oldest 9 years ago. The results were very good in 3 cases and poor in 2 cases.

The authors overcome the ankylosis by removing the sclerotic periarticular tissue restoring the joint surfaces as nearly as possible to their original form and placing between the two surfaces some substance which will prevent osteogenesis and renewed ankylosis. They have used fascia lata in all their cases. The operation is performed best under general anesthesia and the incision may be lateral or dorsal. This operation is indicated in post-traumatic ankylosis but not in ankylosis following infectious arthritis, and probably not in those due to chronic rheumatism although the authors have had no experience in this form.

A good part of the effect of the operation depends on the patience and skill of the patient in re-educating his fingers. This is a long and painful process and some patients will not keep up the necessary tedious daily exercises after they are dismissed from the physician's care. The best result was obtained in the case of a physician who needed his finger for gynecological and obstetrical examinations and who exercised great patience and skill in the re-educating exercises. On the other hand one of the patients who could not be kept under observation was evidently careless in this respect and the result obtained in this case was not very satisfactory.

VUDRAY G. MOROAN M.D.

Schwartz, R. P.: Arthrodesis of the Subtalar and Midtarsal Joints of the Foot. *Surgery* 1946 20 69.

Impairment in the function of locomotion may be due to deformity with or without instability of the foot resulting from trauma infection disordered nerve impulses or congenital influences. A fairly comprehensive historical review is presented describing the various methods of stabilization.

The author describes his preoperative analysis to reveal the individual variations and carefully plan the correction of the particular structural abnormalities. Mediolateral and plantar dorsal roentgenographic tracings are made preoperatively and the lateral view is cut into three parts: the upper representing an outline of the astragalus and lower tibia; the inferior posterior representing the calcaneus, and the inferior anterior representing the foot anterior to the metatarsal joint. These sectional tracings are superimposed upon each other: the composite representing the optimum restoration desired and the amount of cartilage and bone which must be removed. This restoration is checked with the lateral view post-operatively.

DANIEL H. LEVINTHAL, M.D.

Tavernier L.: Pseudarthroses with Bone Loss Treated with Flexible Bone Grafts and Intra-medullary Wire (Pseudarthroses avec perte de substance osseuse traitées par greffes souples sur broche métallique intra-médullaire) *Lyon chir* 1946 41 343

The treatment of pseudarthroses with bone defect always has been a difficult problem. A rigid bone graft can be readily employed in cases in which large bones are involved. Even then the condition often is complicated by secondary fracture of the bone graft. In pseudarthroses of slender bones, such as the bones of the forearm, fixation of rigid grafts is extremely difficult and disalignment of the fragments very often occurs. The use of flexible grafts (osteoperiosteal or cancellous bone) facilitates the procedure considerably but it is difficult, if not impossible, to keep the fragments in proper alignment. Immobilization in a plaster cast is often sufficient, but it is inadequate in many cases, for example in pseudarthroses of both bones of the forearm.

The method of using flexible grafts and intra-medullary wires has the advantages of both methods without their faults. Maintenance of the position of the fragments is as secure as with the use of rigid grafts, the procedure is simple, and the osteoperiosteal graft has the same osteogenic qualities as the cancellous bone grafts.

The advantages of this method are clearly demonstrated in pseudarthroses of both bones of the forearm. The 4 fragments are brought into proper alignment with Kirschner wires. The fixation is sufficiently mobile to allow the application of flexible bone grafts without losing reduction. A plaster cast is used for additional immobilization of the forearm in midposition. The ultimate result of this type of treatment was much better than that ever obtained by rigid fixation.

This procedure was used in 8 cases, 2 of which were pseudarthroses of both bones of the forearm. Preliminary to the bone grafting scars are excised and the adjacent joints, muscles, and tendons are limbered up with the help of physical therapy. The incision is carried along muscle layers or already existing depressions caused by scar tissue adherence to bone. The bone is freed proximally and distally to the fracture line for a distance of about 3 or 4 cm. There is a tendency to save on exposure to preserve the blood supply to the area, but this makes the operation much more difficult and eventually one is compelled to extend the incision to establish good contact of the host bone with the bone graft. Scar tissue is excised until normal muscle is encountered. This is done to assure proper blood supply. The medullary cavity of both fragments is opened; these cavities are usually closed by a plug of condensed bone. Then the Kirschner wire is inserted into the medullary cavity of both fragments. In case of pseudarthroses of the ulna the wire is inserted through the olecranon and in case of the humerus, through the head in the region of the shoulder. In case none of the portions of the bone is easily accessible like in

the radius an opening is made in one end of the bone extending obliquely into the medullary cavity. The Kirschner wire is made to follow the opening and is guided into the medullary cavity across the pseudarthrosis site into the other fragment. The wire is then cut even with the bone surface. In wiring the radius the opening is made on the dorsal aspect of the distal end of the bone. The osteoperiosteal grafts are removed from the anteromedial aspect of the tibia long enough to cover the defect in the host bone and to extend 3 to 4 cm. on each fragment. These grafts are placed with their rough sides toward the host bone and are fixed by encircling catgut sutures. The muscular and fascial layers are closed snugly to hold the grafts in place.

Although cancellous bone replaces bone defects faster and unites more readily with the host bone the author prefers the osteoperiosteal grafts because of the added stability. The skin is closed. A cast is applied. Roentgenograms are taken after a month.

Three cases are presented a pseudarthrosis of the radius of the humerus and congenital pseudarthrosis of the tibia.

A soldier 25 years of age sustained a double fracture of the radius due to a shell explosion in February 1914. In February 1915 he was operated upon in a military hospital because of a persistent pseudarthrosis. In November 1915 malunion of the proximal fracture site was apparent. The pseudarthrosis of the distal fracture persisted. The bone graft used for the repair of the distal fracture at the first operation was found to be dead and had to be excised in the second attempt at repair. At the second operation the malunion of the proximal fracture was osteomized and the fibrous tissue forming the pseudarthrosis of the distal fracture was excised. The marrow cavity was opened in all three fragments. Through a prepared opening in the distal portion of the radius a Kirschner wire was inserted and guided proximally into the medullary canal through all three fragments. The alignment at the proximal fracture site was satisfactory but there remained a defect from 2 to 3 cm. in length at the distal fracture site. A long osteoperiosteal graft taken from the tibia was placed over the radius to extend from 3 to 4 cm. distally and proximally beyond the fracture line. The graft was fixed with catgut to the upper and lower fragments.

At the end of a month there was still some motion at the distal fracture site and a new cast was applied. At the end of 2 months the consolidation was complete but there was considerable dorsal deviation of the distal end of the radius. An osteotomy corrected the deformity of the radius. At the end of another month consolidation of the fracture sites was complete. The shape of the forearm supination and pronation were nearly normal.

Without the medullary splinting with Kirschner wire repair of the malunion would have failed and the result most likely would have been a Z shaped deformity of the radius which would have blocked pronation and supination.

The author reports the case of a 19 year old female who had had acute arthritis of the left hip and right shoulder when a child. Several years before the left hip had been reconstructed by an arthroplasty. Osteomyelitis of the right humerus caused growth arrest in that bone. The humerus measured only 17 cm. in the roentgenogram. The patient requested that the arm be made longer because she wanted to get married. On December 12 1945 a Z osteotomy was done on the midportion of the humerus. A Kirschner wire was inserted transversely into each end of the bone and traction of 5 kgm. was applied to each end. It is generally difficult to get more than 4 cm. lengthening in a normal extremity. After a few days of traction a gain of 10 cm. in length was observed. The traction was removed and a weight was attached to the wire through the distal end of the humerus the patient being allowed to be ambulatory and carry the arm in a sling. Bony union at the osteotomy site did not take place. On February 18 1946 a bone grafting operation was done. Two osteoperiosteal grafts were used the longer graft was placed on the anterior aspect of the humerus and the shorter one was placed on the posterior aspect of the bone. The grafts were held in place with catgut sutures. Prior to this procedure a Kirschner wire was inserted into the medullary canal to bridge the bone defect.

On the tenth postoperative day a superficial abscess had to be incised. In spite of a persistent fistula bony union was observed on the seventieth postoperative day. The arm was from 6 to 7 cm. longer.

In another case a child was admitted to the hospital in January 1943 because of a deformed leg. There was considerable bowing of the lower leg in its distal third. This deformity followed a fall 2 months prior to admission. On March 5 1943 a sliding bone graft was applied by following Albee's technique to correct the deformity. Because of an "osteolytic process" the graft as well as portions of the proximal and distal fragments became resorbed. In spite of walking casts and caliper braces the outward bowing of the leg increased more and more and finally the fibula broke. It was generally agreed that this was not a simple fracture of the tibia caused by a fall but a congenital pseudarthrosis of the tibia. Further questioning of the parents confirmed the diagnosis. On February 15 1945 an open reduction with bone grafting was done. The scar tissue between the fragments was excised. By means of a manual osteotomy of the fibula satisfactory alignment of the bones of the leg was made possible. A Kirschner wire was inserted into the medulla of both fragments of the tibia and cut even with the cortical surface of the bone. An osteoperiosteal graft was taken from the other tibia and fixed to the host bone with encircling catgut sutures. Smaller bone grafts were used to fill the defect between the bone fragments.

The plaster was changed one month after operation. One hundred days after the operation the pa-

tient was allowed to be about in a Delbet plaster. Re-examination after another month, however, revealed motion at the fracture site and some decalcification of the distal end of the graft was noticed. On July 23, 1945 another operation was done. Fibrous and fibrocartilaginous tissue was found to bridge the defect. After excision of the fibrous tissue an osteoperiosteal graft taken from the other tibia was used to bridge the bone defect. At the end of a month union was almost complete and walking in a

Delbet plaster was allowed. A roentgenogram taken in March, 1946 revealed that the Kirschner wire broke at the level of the old site of the pseudarthrosis. The wire was extracted. Today the patient walks without any difficulty although the leg is about 3 cm. shorter.

In conclusion it is pointed out that the outlined procedure is very effective in cases in which union usually is very difficult to obtain. Infection usually destroys the graft and interferes with the formation of solid callus, yet it failed to prevent the formation of callus and to destroy the graft in the cases treated by the author. Another interesting observation was the fact that the Kirschner wire broke even after union was established. The author was forced to extract a Kirschner wire which was left in a tibia with pseudarthrosis for several months. This wire was made of steel covered with chrome (not of nonoxalizable steel). He observed that the wire was superficially oxidized along its entire length. The portion of the wire which came to lie at the level of the pseudarthrosis was eroded and three quarters of its thickness was destroyed. Evidently the wire did not break because of some mechanical factor since the fracture appeared to be healed at the time when the wire was already broken. It broke because of the "biological processes of oxidation" that take place at the site of a healing pseudarthrosis. This also explains the fact that the intramedullary grafts used in the repair of recent fractures and pseudarthroses frequently break transversely at the fracture site. It is apparently due to the action of "very active oxidases" which are found in areas where bone is rebuilt.

Similar favorable results were obtained in the 5 other cases treated in a similar manner and the author feels justified in stating that this type of treatment is easy and efficient.

GRODOK I. RYSE, M.D.

Adams, A. O.: Neurectomy to Produce Atrophy of the Amputation Stump. *J Bone Surg* 94B 876.

The author believes that neurectomy offers the advantage of causing a more rapid and complete atrophy of the amputation stump in large muscled adults rather than other operative procedures. The object is to produce a conically shaped stump. This was achieved in 5 cases, in 3 of which the nerve operation was done at the time of primary amputation. In the 2 other cases, subsequent nerve operations were performed.

A longitudinal incision  $3\frac{1}{2}$  inches in length is made in the lower part of the popliteal space, extending down the leg. The medial sural cutaneous nerve should not be damaged. This nerve may be used as a guide to follow down into the popliteal space to the tibial nerve. The muscular branches of the tibial nerve to the two heads of the gastrocnemius are identified and completely sectioned. The branch to the soleus leaves the tibial nerve at a lower level, but is within the operative field and may be sectioned. The location of this incision is such that the scar has not been objectionable. C. FARR GORDON, M.D.

## FRACTURES AND DISLOCATIONS

Urist, M. R.: Complete Dislocations of the Acromioclavicular Joint. The Nature of the Traumatic Lesion and Effective Methods of Treatment with an Analysis of 41 Cases. *J Bone S* 9 1946, 18-33.

An analysis is presented of 41 cases in which there was a complete dislocation of the acromioclavicular joint. All of the patients were strong, active young soldiers who variously acquired their injuries through acts of violence. Twenty-three of these injuries were acute and were recognized early; the remaining 18 cases were chronic. Eleven cases reported in both groups presented associated fractures of the clavicle, the acromion process, and the coracoid process.

A table is included showing a classification of anatomical variations in the acromioclavicular joint in 100 random roentgenograms of the shoulder. The mechanism of injury and the traumatic lesion are discussed. Experimental observations are reported. An examination of resected joints is reported. The following were of value during treatment: (a) widening of the joint spaces; (b) ballottment; and (c) evolution of the symptoms. Another table contains significant data regarding 18 complete dislocations of the acromioclavicular joint treated by early reduction and immobilization for 6 weeks. In 12 cases the results were excellent and in 6 there were residual symptoms. A similar table shows significant data regarding 11 complete dislocations of the acromioclavicular joint seen late and not treated. All of the patients had marked residual symptoms. Another table presents significant data regarding 5 complete dislocations of the acromioclavicular joint treated primarily by various methods. In 3 there were excellent cosmetic results with pain while in 2 there was slight deformity and subluxation with no residual symptoms. The purpose of treatment in these cases is to secure anatomical reposition and to relieve the symptoms. On the other hand, a patient with a poor anatomical result may have no symptoms. Conservative methods of reduction of the dislocation include bandages, adhesive dressing and strapping, suspensions, harnesses and braces, and plaster of Paris splints.

Fifteen shoulders with complete dislocation of the acromioclavicular joint were treated by means of a plaster jacket applied around the body to the level

of the axillae. A pad was placed across the dislocated acromioclavicular joint and an elastic shoulder strap was stretched tightly over the clavicle. Then the ends were doubled back on themselves between layers of plaster bandage incorporated in the body cast to maintain constant pressure. The scapula was elevated by means of raising the shoulder girdle and incorporating the upper extremity in the body cast in this elevated position. Immobilization was continued for 6 weeks. Twelve of the 15 soldiers returning to duty were completely cured after a period of physical therapy and rehabilitation. In 1 case subluxation developed without pain or limitation of motion. The 2 remaining cases presented subluxation associated with symptoms eventually the patients were subjected to surgical treatment.

The surgical methods used were open reduction and internal fixation arthrodesis coracoclavicular screw fixation skeletal traction and excision of the outer end of the clavicle. Primary excision of the joint is probably not justified in dislocations associated with fractures until a period of duty establishes disability. Complications and sequelae are discussed. The chief obstacle to effective conservative treatment has been found to be interposition of parts between the joint surfaces. Excision of the outer end of the clavicle was used successfully in 9 cases in this series.

RICHARD J BENNETT JR. M.D.

Kestler O. C. Recurrent Dislocation of the First Carpometacarpal Joint Repaired by Functional Tenodesis. *J Bone Surg* 1946 28 858

A review of the literature disclosed that 3 procedures have been suggested for the radical cure of recurrent dislocation of the first carpometacarpal joint. A case report is presented. The operation devised takes into account that the tendons have a logical anatomical course and that the function of the muscle should actively hold the involved bone in place. Also the procedure should not interfere with the original function of the tendon. The author states that these requirements were fulfilled in the case reported. The operative procedure which uses the abductor pollicis longus tendon is explained in detail.

RICHARD J BENNETT JR. M.D.

Cobey M. C. and White R. K.: An Operation for Nonunion of Fractures of the Carpal Navicular. *J Bone Surg*, 1946 28 757

Operative procedures are not considered in fractures of the carpal navicular until a full trial of immobilization has been given. Twelve weeks is considered a reasonable period for union. No fracture older than a year was grafted in this series. The criteria of nonunion are based on roentgenographic findings alone. The operative procedure is explained in detail. The bone graft can be removed from the distal quarter of the radius. Three drill holes are carried across the line of fracture from one fragment into the other. Three square peg grafts  $\frac{3}{4}$  inch in diameter are made and driven into the individual holes made by the drill. A cast similar to that used

for fracture is applied. A roentgenogram is taken at the end of 6 weeks. After union is complete active motion in graduated exercises is started.

Ninety cases have been treated. Of these, 51 were fresh fractures. The average time required for union in these fresh cases was 7.4 weeks. There were 2 cases of nonunion. Bony union subsequently resulted in these 2 cases after bone grafting. Thirty-nine old cases of nonunion which had been treated previously were seen. These ranged from 5 months to 18 years in duration. Ten of these were suitable for the bone graft operation. Of the 10 cases among the untreated fractures in which there was nonunion 7 resulted in union. The average period of immobilization after operation was 9.6 weeks. The history of 6 cases is reported in detail.

RICHARD J BENNETT JR. M.D.

## ORTHOPEDICS IN GENERAL

Hollinshead, E. H., and Markee, J. E. The Multiple Innervation of Limb Muscles in Man. *J Bone Surg*, 1946 28 721

By a careful and rather complete dissection of one cadaver supplemented by the use of routine dissecting laboratory material the authors show that of 38 long muscles of the limbs with separate heads of origin all but 15 were entered by nerve branches of more than one point. Ten of these 15 were known to receive more than one branch in other individuals. These multiple branches may enter the muscle close together or may be distributed for some distance over the length of the muscle. In neither pattern of branching can the ultimate distribution of the nerve fibers within the muscle be deduced from a purely morphological study. Other authors have shown that the multiple nerve branches entering a muscle may control contraction of different segments along the muscle.

DANIEL H. LEVINTHAL, M.D.

Sweetapple, H. A.: Sudeck's Atrophy. *Med J Australia*, 1946 2 581

A typical case of Sudeck's atrophy is one which sustains a relatively minor injury to a limb accompanied by an intractable pitting edema stiffness of the musculotendinous apparatus and roentgenological evidence of bone decalcification. Moreover immobilization in plaster Paris cast and other forms of empirical treatment retard progress rather than ameliorate the syndrome.

The disorder is based upon a vasomotor dysfunction. The skin is dusky red and it may be hot or extremely cold. Pain swelling and osteoporosis are thought to be secondary to vasomotor changes in the deeper structures of the limb. When these manifestations prevail for a long period the basic disorder spills over into the autonomic nervous system and the morbid alteration of the affected parts are no longer reversible.

It is the author's contention that Sudeck's atrophy is a misnomer. Early in its incipency the syndrome reveals a mottled appearance of the bone later a

uniform osteoporosis ensues. Diagnosis of the disease should be made prior to the appearance of generalized osteoporosis, rebellious edema and the intractable pain. Macroscopically the effects of Sudeck's atrophy on the bone architecture may show loss of cortical definition, fading of the lamellae considerable thinning of the cortex, rendering it roentgenologically indistinguishable from tuberculous osteitis.

**Etiology** Hyperemia and sympathetic reflex irritability are mentioned. Equivocally enough, sympathectomy cures the syndrome on the ground of complete peripheral vasodilatation. That calcification is due to hyperemia and vice versa is maintained by Leriche and others. However after a perusal of the various hypotheses connoted in the article one cannot conclude that the mechanism of Sudeck's atrophy is fully understood.

**Treatment** 1. Sudeck's atrophy is said not to exist if the patient responds to rest, immobilization and manipulation. In such cases the diagnosis is erroneous. 2. If a vicious circle exists because of thrombosed vein, adhesions of local nerve, and adjacent structures, correction of each of these abnormalities proves effective. Blocking of a trigger point with novocain, stripping of the adventitia of the main artery of the limb, as advocated by Leriche and his co-workers, or amputation and alcohol or novocain sympathetic block is beneficial in a substantial number of intractable cases.

The author discusses three typical cases in which periarterial stripping was followed by a dramatic relief of pain, cyanosis, and osteoporosis.

SAMUEL L. GOVERNALL, M.D.

Glissan, D. J.: Hallux Valgus and Hallux Rigidus. *Med. J. Australia*, 1946, 385

Hallux valgus, the most common deformity of the foot per se, is accompanied by other foot disorders. Flat foot and contracture of the toes are concomitant

deformities. Similarly the symptoms manifested are not necessarily those of hallux valgus. On the contrary the symptoms are due to a general defect in the function and structure of the foot in which all of the toes sooner or later are involved. The deformity may be unilateral or bilateral. In the majority of instances, the deformity is not a primary one, but it may be a congenital anomaly of the first metatarsophalangeal joint. Moreover the writer emphasizes that painful feet in children whose parents already have hallux valgus may be harboring the deformity as early as the tenth or twelfth years of age.

The lengthy technique can be justifiably summarized as follows:

An elliptical skin incision is made. The extensor tendons are reflected and possibly lengthened. The periosteum of the first metatarsal bone is stripped and a wedged osteotomy is performed just proximal to the reflection of the attached metatarsophalangeal capsule. The two bones are completely osteotomized and the medial cortical spike is abutted laterally to the distal base or head of the metatarsal bone. The periosteum, fascia, and skin are then closed. Immobilization in the overcorrected position is accomplished with an aluminum splint insulated with plaster of Paris.

The etiology of hallux rigidus includes trauma, infection, osteochondritis juvenilis, and Scheuermann's lesion. The symptoms of hallux rigidus may be those of pain, impaired range of motion of the big toe, marginal osteophytes and in severe cases flexion deformity of a crippling nature.

Treatment is not to be instituted in children until they have passed the age of 12. In older patients, in whom fusion is the treatment of choice, the author encountered failures particularly when the articular surfaces were hard eburnated or sclerosed. In the majority of cases, however, fusion was both satisfactory and worthy of continued application.

SAMUEL L. GOVEY NALE, M.D.

# SURGERY OF THE BLOOD AND LYMPH SYSTEMS

## BLOOD VESSELS

Kimbarovskii, M. A.: Experiences with the Operative Treatment of Aneurysm and of Pulsating Hematoma from 1941 to 1946. *Trachebnos Delo* 1946, No. 66 338

Of the 237 cases forming the basis of this report 8 were involvements of the common carotid artery 3 of the external carotid artery 1 of the internal carotid artery 2 of the transversa colli artery 1 of the transversa scapulae artery 1 of the vertebral artery and 1 involving 3 arteries of the neck (vertebral, internal carotid, and a smaller artery). There were 28 cases involving the subclavian artery and 1 case involving the long thoracic artery. There were 51 arterial involvements of the upper extremities and 140 of the lower. Of these those of the femoral artery showed a preponderance with 76 cases. However since the arteries of the extremities did not offer anything unusual in diagnosis surgical treatment or results obtained they are not given special discussion. The injury to the blood vessel resulted from a bullet in 122 (51.5%) of these patients from splinters of shell and airplane bombs in 22 (9.2%), and from mines in 93 (39.3%). This shows a paucity of bullet wounds in comparison with previous wars. The formation of the aneurysmal sac may not occur until weeks of even years after the injury to the blood vessel, and its appearance may be wholly unexpected. In 1 of the author's cases the diagnosis of phlegmon was made by the consulting staff of the hospital.

There are surgeons who do not believe in immediate operation, in the hope of obtaining spontaneous healing however this occurred in the author's material in only a single instance. In general, he believes that the arterial aneurysm, while still small and not endangering the blood supply to the extremity justifies a waiting attitude in individual instances. On the other hand, the arteriovenous aneurysm demands immediate operation. However when the aneurysm has not been operated upon before it reaches the evacuation hospital and there is no immediate indication for interference, operation on the injured blood vessel should not be done sooner than from 4 to 6 weeks. This gives the surrounding tissues time for resolution of the bloody infiltration and for the development of the collateral circulation.

With reference to the type of operation there is also a difference of opinion among surgeons. Some recommend vascular suture, which must of course be regarded as the ideal operation while others prefer vascular ligation. However in practice the former operation exhibits a number of complications which limit its theoretical indications. The author has carried out vascular suture in only 3 instances. Despite the fact that the author regards the technique of vascular suture as easier to accomplish than

is generally supposed he sees no reason for regarding this procedure as the operation of choice. The character of his material has rather prejudiced him against vascular suture, both because so many of his patients showed inflection of the wound with retention of devitalized tissues and foreign bodies and because so many of the blood vessel injuries resulted from the splinters of shells and bombs with extensive and irregular destruction of the wall of the blood vessel which rendered suture difficult. The method preferred by the author is that of Antilys or better of Phylagrus. The most radical, logical and technically feasible method is that of Phylagrus consisting of ligation of both the afferent and efferent vessels with complete extirpation of the sac. This extirpation is carried out as far as possible from every direction and with blunt dissection. However occasionally a sharp instrument may be resorted to or in cases of too intimate adhesions strips of the sac may be left *in situ*. When the operation of Phylagrus is anticipated an attempt is made to encourage the development of collateral vessels by putting pressure on the afferent vessels for 15 or 20 minutes twice daily. Extirpation of the regional sympathetic ganglia was done prophylactically in a number of instances. The operation is given enthusiastic support as a preventive of gangrene. In operation on the arteriovenous aneurysm the ligation of the vein together with the artery is believed to offer the best chance of avoiding the development of gangrene in the affected extremity.

Altogether the vascular suture was carried out in 3 instances the operation of Antilys in 89 and that of Phylagrus in 145. In the neck injuries the blood vessel was frequently injured so low in this region that partial resection of the clavicle and even of the chest wall was necessary. There were only 2 failures the patient with the injury involving 3 vessels in the neck succumbed to a whole series of complications and gangrene developed in a patient with involvement of the leg. However in the last instance the injury was complicated by a badly frozen foot.

JOHN W. BRENNAN, M.D.

Freeman, N. E.: Arterial Repair in the Treatment of Aneurysms and Arteriovenous Fistulas. *Ann Surg.* 1946 124 885.

The author notes that the incidence of gangrene due to acute ischemia following operations on aneurysms and arteriovenous fistulas is rare. Not a single instance occurred in 100 cases operated upon at DeWitt General Hospital, Auburn, California. There was but one case in the entire series of patients in the three vascular centers of the U.S. Army. This splendid record is probably due to waiting a sufficient length of time for the development of collateral circulation and the perfection of surgical technique in order to spare the important collaterals. In addition



prophylactic sympathectomy may have helped practically to abolish gangrene after operations on arterial lesions.

The author discusses various objections to the arterial repair in the treatment of aneurysm and arteriovenous fistulas. Despite these objections to arterial repair an attempt was made to restore the continuity of the artery by repair in 23 cases of aneurysms and arteriovenous fistulas on the Vascular Surgical Section at DeWitt General Hospital between the months of June and November 1945. Success of the repair was demonstrable either by arteriography or by the presence of the normal arterial pulsations distal to the lesion in 18 of the 23 cases. The only complications which could be ascribed to the attempted repair were the possible recurrence of an arterial aneurysm in one patient and the recurrence of an arteriovenous fistula in another case after transvenous suture.

Detailed clinical experiences are presented with comments on 22 cases. Transverse repair of the artery was attempted in 17 cases and proved successful in 15. Of the 2 unsuccessful attempts thrombosis occurred at the suture line in 1 patient but this was due in part to faulty technique in not obtaining adequate control of the artery above the fistula. In the second individual, repair was attempted of an arterial aneurysm.

The author observes that it has generally been found desirable to use any sound portion of the arterial wall, even to one-sixth of the circumference, rather than to perform a complete transection with end-to-end anastomosis. Mobilization of the artery may be impossible because of important arterial branches. In no case was a significant collateral artery sacrificed in order to attempt repair of the major vessel.

Complete control of the arterial supply to an arteriovenous fistula is essential for repair. Arteriography has been helpful in the study of patients with arteriovenous fistulas. Before operation it has served in the accurate localization of the lesion and in demonstrating the location of important collateral vessels. Again, it has helped to show the presence of an aneurysmal sac. Following operation, arteriograms have been useful in disclosing the true state of continuity of the artery.

The role of sympathectomy in the repair of arterial lesions is not clear. Thirteen of the patients in this series were treated by prophylactic sympathectomy before operation on the arterial lesion. Of this number two attempted repairs failed. Sympathectomy was not performed in 10 patients. Arterial thrombosis occurred in only one of these cases. It is possible that sympathectomy might have prevented arterial spasm. It is probable that a swift flow of blood prevents thrombosis at the suture line. Possibly sympathectomy may have promoted an increased volume flow of blood and in this way improved the chances of successful repair.

In conclusion the author notes that arterial repair was attempted in the treatment of 23 aneurysms and

arteriovenous fistulas. Success was demonstrable either by arteriography or by the presence of normal peripheral arterial pulsations in 18 of these attempts. In one patient recurrence of an arterial aneurysm was subsequently reported by the patient. In a second patient, recurrence of an arteriovenous fistula followed transvenous suture. Subsequent excision of the lesion was necessary. Thrombosis at the suture line occurred in 3 patients but the collateral circulation proved sufficient to prevent gangrene. Repair of the defect in the wall of the vein was performed on 18 occasions. Phlebography in 12 of the patients after recovery demonstrated the patency of the vein in 6 patients but in 6 other postoperative studies, showed the vein to be occluded. No instance of thrombophlebitis or pulmonary embolism was encountered. Transverse suture of the defect in the arterial wall after excision of the damaged portion has been found more satisfactory than longitudinal suture, end-to-end anastomosis, or transvenous repair. Marked improvement in pulsatile circulation in patients after repair of arterial lesions in comparison to a control group who were treated by quadruple ligation and excision of the arteriovenous fistula, has been demonstrated by oscillometry.

The functional capacity especially as shown by freedom from intermittent claudication is increased in patients when the continuity of the major artery to the extremity is preserved.

HENRIK F THURMOND, M.D.

Carroll W W: Venous Surgery. *Q Bull Northwest Univ M School* 940, 20 373.

The patients considered in the present report are (1) those with varicose veins resulting from valvular incompetence and (2) those with cutaneous ulceration of the lower extremities due to venous stasis resulting from various causes.

The author notes that an appreciation of the fact that varicose veins due to valvular incompetence are primarily related to valvular deficiency in the femoral and iliac trunks, makes our search for pathological perforators more logical. Such perforating veins may be located in the thigh, the lower leg, or in the popliteal space. In the latter instance the vein involved is anatomically designated as the lesser saphenous vein. The records in this article show that the resulting reflux was manifest through the lesser saphenous system in 10 per cent of 300 consecutive extremities requiring surgical correction for varicose veins. The technique for the treatment of varicose veins of the saphenous vein is described in detail.

Ulceration of the skin of the lower leg related to long standing venous stasis is known to result in serious disability because of a failure to heal. Excision of the ulcer-bearing area and coverage of the saucerized defect with a free skin graft of intermediate thickness results in the elimination of the open wound and its attendant long-standing painful duration. Such patients are restored to a satisfactory capacity for work. The author reports complete "takes" in 21 out of 23 such instances without



was found usually at 5 hours after transfusion, and this finding is in agreement with the observations of others. Feces urobilinogen was considerably increased after old blood but not after fresh blood transfusions.

In 5 of 6 patients studied, it was apparent that an increased rate of destruction of blood must have taken place after the use of old blood compared with that following the use of fresh blood. It is thus evident that there is an increased extravascular destruction of red blood cells after transfusion of old blood, for there is a significant rise in the serum bilirubin and feces urobilinogen excretion after such a transfusion.

LeRoy J. KERNAN, M.D.

#### LYMPH GLANDS AND LYMPHATIC VESSELS

D'Errico, G.: Primary Lymph Gland Tumors of Vascular Origin—Lymphangioma of the Abdominal Lymph Glands (I tumori primitivi linfoglandolari di origine vascolare)—A proposito di un caso di linfangioma delle linfoglandole addominali. *Riforma med.* 1946 60 393.

There is still a great deal of confusion in regard to primary tumors of the lymph glands, some authors going so far as to say that all lymph gland tumors differ radically from each other and cannot be grouped into classes. Anardi's classification is probably the best. He differentiates between tumors originating from the parenchyma, including lymphoblastomas, lymphocytomas, and lymphomas; tumors originating from the stroma, including fibromas, lipomas, angiomatous fibrosarcomas, and sarcomas; and tumors originating from the blood or lymph vessels, including endotheliomas, peritheliomas and reticulomas. The cell characteristics of these different groups are discussed and attention is called to the fact that angoma is a mature and benign tumor while endothelioma is an immature and malignant tumor.

In view of this confusion the detailed description of individual cases seems worth while. A case is described in a girl of 13 whose illness began about 6 months before admission to the hospital with pallor, loss of weight, and extreme fatigue on slight exertion. After some months enlargement of the abdomen was noted with abdominal pain and diarrhea. Roentgen examination showed a tumor apparently at the hepatic flexure of the colon. Operation revealed a tumor of the size of a coconut at the hepatic flexure but not connected with the colon. Other round tumors varying from the size of a hazelnut to that of a large mandarin were scattered over the gastrocolic ligament with a few in the mesogastrium and omentum. They were removed and weighed altogether 1,200 gm.

Microscopic examination showed that the lymph gland tissue had been replaced almost entirely by tumor tissue angiomatous in structure. There were many newly formed vessels, the smaller ones consisting of a simple endothelial tube with the surrounding tumor cells resting directly on its walls. The histological picture of these interstitial tumor cells was the same as that of the endothelial cells of the capillaries and the cells probably originated from an extravascular proliferation of the endothelial cells. The larger vessels contained leucocytes, which showed that this tumor had originated from lymph vessels rather than blood vessels. The tumor very clearly originated from the lymph glands of the abdomen and not from any of the abdominal organs. The peripheral lymph glands and the lymph glands of the thorax were not involved. The tumor showed mixed characteristics of the endothelioma and the perithelioma.

Photomicrographs of the histological findings are given.

In spite of roentgen treatment the patient died a few weeks after the operation.

AUDREY G. MORGAN, M.D.



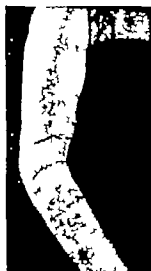


Fig. (Marino) Result of the surgical extirpation and grafting of the cutaneous bandage

pect of the throat and neck, the transplant being applied immediately after excision of the cicatrix.

JOSEPH W. BRECKENRIDGE, M.D.

Leveton, A. L.: The Surgical Principles of Split Thickness Skin Grafting. *J B Surg* 946 28 699.

The author gives an excellent description of the use of the split thickness skin graft. There are many technical points of interest in his experiences with the preparation, application, and postoperative care of the graft.

Split thickness grafts can be used as follows: (1) in clean granulating surfaces; (2) over the yellow base left by the excision of granulations; (3) in extensive burns, crushing injuries, or avulsions, and in infections with loss of tissue, as soon as the granulating bed is clean; (4) over fresh raw surfaces, if subcutaneous tissues are still present in the floor of the wound; and (5) as an intermediate step before the application of a full-thickness graft in obliterating osteomyelitis cavities.

Obviously the thicker the split-thickness graft, the better the coverage and the less the shrinkage. When it is laid on a freshly denuded scar base, on periosteum, or in an area surrounded by tense skin, shrinkage is less than if it is applied to a fresh raw surface or movable base. Should any question arise about the cleanliness of the recipient area, the surgeon would do well to err on the side of conservatism and choose a graft of lesser thickness rather than risk the loss of a split-thickness graft.

In about 3 hours the graft is firmly attached to the base by the formation of fibrin, and leucocytes and fibroblasts begin their invasion of the clot. In about 18 hours the endothelial buds arising from proliferation of the endothelium of the host of blood vessels begin to invade the graft. Reichert demonstrated

that the regeneration of small arteries across clean operative wounds occurs by the end of the second day; that veins and lymphatics become anastomosed by the end of the fourth day; and that the process is physiologically complete by the eighth day after operation. After the lapse of 2 or 3 months, the cellular infiltration disappears. The fibroblasts become mature compressed cells of fibrous tissue and lose their plump spindle shaped appearance. A layer of fat of variable thickness is now found to line the deep surface of the graft, permitting it to move freely over the underlying tissue.

Full normal sensation usually develops in free skin grafts. It is influenced by the amount of deep scar tissue that is left behind and depends upon the presence of sensory nerves in the area and on the thickness of the graft. The sensations of pain, temperature, and touch may develop as early as in 5 weeks or as late as after several months.

Concerning the use of the Padgett dermatome, the author outlines several points of technical interest. The drum, brush, and the donor site should be absolutely dry; no trace of moisture may be present. It is well to go over the drum and the skin with ether to assure the dryness of these areas. The blade is placed in the instrument with the bevel away from the drum, and held in place by the clamp. It has been the author's practice not to use the same blade more than three times without having it sharpened. Cold sterilization is advocated. The cement is not poured until it is ready for use; if poured too soon its volatile elements evaporate and the viscosity increases. The optimum viscosity of the cement is also a matter of importance. If too thick, ether should be added until the proper consistency is obtained.

On application of the adhesive the drum is held in the left hand with the back of the blade and the carriage resting on the operator's wrist. The brush should have fine bristles from 1/16 to 2 inches wide. The cement is applied to the drum in a thin layer with sweeping strokes. There must be no back and forth brushing; a thick layer of cement will dry unevenly and invite failure. The edge of the drum should be adequately covered with glue, as this is the edge at which the blade engages the skin. Good adhesion between the skin and the drum at this point is of the utmost importance. After application of the cement to the drum and while the drum is still being held in the left hand the donor site is painted with adhesive. The same precaution of smooth even application of the cement is observed. Drying can be hastened by gentle fanning with a folded towel. Failure of any steps necessary for the successful application and adherence of the cement to the drum and the skin calls for immediate cessation of the procedure, which must be started again from the beginning. This means that every vestige of cement must be removed from the drum and the skin. Should blood or moisture be present on the drum or the donor site, it is thoroughly removed and the area is dried by sponging with ether. The graft is not placed in saline solution before use but is merely placed in

the folds of a damp towel or the cut surface is folded on itself. If the graft were allowed to soak in a basin of saline solution, the serum in the endothelial spaces would be washed out, small amounts of natural adhesive agents would be removed and the take of the graft might be jeopardized. A solution of 0.5 per cent procaine, containing from 6 to 8 drops of adrenalin to the ounce is used to infiltrate the scar bed. The adrenalin assures a dry bed until the graft has been sewed into place and the compression dressing applied. If the area will permit a tourniquet is used and the adrenalin solution may then be omitted. Excision of the scarred area is now undertaken. This must be complete and the underlying normal tissue must be exposed. The area to be excised is outlined with gentian violet. 5 per cent brilliant green in alcohol, or Bonney's blue solution. Perfect hemostasis is obtained first, with the adrenalin solution or the tourniquet. A blood vessel that requires tying should be ligated with the finest silk obtainable and the knot cut short.

It has been the author's practice to leave the granulating tissue in place if it is of recent origin and short duration. If the ulcer is old and calloused it is advisable to remove the granulation tissue by sharp dissection—never by scraping—to the smooth yellow base which has a satisfactory blood supply. Strips of 3 per cent xeroform gauze are laid smoothly upon a large abdominal pad. The surgeon without loss of time, places the pad over the donor site. Firm pressure is maintained and the whole area is bandaged snugly with a bias-cut stockinette bandage.

Postoperatively the odor of suppuration or of pyocyanus infection or a persistent elevation of temperature should call for an immediate inspection of the graft. There is no adequate reason why the graft should not be inspected before the usually accepted 10 to 14 day period. There are definite advantages to inspecting the graft much earlier. If a small clot or a collection of serum or blood is present that area may be saved by timely incision for evacuation of such fluid. If the wound is an early traumatic or an aseptic surgical wound the graft is inspected on the sixth or seventh day. If it is a granulating wound the graft is inspected on the third or fourth day. If the patient is febrile the graft is inspected at an earlier date. Upon inspection of the graft in the first week, it may present a mottled appearance. Some areas or the entire graft may appear cyanotic. This is not to be interpreted as death of the graft but rather as incomplete vascularization and diffusion of the blood pigments. In such cases it is well to continue with moist dressings until all such discolorations disappear. Should the graft be dry pink and adherent to the base one may apply a layer of gauze (44 by 40 mesh) without wrinkles and impregnated with 3 per cent xeroform. Over this is placed a voluminous dry pressure dressing. This dressing is changed every 3 or 4 days for about 3 weeks. At the end of this period, all dressings are discontinued and a 2 per cent boric ointment is applied to keep the graft and the surrounding skin soft. If there is any ques-

tion about the status of the graft during the immediate postoperative period, one should at once revert to wet voluminous pressure dressings.

C. FRED GOTTLINGER, M.D.

Gordon Taylor G. and Patey D. H.: A Further Review of the Interinnominoabdominal Operation Based on 21 Personal Cases. *Brit J Surg* 1946 34 61.

The authors review 21 cases in which these drastic operations were performed by them in the past 23 years. They have also made a chart which summarizes briefly the 73 cases which have appeared in the literature since 1935. In their own group of patients, 6 died shortly after surgery, 7 lived from 13 weeks to 5 years before they died of a recurrence, 5 are still well 1 or 2 years after surgery, and 3 are well 7, 11 and 17 years after surgery. All patients had some type of sarcoma, the most common being spindle cell sarcoma or chondrosarcoma.

Several aspects of the technique are discussed. The usual anesthesia is spinal 10 c.c. of 1 to 1,500 nupercaine are combined with general anesthetics such as pentothal nitrous oxide, and ether. The patient is placed in the lateral position for the iliac, inguinal, pubic, and gluteal portions of the operation and on his back for division of the symphysis pubis. The Gigli saw is used for the bone section after division of the internal iliac artery and division of the psoas muscle have been accomplished. The external iliac artery is divided distal to the origin of the deep epigastric and deep circumflex iliac arteries to assure good vascular supply to the abdominal muscles. A catheter is in the urethra during and after surgery. Blood for transfusion is always available. The anus is kept out of the operative field by suturing cellophane or green protective over it. The procedure requires about an hour and ten minutes. In addition to the usual postoperative care, the patient is placed on a type of water mattress. Chemotherapy is used and the dressings are kept firm with elastoplast.

DANIEL RUGE, M.D.

Barclay, S.: Resuscitation by Cardiac Massage. *N Zealand M J*, 1946 45 446.

The author reports the case of a 36 year old man who while being subjected to intravenous pentothal anesthesia for tooth extraction suddenly developed complete respiratory and circulatory paralysis. After 12 minutes of complete cardiac arrest spontaneous cardiac action was again resumed following transabdominal transdiaphragmatic cardiac massage combined with the intracardiac injection of adrenalin. Respiratory function returned and the patient lived 43½ days. Autopsy disclosed severe diffuse cerebral damage.

Twenty-nine minutes of cardiac arrest appears to be the longest recorded interval after which spontaneous heart beats have been resumed. A case from the literature is reported in which artificial respiration and cardiac massage were carried on for 20 minutes before spontaneous heart beats were resumed.

the patient had a perfectly normal recovery. Thus under these conditions sufficient circulation may be artificially maintained to prevent serious brain damage. If following cardiac arrest the resumption of cardiac function, either by spontaneous action or by rhythmic cardiac massage occurs within 4 minutes recovery is to be expected. But if the interval of cardiac arrest is longer than 8 minutes recovery does not occur.

F. J. LEHRMANN, JR., M.D.

#### ANTISEPTIC SURGERY TREATMENT OF WOUNDS AND INFECTIONS

Moore, F. D., Peacock, W. C., Blakely, E., and Cope, O.: The Anemia of Thermal Burns. *Ann. Surg.* 94b, 24, 81.

The following etiological agents have been described as causative of the anemia of burns: external blood loss from infected granulations; early destruction of red blood cells due to heat; increased fragility of red blood cells; destruction of red blood cells due to anti-A or anti-B agglutinins in plasma; and suppression of the regenerative activity of the bone marrow by burn toxins.

In the present study the authors measured the red cell mass by the injection of donor cells containing radioactive iron and quantitated the dilution or concentration of these cells by means of a Geiger counter. In this manner the selective destruction of donor and recipient cells was determined after a radioactive transfusion. By the injection of radioactive iron in the form of ferric ammonium citrate failure of the latter to appear in the peripheral blood according to a normal predetermined pattern was used to measure bone marrow activity.

In 4 cases, studies were made of early hemolysis, internal red cell disappearance, peripheral blood correlation, radioiron utilization, reticulocyte response, and pigment excretion. False anemia due to hemodilution from increased plasma transfusions was distinguishable clinically by examination for the stage of edema formation or resorption, the urinary output, serum protein dilution, and indices of peripheral erythrocyte concentration. The latter conditions indicated the necessity of withholding fluids to enable renal excretion to complete edema fluid resorption.

The true anemia of burns was characterized as an anemia divisible into three stages. The first stage was associated with the trauma of the burn itself and the resultant initial hemolysis. Cell destruction under those circumstances was less than 1 per cent of the red cell mass. The second stage of anemia developed within 10 days of the injury. During this period as much as 250 c.c. of red cells were lost or destroyed daily. Following the latter there was often a short period of positive red cell balance. The third stage occurred in the third or fourth week, and was again characterized by a daily loss of 500 c.c. of blood. Significant amounts of blood were lost as a result of debridement, in the cutting of skin grafts, and through the open wound into the dressing, particularly during the separation of the burn slough.

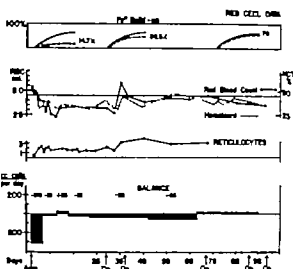


Fig. 1. (Moore et al.) Radioiron utilization, peripheral blood findings, and red cell balance showing an early and late progressive anemia in an extensively and deeply burned patient (78 per cent total, 45 per cent third degree). The radioiron utilization (Fe build-up) is shown diagrammatically. The first test done on entry showed little elaboration into peripheral erythrocytes, correlating with the relative lack of reticulocyte response about the thirtieth day marrow function had improved, evidenced by better iron utilization as well as increase of reticulocytes to 4 per cent. By the eighty-fifth day utilization was normal. The peripheral counts demonstrate an early profound anemia with relatively little reticulocyte response, followed about the thirty-fifth day by rise with reticulocyte increase coincident with massive transfusion. Thereafter nearly normal levels were maintained. The red cell balance shows an early massive red cell loss (internal destruction) followed by relative balance until about the fiftieth day when, for about 3 weeks, cell disappearance increased again. After this period slightly positive balance obtained. (Courtesy of J. B. Lippincott Co.)

Although penicillin was used to combat infection nevertheless there seemed to be a relationship between large open infected wounds and the true anemia of burns. Studies in radioiron utilization indicated suppression of bone marrow activity, disorders of iron metabolism, and delayed hemoglobin synthesis of both the hemin and globin fractions. The relationship of the alarm reaction to the anemia of burns may be a positive one, as suggested by the prolonged negative nitrogen balance and the negative potassium balance which were found in all but one case.

BENJAMIN G. P. SHAFEROFF, M.D.

Connor, G. J., and Harvey, S. C.: The Pyruvic Acid Method in Deep Clinical Burns. *Ann. Surg.* 94b, 24, 790.

The primary objective in the treatment of severe burns is the rapid closure of the burn wound since all physiological disturbances are traceable to the open condition of the wound. The main cause for delay in skin grafting after correction of peripheral vascular failure is associated with the time loss awaiting the

slough of dead tissue. The present report is devoted to a new chemical method for the local treatment of burns by the use of pyruvic acid which is intended to hasten the slough of burned tissue.

A stock or standard solution of pyruvic acid is made by the addition of 1 liter of distilled water to 7 c.c. of C.P. pyruvic acid to make a solution with a pH of 1.9. From the latter a paste is prepared by the addition of an 8 to 10 per cent volume of corn starch. The success of the surgical treatment of burns by this method is dependent upon the use of a thick layer of pyruvic acid paste in direct contact with the wound. A burn extending from the ankle to the leg ordinarily requires about 3,000 c.c. of paste and first, second and third degree burns can be treated under the same dressing and the same standard pyruvic acid paste. Preliminary cleansing and débridement of the wound are not done. Evaporation and drying of the paste should be prevented by the application of an impermeable retaining dressing of vaseline gauze. The first dressing is applied at any time but may be delayed during the phase of circulatory imbalance. The second dressing (first redressing) is made 2 or 3 days later in the same manner as previously. A characteristic feature of the wound at this time is the prominent demarcation of the dead tissue. At the third dressing beginning separation of the slough should be evident. The proper cleavage plane is sufficiently apparent so that further separation can be facilitated by section of the anchoring strands of dead connective tissue, and subsequent application of pyruvic acid paste will reach the remote areas of the burn.

In the present series 30 burn cases were treated with pyruvic acid paste. The slough separated from the margin to the center of the burn and was removable in large sheets. Living islands of skin survived. Large deep thermal burns were ready for grafting within 10 or 12 days after the initial application of the pyruvic acid paste. With the removal of the slough there was a clean vascular surface ready for immediate grafting.

BENJAMIN G P SHATIROFF M.D.

Meleney, F. L.: Penicillin in the Treatment of Established Surgical Infections. *Ann Surg* 1946, 124: 963.

The Subcommittee on Surgical Infections appraised the results of penicillin therapy as follows: (1) excellent, when response was obtained within 72 hours after the beginning of treatment, (2) good when response was obtained from 7 to 10 days after the beginning of treatment, and (3) questionable when the surgical procedure and associated therapy could have been the effective factors. In some cases the infection ran its usual course in spite of the use of penicillin. This classification was used by 6 groups of surgeons located in different parts of the country reporting on 1,000 cases of established surgical infections. In this group there were 744 cases treated with penicillin. The data obtained from the case reports were transferred to the McBee System punch cards from which the following conclusions became apparent:

Penicillin although of great benefit, was not a panacea. Favorable results were obtained in 65 per cent of the entire series of cases. Dramatic results were demonstrated in the patients receiving penicillin therapy for cellulitis and furunculosis. Unsatisfactory results followed its use in the treatment of empyema, burns, gas gangrene and actinomycosis. When the cases are grouped according to their severity: (1) acute (2) chronic with acute exacerbation and (3) chronic, the impression is gained that penicillin is more effective in the acute than in the chronic cases. In the acute cases there is an important relationship between the character of the response and the time of the initiation of treatment. In this group of cases studied 662 of the patients had serious infections and 384 had already received some form of sulfonamide therapy with favorable effects in 65.4 per cent. By the use of penicillin surgery may be obviated in some types of surgical infections, while under other circumstances surgery is required in conjunction with penicillin to effect a cure. On the basis of results in relation to the methods of administration particularly significant was the large proportion of cases controlled by the local application of penicillin. The adequate dosage of penicillin is defined as that amount which will control the infection and get the patient well. Nevertheless it is directly dependent upon the number and vulnerability of the offending bacteria, the amount and penetrability of the infected tissue and on the degree with which the drug is absorbed and excreted. The author believes that a maximum of 320,000 units of penicillin per day represents efficient therapeutic dosage which need not be exceeded. The acuteness or chronicity of the surgical infection is related to the bacterial flora of the purulent exudate. In acute infections one species of organism is usually found while in chronic infections a mixture of organisms is recovered.

The bacteriologic studies included a bacterial classification of species as aerobic or anaerobic identification and a determination of pathogenicity. The first 4 principal bacterial groups were listed as the hemolytic streptococcus, the coagulase positive staphylococcus, the gram-negative aerobic and nonspore-forming rods (*Escherichia coli*, *Aerobacter aerogenes*, *Pseudomonas pyocyaneus* and *Bacillus proteus*) and the *Clostridium welchii*. As a rule all of these groups were more frequently found in mixtures than in pure bacterial cultures. The largest percentage of excellent results was obtained in the pure staphylococcal infections. Aerobic cocci in pure culture responded favorably while the anaerobic cocci and rods yielded unfavorable results. In patients with septicemia from the hemolytic *Streptococcus* an excellent response was obtained in 87.5 per cent of the cases and similarly in 69 per cent of cases with *Staphylococcus aureus* septicemia. Analysis of the penicillin failures revealed them to be ascribable to resistant strains of staphylococci or streptococci, the insufficient or too late administration of penicillin, associated chronic debilitating disease (tuberculosis, diabetes or arteriosclerosis) and finally overconservatism in surgery.

BENJAMIN G P SHATIROFF M.D.



Nichols, D. R., and Herrell, W. E.: Streptomycin. *J Am. M. Ass.* 1946, 131: 300

The antibiotic agent, streptomycin appears to have a place in the treatment of certain important bacterial infections. With few exceptions, the degree of sensitivity of organisms to streptomycin, as determined by in vitro studies, can be used as an index of the probable effectiveness of the treatment with streptomycin.

Satisfactory concentrations of streptomycin can be obtained in the blood and urine following intravenous, intramuscular and subcutaneous administration. The antibiotic is not destroyed in the gastrointestinal tract and a large percentage of it can be recovered from the feces when it is given by mouth. After oral administration, however streptomycin cannot be detected in significant amounts in the blood and urine of patients. Streptomycin may be administered locally. It also may be administered by means of intrathecal injection and it may be instilled into various body cavities. Streptomycin diffuses fairly readily throughout the body. It is excreted readily in the urine without evidence of a toxic effect on the kidney. The usual daily dose of streptomycin employed in the treatment of infections is 3,000,000 to 3,000,000 units (2 to 3 gm.).

From the analysis of the results obtained in the treatment of 101 patients who received streptomycin under the supervision of the authors, and from the analysis of the results obtained in an additional group of 88 cases, certain conclusions can be drawn.

Streptomycin appears to be of considerable value in the treatment of bacteremia owing to gram-negative organisms sensitive to its action.

Streptomycin is of definite but limited value in the treatment of infections of the urinary tract. Best results are obtained when the organism of infection is *Proteus vulgaris* or *Aerobacter aerogenes*. Good results may be obtained at times when the organism of infection is *Escherichia coli* or *Pseudomonas aeruginosa*. Intensive treatment for a short duration appears to yield the best results.

Meningitis owing to *Hemophilus influenzae* usually responds satisfactorily to streptomycin. Additional treatment in the form of sulfonamides and antiserum may be indicated for this infection. Streptomycin appears to be of greatest value in the treatment of tularemia. It appears to be of definite value in the preparation of patients for pulmonary resection. Temporary or permanent eradication of sensitive organisms from the tracheobronchial tree at times can be achieved by its use. Temporary symptomatic improvement may occur from the use of streptomycin in the treatment of osseous. At this time final statements cannot be made concerning the value of streptomycin in the treatment of pulmonary and extrapulmonary tuberculosis.

Included among the infections in which streptomycin has proved of doubtful value are typhoid and paratyphoid fever, undulant fever, osteomyelitis, peritonitis, and cholangitis.

Organisms at times may develop resistance to streptomycin with incredible rapidity. This has a tremendously important bearing on the clinical results obtainable following its use.

No serious uncontrollable toxic reactions have been encountered from the use of streptomycin in the cases herein reported. On the other hand, irreversible neurotoxic effects on the eighth cranial nerve may occur if treatment with streptomycin is prolonged.

Keefer, C. S., and Associates: Streptomycin in Infections. *J Am. M. Ass.* 1946 33: 4, 70.

A study was made by 55 investigators of the results obtained with streptomycin in the treatment of 1,000 cases of various infections. The discussions of these cases are concerned with the overall results in the various groups. The infections selected were tularemia, hemophilus influenza infection, urinary tract infection due to gram-negative bacilli resistant to sulfonamides, typhoid salmonella infections, acute brucellosis infection with bacteremia, bacteremia due to gram-negative bacilli, bacterial endocarditis due to gram-negative bacilli and Friedlander's bacillus infection (*Klebsiella pneumoniae*). A study of tuberculosis was not made. The specifications for streptomycin which were made effective by the Food and Drug Administration of the Federal Security Agency on July 15, 1946 are given in full. The modes of administration, such as intramuscular injections, subcutaneous injections, intrathecal injections, oral administration and inhalations, are described. The distribution in the body fluids and the excretion is also described. The results of treatment in these series are summarized in tables.

Following the tabulation of each of the results the authors make comments regarding the treated cases. They agree that streptomycin is an extremely effective agent in tularemia and that it is by far the best therapeutic agent for the treatment of this disease. In cases of bacteremia it was apparent that streptomycin was important in controlling the infection and in reducing the fatality rate.

The prognosis in these cases, however, was determined to some extent by the severity of the local lesions and many factors, such as the age of the patient, the site and extent of the initial lesion, the species of infectious organisms, the presence of complications, and the duration of the infection, had to be taken into account in assessing the results of the treatment with streptomycin. In some cases it was difficult to evaluate the precise role of streptomycin in bringing about recovery as the number of cases remains so small.

More extensive studies of streptomycin in the treatment of tuberculosis of various organs are necessary. A long range program should be planned and the patients should be followed up for a minimum period of 5 years. From the experience which has accumulated so far it appears that a minimum period of from 3 to 6 months of treatment will be required and in some cases it will be necessary to treat patients for a longer time. Streptomycin has an inhibitive effect on the growth of the tubercle bacillus and since the exudative lesions do not progress while the patient is under treatment the agent should be helpful when it is combined with

other established methods for treating this infection. The authors show the range in sensitivity of gram-positive and gram-negative bacteria and of actinomycetes to the bacteriostatic action of streptomycin in a table, and the suggested dosages in another table. In summing up the optimum dosage is that amount which will bring the infection under control and assist in the sterilization of the focus of infection. Table VI gives the data on reactions while Table VII gives the occurrence times and duration of reactions. The most frequent and disturbing of reactions to the drug is vertigo and its occurrence and duration in 33 cases is given in the original article. The causes of streptomycin failures are (1) the use of the drug in the treatment of infections which are not susceptible to its action (2) inadequate dosage; (3) development of resistance to streptomycin in vivo (4) changes in species of the infecting organisms during treatment and (5) localization of infections in an area that cannot be reached by streptomycin.

DeBakay M. E. and Putlaski E. J. An Analysis of the Experience with Streptomycin Therapy in United States Army Hospitals. *Surgery* 1946 20 749

This article reports the cumulative experiences with streptomycin used in the treatment of 706 patients in 30 army hospitals. The intramuscular injection of 400 mgm. of streptomycin at 4 hour intervals provided a level of 16 micro g. S units per cubic centimeter in the serum and a mean urinary level of 1,000 micro g. S units. Intrathecally streptomycin was given in from 50 to 100 mgm. doses dissolved in isotonic saline solution. Orally, streptomycin was given in from 4 to 4 gm. daily doses divided over 6 hour intervals.

The largest single group (364) of the cases were those with urinary infections of the mixed type. Streptomycin was markedly effective against the *Escherichia coli* and the *Friedlander* organisms. Therapeutic efficiency of the drug depended on the correction of urinary obstruction, retention of residual urine and undrained abscesses. Streptomycin was especially indicated in gonococcal infection with urethritis and in gonococcal infection resistant to infections with penicillin.

The second group comprised 179 cases of wound and abscesses, including staphylococci, streptococci, clostridia, the fecal type of gram-negative bacteria, *Proteus*, *Pseudomonas*, *aeruginosa*. All these wounds were complicated by either chronic osteitis, or fibrosis with local anemia or infected recesses. Although in 90 per cent of the cases the condition was listed as improved it was thought that the improvement was primarily the result of surgical wound revision.

The enteric diseases studied were dysentery due to the *Shigella*, nonspecific chronic ulcerative colitis and epidemic dysentery of infants. In ulcerative colitis patients seemed to be temporarily benefited but sigmoidoscopy failed to reveal any improvement.

The *Shigella* type of dysentery and epidemic infant diarrhea responded well to streptomycin. In peritonitis due to mixed infection of fecal origin streptomycin appeared to be useful as an adjuvant to the regular surgical measures. Patients with bacteremia were benefited by the use of adequate doses of streptomycin provided the foci were eradicable and the causative organism was sensitive to the antibiotic. More intensive studies of streptomycin will be required to determine its efficacy in the treatment of tuberculosis which in this statistically insignificant series showed promise.

In brucellosis of the chronic type with impenetrable foci of infection streptomycin was of doubtful value. In the treatment of meningitis streptomycin was found potent provided that the organisms were of proved sensitivity and that the drug was administered intrathecally. Streptomycin was therapeutically effective when administered to patients with phoid fever before hidden foci developed. Patients with blastomycosis and pemphigus did not respond to streptomycin. Of a wide variety of reactions to streptomycin the most unusual was that of disturbance of the vestibular apparatus which frequently produced permanent damage and necessitated stoppage of the drug. BENJAMIN G. P. SHARTZOFF M.D.

## ANESTHESIA

Barton G. D. Wicks W. R. and Livingstone J. M. The Effect of Pentothal Alone and in Combination with Oxygen or Nitrous Oxide on Arterial Blood Gases. *Anesthesiology* 1946 7 505

A clinical and experimental study was made to determine if there is any marked variation in the arterial blood gases in human beings and dogs under moderate pentothal anesthesia. Six patients and 6 dogs were utilized in the studies. Four arterial blood samples were taken from each patient and 6 dogs were first taken prior to the administration of pentothal, the second after sodium pentothal anesthesia, the third, after combining mask inhalation of 100 per cent oxygen with pentothal and the fourth after administration of a mixture of 30-50 nitrous oxide and oxygen in addition to pentothal anesthesia. The oxygen and carbon dioxide were analyzed by means of the Van Slyke and Neill method. Pentothal was administered by the intermittent fractional dose method with a 25 per cent solution.

In patients who had received premedication a moderate depth of anesthesia produced no decrease in the blood oxygen after the administration of pentothal alone, but there was a significant rise in the blood oxygen after the combination of 100 per cent oxygen and pentothal.

Dogs without premedication and under pentothal alone showed a more marked fall in the blood oxygen and a rise to or slightly above the initial values after 100 per cent oxygen or 50-50 nitrous oxide was administered.

The carbon dioxide values remained quite constant in each of the 4 arterial blood samples from dogs but showed a slight rise in those from patients, after the administration of pentothal. When 50-50 nitrous oxide was administered with pentothal the amount of pentothal required to maintain the same plane of anesthesia was only one-fourth of that necessary when pentothal was used alone or with oxygen.

The addition of oxygen or nitrous oxide oxygen to pentothal for anesthesia produces a definite increase in the blood arterial oxygen values. MARY KARP MD

Beecher H. K.: Resuscitation and Anesthesia. *Aesthesiology* 946 7 644.

The author's study is based on experience with resuscitation and anesthesia during World War II.

Every effort is directed toward a single aim that of presenting to the surgeon a patient who will be as favorable an operative risk as possible. Several principles that are basic have emerged from, or have been tested in the present conflict.

1. Reduction in the time from wounding to surgery means the saving of extremities, the minimizing of deformity, the shortening of convalescence and the saving of lives. Every effort is bent toward reduction in evacuation time.

2. Economy of materials of time, and of lives will be effected by preventing serious deterioration of the patient's condition.

3. Once rapid restoration of good blood color and a systolic blood pressure to an arbitrary level of about 80 mm. of mercury have been accomplished the rate of infusion of blood or blood substitutes depends on several factors (a) if blood for transfusion or operation will not be available for a matter of hours, infusion of plasma should be rapid enough only to maintain the aforementioned state. (b) if a patient must await surgery for a considerable period even though blood may be available, as long as the systolic blood pressure is not below a level of about 80 mm. of mercury the mucous membranes of good color the skin warm, and the pulse of good quality there is no need to administer further blood until surgery is available. (c) when surgery is available further transfusion of blood is advisable so that a rising (or normal) blood pressure is achieved at the time the anesthesia is started.

4. Recovery from the damage produced by low blood pressure and by tissue anoxia probably requires many days. Practically it is necessary to initiate the surgical procedure long before the consequences of shock can be fully overcome. Operation is undertaken as soon as experience has shown that the patient will tolerate it, indicated chiefly by a rising blood pressure (80 mm.) or above, a falling pulse rate, a warm skin and good color of the mucous membranes.

5. Resuscitation, as it is usually thought of, is only supportive. Surgery alone checks the consequences of the wound.

Resuscitation includes all methods of management of the wounded man that make him, first, transport

able and then prepare him to meet the stress of essential surgery.

In the field, these methods are of the simplest order and have the single object of making the casualty transportable (a) continuing hemorrhage must be controlled (b) severe pain is the only important indication for the use of morphine, and when the relief of pain is urgent the intravenous route is the choice (c) adequate immobilization of the wounded part particularly when skeletal injury is suspected, not only prevents further local damage but prevents shock, (d) food should not be given.

In the field or evacuation hospital the continuous service of one man in charge of resuscitation is desirable. General care in the preoperative ward includes (a) head-down position for all patients when the systolic blood pressure is falling or is below 80 mm. (b) the body heat of a wounded man is to be conserved by means of blankets (c) oxygen therapy is instituted when cyanosis is present when the pulse rate is unduly high or when the wound itself may cripple cardiorespiratory function (d) the administration of any fluid or food by mouth is generally contraindicated. Aspiration of vomitus is one of the most serious and common accidents to be encountered, and this may be precipitated by anesthesia (e) glucose and saline solutions are useful only in the treatment of dehydration, (f) in the hospital where initial surgery is to be carried out one unit of plasma to about three blood transfusions has been found desirable in preparing for and carrying badly wounded patients through operation.

The seriously wounded need very little premedication, and morphine should be avoided in most cases. Atropine is useful to decrease the flow of mucus under ether and to minimize vagal reflexes. When local anesthesia is to be employed, if pain and considerable discomfort are to be anticipated, morphine may be used.

Three agents fulfill all of the important requirements of military surgery: ether, sodium pentothal, and procaine hydrochloride.

Ether has clearly emerged as the agent of choice for the seriously wounded, for the man in bad condition, and for long operations.

Acceptable practice in the employment of sodium pentothal includes the use of a 2.5 per cent solution the routine administration of oxygen with it and frequent observation and recording of pulse rate and blood pressure levels. A method of reducing the total quantity of sodium pentothal used is to supplement the agent with 50 per cent nitrous oxide and 50 per cent oxygen. Sodium pentothal is useful for 30 to 45 minutes, or less, of anesthesia in the lightly wounded and when employment of a noninflammable agent is imperative. Spinal anesthesia has few indications in surgery in forward areas.

Intratracheal intubation under general anesthesia is especially desirable for intracranial, maxillofacial, thoracic, and abdominal surgical procedures, and in other cases when the position of the patient makes it difficult to maintain a good airway.

The routine use of postoperative bronchoscopy even in open thoracic cases is undesirable

MARY FRANCES POT, M D

Frankson G. and Gordh T : Headache after Spinal Anesthesia and a Technique for Lessening Its Frequency *Acta chir scand* 1946 94 443

One of the most common and important complications of spinal anesthesia is the headache which sometimes occurs after operation. In most tabular summaries the incidence is between 15 and 30 per cent and most common in female patients younger than 40 years of age.

Two types of headache can be distinguished. One is characterized by increased intradural pressure—a rare type in which the ache is of a splitting character and does not react favorably to the patient lying in bed with the head end lowered. The second and more common type is characterized by a reduced intradural pressure. It is marked by a bandlike oppressive ache around the head sometimes more pronounced in the forehead or nape usually aggravated by movement, and often combined with vertigo. It tends to diminish when the patient keeps quiet and lies with his head low. It is considered that the headache in such cases is caused by the reduced intradural pressure. This reduction in pressure may be caused by diminished production increased resorption or leakage of the spinal fluid. Changes in production and resorption may be precipitated by irritation caused by the anesthetic or the needle. To judge by the authors' investigation the chief cause that induces a headache or reduces the intradural pressure seems to be connected with the needle and puncture procedure that is, leakage of the cerebrospinal fluid into the epidural space. The authors have demonstrated that such leakage occurs and in autopsies have demonstrated that the dural puncture opening had been open for 2 weeks or longer. They believe that an attempt should be made to reduce the leakage at the puncture opening in the dura diameter (from 0.7 to 0.9 mm.) They point out also the importance of the angle at which the point of the needle is held during the perforation of the dura and the importance of placing the beveled part parallel with the direction of the fibers of the dura whereby a narrow slitlike opening will be obtained with a greater tendency toward contraction. They contrast this with placing the beveled part at right angle to the longitudinal fibers whereby the fibers are cut off with a diminished prospect of closing the opening rapidly. They find by actual count that the number of fibers broken when the bevel is at right angles is twice that when the bevel is placed parallel to the fibers. They also find that the number of fibers torn off is directly proportional to the diameter opening is produced by a needle 0.5 mm. in diameter especially if beveling is placed parallel with the longitudinal direction of the dura fibers a finer needle causing less and less protruded leakage.



Fig. 1 (Frankson and Gordh) Sections in the plane of the dura after puncture. a, The beveling of the needle parallel with the longitudinal direction of the dura fibers b, the beveling of the needle at right angles to the longitudinal direction of the dura fibers. Diameter of needle 0.5 mm (x 50)

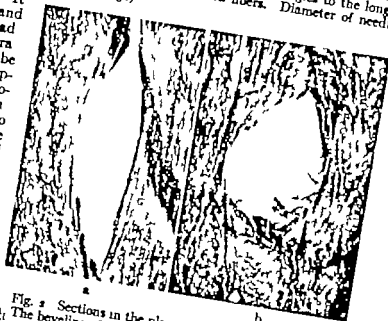


Fig. 2 Sections in the plane of the dura after puncture. a, The beveling of the needle parallel with the longitudinal direction of the dura fibers, b, the beveling of the needle at right angles to the longitudinal direction of the dura fibers. Diameter of needle 1.0 mm (x 47)

The authors suggest the use of a fine needle (a special needle with introducer called Antoni Sise needle) of 0.5 mm. diameter. They describe the technique of inserting the 'introducer' first and then through this the fine needle. By this procedure they find that spinal anesthesia headache has been very considerably reduced and that no prophylactic measures regarding position are necessary.

G ALBIN LIVA, M D  
Harmel M H., and Lamont A : Anesthesia in the Surgical Treatment of Congenital Pulmonic Stenosis. *Anesthesiology* 1946 7 477

The authors present an account of their experience in the administration of anesthesia in 100 patients

operated upon by Alfred Blalock for the relief of congenital pulmonary stenosis or atresia.

They state that the condition for which these patients undergo operation is, essentially, an insufficient flow of blood through the lungs due to pulmonary stenosis or atresia associated with the other stigmata of the tetralogy of Fallot with other congenital abnormalities and their sequelae. A compensatory polycythemia has developed and marked changes in the oxygen and carbon dioxide content of the arterial blood are found. It is obvious that most patients have a small cardiac reserve, and the physical activity is usually extremely limited.

The preanesthetic medication has usually been morphine and atropine given 90 minutes before the beginning of anesthesia, although on occasion nembutal instead of morphine has been used, or scopolamine instead of atropine. The authors like to have the patients so depressed that, if undisturbed, they will fall asleep. Venous cannulation and other painful or disturbing procedures are done after the induction of anesthesia.

The operation consists of making what amounts to an artificial ductus arteriosus by anastomosing one of the arteries arising from the arch to one of the main divisions of the pulmonary artery. Most of these patients seem to tolerate the partial collapse of one lung fairly well. Serious trouble, if it comes, more often starts when the anastomosis is begun, although not infrequently the exploration or even just the opening of the pleural cavity has been sufficient to weaken the action of the heart.

For induction, cyclopropane is usually chosen because it permits a rapid smooth induction and a high oxygen tension. Vinethene and nitrous oxide have also been successfully used.

For maintenance with the closed to-and-fro absorption technique, cyclopropane alone was used 56 times and ether alone was used 15 times. In 32 patients, a moderate amount of ether was added to the cyclopropane throughout the greater part of the procedure. Since the authors find it very much easier to provide a quiet operative field with cyclopropane they state that they are more likely to use that agent.

In the authors' experience the maintenance of positive pressure in the respiratory tract during both expiration and inspiration does not produce a sufficiently quiet field. The use of controlled respiration or of pressure on the breathing bag during the inspiratory phase of respiration better serves to maintain adequate tidal exchange and to relieve the patient of some of the muscular effort of breathing factors which are of some importance.

Although 6 cases were managed without the insertion of an endotracheal tube, the authors much prefer to use a tube. The endotracheal tubes always fit tightly enough without cuff or pack so that at the pressures employed there is no appreciable leak. For all of the cases when the closed technique was used a Foregger apparatus equipped with their water manometer has been employed. The manometer is set to blow off at 8 to 12 cm. of water pressure.

In the cases of most children, the induction proceeds at normal speed. There should be no hesitation in postponing the operation if there are any serious complications during the induction or if the patient does not react normally to the anesthetic agent.

A weakening of the cardiac action appears to be the commonest complication with either ether or cyclopropane. This complication occurred 5 times with ether 10 times with cyclopropane, and 15 times when both agents were used together. This complication was encountered in 42 per cent of the patients in whom the operation was on the right side, and in 24 per cent of the patients in whom the operation was on the left side. Whenever it occurs the operation is interrupted if possible, the retractor holding the ribs apart is released, and the lungs are reinflated.

The pulse rate varies considerably. There seemed to be no significant differences according to the agent used. The blood pressure also varies in no consistent fashion. The pulse pressure is usually reduced and has frequently been as little as 10 mm. of mercury. Minor cardiac arrhythmias, usually transient, have been noted in 22 anesthetics (11 patients). Respiratory complications during operation have not been very frequent. In 5 instances it was thought that bronchiolar constriction might have been present. Traction on the pulmonary artery has seemed to initiate the obstruction several times. Not infrequently when the anastomosis is opened there is a fairly sharp fall in both the systolic and diastolic pressure, with an increase in pulse pressure and pulse rate. The pressure usually rises again within 15 minutes. The tachycardia may persist for hours of days.

It is obvious that a successful anastomosis, when permitted to function, will immediately increase the flow in the pulmonary vessels and the work on the left side of the heart. It is surprising that these changes have not more frequently caused pulmonary edema and heart failure. Another possible complication resulting from the alteration in the hemodynamics is bleeding from the lungs. Sixteen patients have shown signs of interference with the flow of blood to the brain after operation.

As compared to the resting unanesthetized values, after 10 or 20 minutes of anesthesia the oxygen content, oxygen saturation and carbon dioxide content rose and the oxygen capacity fell. From 6 to 20 minutes after the operation had ended the oxygen content, the saturation, and carbon dioxide content were less than during anesthesia but still higher than before anesthesia, and the oxygen capacity was lower than during anesthesia. It is thought that a considerable rise in oxygen saturation which accompanies the administration of an anesthetic atmosphere rich in oxygen is an important factor in the ability of the patients to withstand operation.

Twenty three of the 100 patients died. The mortality rate was lower in those patients between 6 and 10 years of age. The duration of the operation appeared to have no influence on the mortality rate.

A larger proportion of the patients died when the innominate artery was selected for anastomosis. Fewer patients died when cyclopropane alone was used.

If those patients who received ether and cyclopropane together are grouped with those who received cyclopropane alone the combined mortality rate is not significantly different from the mortality rate in those patients who received ether alone for the maintenance of anesthesia. The authors believe that the hazards inherent in the physical condition of the patients and in the delicate operation have been of greater influence than the anesthetic factors.

MARY FRANCES POT M D

## SURGICAL INSTRUMENTS AND APPARATUS

Jenkins, H. P., Senz E H., Owen H. W. and Jampolski, R. W.: Gelatin Sponge for the Control of Hemorrhage. *J Am M Ass* 1946 132 614.

After a short survey of the work done by others and by themselves in the past concerning absorbable spongelike hemostatic agents the authors report first a series of experiments on animals. In 12 dogs substantial parts of the liver were resected and the defects 'blanketed' with gelatin sponge which was fixed with pressure for from 5 to 10 minutes. This controlled the hemorrhage. Two of the animals died later from biliary peritonitis. Studies of the healing showed that the sponge unlike foreign bodies in general appeared to promote the healing process.

Massive hemorrhage from wounds in the vena cava of 27 dogs could be controlled by a patch of gelatin sponge applied with finger pressure. The patch becomes endothelialized and the wall defect healed with an endothelialized scar within about 3 weeks. The fact that in 1 case a large mural thrombus was observed suggested the use of anticoagulants when one is attempting to stop massive venous bleeding by the use of gelatin sponge in human beings.

Rats in large arteries were patched similarly in dogs but a sheath of chromicized catgut was found necessary to prevent blowouts. In these experiments propagating thrombosis was encountered once.

Stab wounds of the heart were similarly treated and it was found that gelatin sponge patches held to such wounds for about 10 minutes became adherent and stopped the hemorrhage.

The gelatin sponge was used in 130 clinical cases and it was found useful on the liver after cholecystectomy and biopsy in thyroidectomy near the recurrent nerve in the abdomen after freeing of the adhesions in the chest after excision of the thickened pleura or removal of mediastinal tumors it was also found useful after biopsy of abdominal tumors areas and after removal of skin grafting on donor used as packing after rectal operations as nose packing in recurrent nose bleeding and after tooth extractions.

Gelatin sponge is not supposed to be used when hemostasis by clamp and tie will work satisfactorily. It is mainly used at this time when these methods fail or when their use entails danger. It should also serve well as a first aid dressing.

Extensive venous hemorrhage during removal of an organ or a tumor cannot ordinarily be stopped with clamps and requires gauze packs; however, the removal of these packs may start new bleeding. Gelatin sponge needs not be removed which obviates the danger of secondary hemorrhage. Up to this time extensive abdominal resections could be done safely only when unlimited amounts of blood were available for replacement of the blood lost during the operation. Gelatin sponge may help to reduce such losses and thus surgeons in places where unlimited amounts of blood are unavailable may now attack problems they have avoided in the past. Liver surgery will be helped greatly by the new material as will work on the bile ducts or the pancreas. Gelatin sponge will be of value in injuries of the portal vein in neurosurgery for bleeding from the dural sinuses in the skull technique mentioned in the animal studies for the repair of arterial wounds and for patches to be used on heart wounds. As to the mode of action the authors believe that the gelatin sponge acts as a framework for the clot and is finally absorbed. They have not been able to establish what effect if any preliminary wetting of the sponge with thrombin has on its efficacy but they recommend the use of thrombin with the sponge in clinical cases.

HIRSHEN LAMM M D

# PHYSICOCHEMICAL METHODS IN SURGERY

## ROENTGENOLOGY

Heublein, G. W.: Some Observations Concerning the Hypophyseal Fossa. *Am. J. Roentg.* 1946, 50: 299

The pituitary fossa of 100 apparently normal young adult soldiers was measured. Its average anteroposterior diameter was found to be 10.66 mm and its average depth 8.30 mm. The largest fossa measured 13 by 9 mm. and the smallest 8 by 5 mm. This agreed closely with the measurements reported by Kohnblum.

The average size of the fossa in 6 cases of pituitary adenoma was 23 by 17 mm.

Various normal anatomical variations of the sellar configuration are discussed. The shape and the calcium content of the dorsum sellae are influenced by (among other factors) the basilar sinus (described by Batson and Kohnblum). The sphenoparietal sinus or sinus of Bercet—another venous sinus of importance in the reading of roentgenographs of the sella—may be mistaken for an enlarged channel of the middle meningeal artery. Other vascular channels may simulate fractures through the sella.

Intrasellar calcium deposits are not necessarily of clinical significance but suprasellar calcifications (above the diaphragma sellae) raise the suspicion of Rathke's pouch tumor or other pathological changes.

Case descriptions illustrate sellar changes caused by various pathological conditions. Extreme calcification of the petroclinoid ligaments was caused by a parathyroid tumor. Various changes in shape and size of the sella were caused by pituitary adenomas in 6 instances. They were associated with restricted visual fields. Choked discs were absent, however. A

malignant chromophobe adenoma of the pituitary gland caused intrasellar as well as perisellar changes. An enlarged third ventricle (caused by a large pituitary adenoma) flattened the clinoid processes from above and caused "cupping" of the upper superior margin of the dorsum sellae. Similar changes were caused by a narrowing of the aqueduct with consequent third ventricle enlargement due to ependymitis in one case and due to a large frontal cystic astrocytoma in another instance. (There was no direct influence of the tumor on the sella.) A large parasellar bone erosion was caused by a lymphepithelioma (nasopharyngioma). Erosion of the sella by metastatic tumor was seen only in 1 of 360 cases of malignant disease treated in the radiotherapy department of the Percy Jones General and Convalescent Hospital in 1944 although 29 per cent of these cases had evidence of tumor metastases. In this single case the etiology was multiple myeloma.

Aneurysms of the circle of Willis may cause sellar deformities. Usually however they are recognized by their calcium content (to be distinguished from vascular sclerosis without aneurysm) or by means of angiography.

A pitfall in the diagnosis of sellar erosion is decalcification due to pulsation of the brain transmitted to the sella through the basilar sinus, to senile atrophy to minute basophilic adenomas, and possibly due to a persistent rest of notochord, the so-called physaliform ependymoma. A faulty roentgenographic technique may reveal restitution of the sella following deep roentgen therapy whereas correct roentgenographs will fail to show changes.

GERHART S. SCHWARTZ, M.D.

Pendergrass, E. P., and Perryman, C. R.: Porencephaly. *Am. J. Roentg.* 1946, 56: 441

According to the authors, porencephaly is the end point of many disease processes. It is usually defined as a defect communicating with the ventricles or separated from them by a layer of brain tissue, and covered on the outside by the arachnoid. This condition must be considered in the differential diagnosis of mass or contracting lesions involving the brain. Occasionally it is confused with cystic lesions. Encephalography or ventriculography is necessary to establish the diagnosis of the condition. Roentgenologically the types of porencephaly have been classified as lobe, "interlobe" and hemisphere.

In the series of 29 cases studied, the average age of the patients was 16 years, the oldest being 34 years and the youngest, 9 months. The duration of symptoms varied from 3 months to lifetime (30 years).

Most of the patients (26) sought medical attention because of epileptic attacks, which usually had been preceded for several years by other symptoms such as weakness of an extremity, strabismus, or mental retardation. Others complained of headache, poor



Fig. (Heublein) Characteristic appearance of the hypophyseal fossa in patient with pituitary adenoma. The thinned and apparently elongated dorsum sellae is shown by the arrow.

memory irritability sluggishness and excitability. Sixteen of the patients in the series had paresis of one or two extremities and 2 of these had facial paralysis as well.

Atrophy or hypodevelopment of one half of the body or the involved extremity was present in those who had had paralysis since early childhood. Occasionally anesthesia was present. Papilledema was present in 3 patients. Four patients had homonymous hemianopsia and bitemporal hemianopsia. Peripheral constriction of the visual fields was noted in one patient. The symptoms were dependent to a large extent upon the location of the lesion. Unilateral change in thickness of the skull was the most common observation in the conventional roentgenograms of patients with porencephaly. Generalized or localized thinning was most frequently present, and unilateral thickening of the vault was less often demonstrable. Asymmetry of the vault was also occasionally observed. Calcification similar to that in malignant gliomas was found in one instance.

FRANK L. HUSSEY M.D.

Pendergrass, E. P., and Perryman, C. R.: Optochiasmatic Arachnoiditis. *Am J Roentg* 1946 56: 579

Ten cases of optochiasmatic arachnoiditis are reported in which the pneumoencephalograms showed incomplete filling and distortion or blurring of the cisterna chiasmatica and/or of the neighboring cisternae interpeduncularis and pontis.

Five patients had visual disturbances and optic nerve atrophies. Operation revealed arachnoiditis involving the chiasma in 4 of them (luetic in nature in 1 instance) and a small suprasellar meningioma in 1 patient. None of these showed sellar changes.

The other 5 patients had no eye symptoms or changes. Of these 4 suffered from epileptic convulsions and 1 displayed post-traumatic headaches and weakness in the right arm and shoulder. Craniotomy



c (Legend below)

performed in 1 instance showed a microscopically fresh blood clot. In this group the encephalogram showed a decrease in the number of subarachnoid pathways in addition to cisternal changes. In some of the latter cases the escape of cerebrospinal fluid through the foramina of Magendie and Luschka was apparently interfered with by arachnoid adhesions causing dilatation of the ventricles.

The authors conclude that a careful pneumoencephalographic study of the cisternae will lead to the diagnosis of perichiasmatic arachnoiditis more frequently than is generally anticipated.



Fig. 14 (Pendergrass and Perryman) a, The lateral encephalogram demonstrates cisternal adhesions, b, shows a

generalized obscuring of the cisternae and c, shows a variation in the size and number of cortical pathways.



cause of the reaction, and according to the other allergy to liberated (decomposition) toxins is the cause. The author noted that, in addition to his own cases, there were 5 instances in which the radiation had been directed to the trunk over an area in which the red bone marrow was affected. He concludes that at least in his cases allergy was the causative factor but that a hypersusceptibility of the bone marrow to radiation must have pre-existed and that had led to the thrombopenia.

GERHART S. SCHWARTZ, M.D.

Piemonte, M.: Histopathogenetic Considerations of Radionecrosis (Considerazioni Istopatogenetiche sulla radionecrosi). *Radial med.*, Milan, 1946 3 9.

Late radionecrosis is well known in its clinical aspect today the divergencies and uncertainties beginning when one passes from the clinical picture to the pathogenetic interpretation. There are those who attribute its cause to arterial and arteriolar lesions above all, productive endarteritis those who attribute it to a fundamental capillary lesion those who believe in an injurious action by the radiations on the nervous vasomotor apparatus and therefore, in ultimate analysis, again to an action on the circulation although it is indirect. Others believe it is due to technical error, overdosage but in this case one must still explain how the lesion is initiated. Others speak of an elective caustic action by the radiations, giving importance also to cofactors such as trauma and infection. Ewing has a similar theory but calls attention to the contemporaneous vascular lesions.

Bjorne Dahl recently proposed a new interpretation concluding that the epidermal cells and piliferous follicles are destroyed by the radiations which also damage the connective tissue and the capillaries and induce a paralysis in the capacity of these elements to repair and proliferate. Secondly when the epidermis is separated one has a vascular reaction which reaches its maximum in the corium, where one observes an imposing capillary dilatation with the formation of an edema in contrast. This edema blocks the blood circulation of the denuded connective tissue and therefore leads to mortification by asphyxia. The necrosis can therefore deepen by regularly bringing every new layer of tissue which becomes necrotic to the formation of edema and to the obstruction of the circulation in a deeper layer. In this way one establishes a vicious circle which is only interrupted when the connective tissue and vessels have recovered their capacity to form granulation tissue.

The author studied the histology of late radionecrosis in 27 cases to see if one could discover elements for orientation in the microscopic pictures of the lesions for the pathogenetic interpretation of the process. He believes that the beginning of radionecrosis is to be attributed to phenomena of vascular thrombosis which manifest themselves consequently by lesions determined by the radiations in the walls of the blood vessels.

The author feels that indubitably the blood vessels are among the most radiosensitive elements and that by consequence of radiation even in a technically correct manner the muscular layer always presents regressive phenomena and the intima productive phenomena. The radiations therefore come to injure the most important functional elements in the vascular wall (the muscular) from which contractility is derived and the intima which assures normal canalization. He describes the histological attempts at repair of this process in the vascular wall and concludes that the result of all this is a slowing down of the circulation in the vessels irradiated. In this connection, an injury of any nature which comes to act on a vessel so anatomically altered can with ease lead to the formation of a thrombus with sudden interruption of the blood supply to the vascular territory situated beneath it.

The author also states that stabilisation of a sufficient collateral circulation is not permitted because all the vessels of the irradiated area present similar lesions, and that not even the cells of the tissue irradiated, which is deprived in all or in part of its circulation, are in their best condition of vitality and resistance.

This interpretation of radionecrosis explains the many particulars of the process—the reasons for the clear demarcation, clinical or histological, of the necrotic focus which remains a focus of ischemic necrosis almost resembling an infarct. All of the zone which depends for its blood supply from the vessel or vessels thrombosed not receiving a sufficient supply from the collateral circulation because of the vascular alterations of the same coexistent nature, must be a victim of regressive phenomena while the surrounding tissue demarcates it cleanly.

G. ALBIN LIVA, M.D.

## RADIUM

Caceres, E.: Treatment of Cutaneous Hemangioma with Radium. *Am J Roentg* 94, 55 5 3.

The present article is based on a study of 66 cases of hemangioma treated with radium at the Chicago Tumor Institute.

As a rule, hemangioma increases in size at a slower or faster rate during infancy. For this reason and since radiosensitivity is greatest early in life treatment should be instituted within the first 6 months after birth. If there is a rapid increase in size or beginning ulceration treatment of the hemangioma must be given immediately even during the first weeks of life.

Of the various methods of treatment that can be used the application of radium is believed to be the most satisfactory. The author limits his discussion to the technique and dosage with (1) filtered contact radium and (2) filtered radium at a distance (mold plaque). The different types of radium applicators used at the Chicago Tumor Institute are briefly reviewed and the approximate dose with each is indicated.

The final result was excellent in 49 cases (74%) satisfactory in 13 cases (20%) and unsatisfactory in only 4 cases (6%).

Some photographs taken before treatment and from 7 months to 2 years and 9 months after treatment are presented for the purpose of illustration.

T. LEUCOTIA, M.D.

### MISCELLANEOUS

Taylor H. C. Jr. and Twombly G. H.: Cancer of the Cervix: A Study of the Effect of Interstitial Radon Needles as Compared with Roentgen Therapy Given through Intravaginal Cones. *Am J Roentg* 1946 56 513

In a former report from the Memorial Hospital New York New York the effect of the massive and divided roentgen irradiation on the five year results of carcinoma of the cervix was analyzed. The massive irradiation was carried out by administering 750 roentgens at a single treatment to each of 4 pelvic fields, with 200 kilovolts and 0.5 mm of copper at 50 cm. skin target distance. In the divided irradiation 12 treatments of 200 roentgens each were given to each of 6 pelvic fields, with 200 kilovolts 0.5 mm of copper at 70 cm. skin target distance. Both methods were supplemented with the same type of radium application i.e. 2 intracervical capsules delivering 3,000 mc. hr. and 1 vaginal bomb delivering 1,500 mc. hr. The five year cures amounted to 30 per cent and 36 per cent respectively proving that the divided dose technique of external roentgen irradiation has certain advantages over the massive dose technique.

In the present report this study is being carried one step further. All cases of cancer of the cervix examined during the period from 1943 to 1944 were divided into two equal and comparable groups. One group was treated by replacing the vaginal bomb (but not the intracervical capsules) with intra vaginal roentgen therapy and the other by replacing it with interstitial radon needles which were introduced directly into the parametria through the vaginal vault. The external roentgen was given in both instances with the divided dose technique.

In the first group the intravaginal roentgen therapy was carried out with 150 kilovolts 3 mm. aluminum, at 35 cm skin target distance. Special lead-lined brass cones were used which were inserted by means of an obturator into the vaginal canal with the patient's legs in stirrups. In the typical plan the intravaginal treatment was given 3 times a week during the course of the external roentgen irradiation and before the intracervical application of the radium. Three fields were used: one (4 cm. in diameter) directly to the cervix, and one each (3 cm. in diameter) to each parametrium through the lateral vaginal fornices at an angle of 30 degrees from the long axis of the body. The dose on the cervix amounted to 4 exposures of 500 roentgens in air (total 2,000 roentgens) and on each parametrium to 4 exposures of 750 roentgens in air (total 3,000

roentgens). Not infrequently the typical plan could not be followed. In such instances adjustments based on individual requirements were made.

In the second group the interstitial radon needles were inserted at the time of the intracervical radium application (consisting in this instance of a radon tandem) which as a rule, was 2 weeks after the completion of the external roentgen irradiation. The plan of Nolan and Quimby was followed, which is described in detail. The intracervical tandem and the parametrial needles were left *in situ* until a total dose of 6,000 mc. hr., 3,000 mc. hr. from the tandem and 3,000 mc. hr. from the needles had been delivered.

Although the time of observation was too short (from 9 to 34 months) the superiority of the first method over that of the second cannot be doubted. Thus, the percentage of cases apparently free of cancer when intravaginal roentgen therapy was applied was 48 (54 of 113 cases) whereas with interstitial needles it was only 26 (26 of 94 cases). Furthermore, the patients treated with needles had more severe immediate reactions (diarrhea, dysuria, bleeding) and a larger incidence of late sequelae (stricture, fistula) than did those treated with intravaginal roentgen therapy.

The conclusion is reached that the use of interstitial radon needles in cancer of the cervix is ineffective and dangerous. The intravaginal roentgen therapy in this respect, seems to have a definite advantage, but one should wait for the 5 year results before expressing an opinion also on the relative value as compared to that of the vaginal radium bomb.

T. LEUCOTIA M.D.

Blomfield G. W. and Spiers, F. W.: Dose Measurement in Beta Ray Therapy. *Brit J Radiol* 1946 19 349.

The early use of beta ray plaques was largely on an empirical basis, since the biological effect was not directly proportional to the ratio of milligrams of radium to the area in square centimeters. The present improved construction of the plaques plus standardization of the determination of the beta ray output of the individual plaques should place this form of therapy on a more exact basis.

The authors have calibrated 2 plaques by means of a specially constructed ionization chamber. The chamber was standardized by calculation of the capacity and the volume and by conversion of the unit into a 7 ray chamber then by a known quantity of radium determining the capacity and volume. A factor of 55 (capacity/volume) was thought to be the best obtained for conversion of the potential change due to beta ray ionization to c.s.u./c.c. (roentgens). Plaque LGI 20 containing 20.4 mgm. of radium distributed in a 4 sq. cm. area with 0.10 mm. of monel filter had an aluminum H.V.L. of 0.43 mm. and a surface dose rate of 4450 r/hr. Plaque LGI 30 containing 31.0 mgm. of radium distributed in a 6 sq. cm. area with 0.10 mm. of monel filter had a H.V.L. of 0.55 mm. of aluminum and a surface dose rate of

4700 r/hr. The addition of 0.02 mm. of aluminum filter to plaque LGI so reduced the dose rate to 4550 r/min and increased the H.V.L. to 0.33 mm. of aluminum, which indicates the extreme sensitivity of beta ray plaques to filtration. The  $\gamma$  rays contribute only from 3 to 4 per cent of the total dose rate.

The relative fall in dose rate with increase in distance between the plaque and the phantom is considerably less than predicted from the inverse square law. This is thought to be due to the oblique filtration effect and must be taken into account in the application of plaques to certain anatomical sites.

The beta ray dosage from plaque LGI so was measured independently by G. J. Neary at Mount Vernon Hospital with the apparatus which he had developed. (*British Empire Cancer Campaign Report*, 1943 and *Br J Radiol* 1946 19:357) The results were in excellent agreement with the values obtained by the authors at distances greater than 1.0 mm. At shorter distances it was thought the differences observed were due to the difference in the construction of the chambers. Smereker and Juris (*Strahlentherapie*, 1935 11:327) report values more than 50 per cent higher than the author's. However the former standardized their chamber with 9-12 k.v. grenz rays having approximately the same H.V.L. as the plaques. Such a calibration is questioned due to the extreme difference in energies of the x rays and the beta radiation.

If a plaque is used as a "bomb" the surface dose and the field distribution is considerably improved by the addition of a 1.0 mm. lead elliptical "reflector." The surface dosage however is no greater than one would expect if the same quantity of radium were distributed in a plaque of the same (large) surface area. This method of treatment ("bomb") while more convenient, is no more economical in radium.

The depth dose curve (in water) of beta radiation corresponds approximately to 25 k.v. grenz rays. The H.V.L. is 1.3 mm. of water.

Small rodent ulcers are first curetted, then given a surface dose of 7000 r (2 mm. depth dose of 2500 r) at a single seance. Portwine stains are given 1000 r at 2 or 4 week intervals for a total of 3000 r. Special mention is made of this form of therapy for early superficial rodent ulcers of the inner canthus overlying the lacrimal sac. Adequate dosage can be administered to the ulcer with little or no damage to the lacrimal apparatus. Recurrent rodent ulcers, skin nodules from carcinomas of the breast, and cavernous angiomas are considered too deep for this form of therapy.

The beta-ray plaque is of value in the treatment of superficial lesions. Any lesion requiring more than a 30 per cent depth dose at a depth of 0.25 cm. should be treated by some other method.

R. B. LEWIS, M.D.

## MISCELLANEOUS

### CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

Imperati, L., D'Errico G and Ruggiero A.: The Study of Operative Trauma as a Factor in the Production of Shock (Ricerche sul trauma operatorio quale fattore di squasso) *Gior ital chir.*, 1946 3 365

A study of hemodynamic changes following operative trauma in 20 patients brings the authors to the following conclusions

A marked fall of the systolic pressure indicates postoperative shock but a normal or increased systolic pressure does not exclude the presence of compensated shock. A fall of the differential pressure and of the oscillometric index serves as a sign of latent or compensated shock. Differential pressure expresses the energy of the contraction of the heart with peripheral resistance on one hand and contractility of the blood vessels on the other. A fall of the venous pressure is an early sign of shock especially of compensated shock, and particularly if a sharp fall of the systolic pressure takes place. On the other hand a fall of the differential pressure and of the oscillometric index reveals the presence of latent shock.

The author applies the term compensated or latent shock to impending shock.

An accelerated absorption by operated patients of an intradermal wheal produced by the injection of 0.2 c.c. of saline solution is related to an increased permeability of the capillaries and to dehydration of the tissues.

JOSEPH K. NARAT M.D.

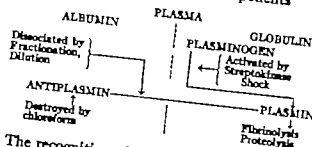
Macfarlane R. G and Philling J.: Observations on Fibrinolysis: Plasminogen Plasmin and Antiplasmin Content of Human Blood *Lancet* London, 1946, 2 562

The clots formed by normal whole blood or by recalcified citrated or oxalated plasma will remain intact in their own serum for days, or even weeks if bacterial growth is prevented. Under certain circumstances, however this stability is lost, so that soon after coagulation they break up and disappear. This phenomenon called fibrinolysis has been, until recently mainly of academic interest now there are indications that it may prove to be a manifestation of a fundamental physiological process.

Fibrinolysis has been produced experimentally in dogs by hepatectomy and peptone shock, and by treatment of plasma with chloroform *in vitro*. The latter was considered as being formed from the digestion of fibrin by the proteolytic action of thrombin. Some observers however think that another enzyme related to trypsin is responsible for the reaction. Still others consider it an enzyme associated with the globulin of the plasma, and suggested the name "plasmin" plasminogen is the name given

to its inactive precursor and in the familiar culture filtrates of certain strains of *Bacillus hemolyticus* streptococci streptokinase has been ascribed to the bacterial activator.

A fourth component however has been added to these, inasmuch as normal plasma or serum contains an antiproteolytic factor associated with the albumin fraction. It is probably concerned with the absence of fibrinolysis in normal blood and has been designated antipiasmin. The following schematic diagram shows the interrelation of the components



The recognition of these components of a proteolytic system existing in normal blood greatly facilitates an approach to the problem of spontaneous fibrinolysis in man. It is most probable that the disappearance of fibrin in blood taken after sudden death (Ludin 1936) trauma (Macfarlane, 1937) or burns and hemorrhage (Tagnon *et al* 1946) is due to the activation of this system.

The possible significance of such a process becomes the more apparent when it is realized that the plasminogen of normal blood is of a potential activity sufficient to destroy the total fibrinogen of the body in a few minutes and the more interesting since it is apparently associated with the problem of latent shock. Further investigation is desirable, and might be divided into studies of three aspects of the problem: first the interaction of the plasma factors culminating in fibrinolysis; secondly the nature of the physiological process that activates the proteolytic system; and thirdly the effect on the living in the blood stream.

The experimental technique for the quantitative assay of plasmin is described and the interrelations of plasminogen antipiasmin and plasmin are recorded in table form.

From the experiments it appears that normal plasma contains at least three factors concerned in fibrinolysis. In the globulin fraction is a certain amount of active plasmin, and a further quantity of its precursor plasminogen. It might be argued that the activity observed in this fraction was induced by the technique of separation but, since it is lost on recombination with albumin it is reasonable to suppose that this proportion of plasmin exists in normal blood in combination with the antipiasmin of the albumin fraction. If this is so the combination is a

loose one, being broken by fractionation. Moreover if the plasmin content of plasma is for any reason increased, fibrinolytic activity first becomes apparent in the higher dilutions of the plasma, suggesting that dilution favors dissociation of the plasmin-antiplasmin complex, though in normal plasma there is a sufficient excess of inhibitor to prevent activation.

It is an alteration of the plasmin-antiplasmin balance, therefore, that determines the presence or absence of fibrinolysis activity in the blood. Alterations resulting in an increased activity have been observed as follows:

- 1 Streptokinase increases the plasmin content of the plasma by activating available plasminogen, but does not appear greatly to affect the antiplasmin.

- 2 Chloroform destroys antiplasmin, thus releasing the plasmin normally in combination with it.

- 3 The spontaneous fibrinolytic activity observed in the authors' subjects is due to an increase in plasmin and also apparently to a decrease in antiplasmin.

The mechanism by which plasminogen is activated in these subjects is at present unknown.

STEPHEN A. ZIEMAN, M.D.

Levenson S. M., Green R. W., Taylor F. H. L., Robinson, F., and Others: Ascorbic Acid, Riboflavin, Thiamin and Nicotinic Acid in Relation to Severe Injury, Hemorrhage, and Infection in the Human. *A. M. Surg.* 946, 124, 840.

Few careful studies other than those of ascorbic acid and vitamin K in relation to surgical conditions have been reported in the field of vitamin therapy. In the meantime all known vitamins are being used in the care of surgical patients, with increasing frequency and in increasing doses.

Recent work in the laboratory has shown that many vitamins play much more fundamental roles in the animal organism than that of merely preventing or curing the well known syndromes of scurvy, beriberi, pellagra, or hypoprothrombinemia. For instance, thiamin and nicotinic acid both play fundamental roles in the enzyme systems that control the metabolism of carbohydrates. Riboflavin is also important for the carbohydrate metabolism and, in addition, has a function associated with amino acid metabolism. Ascorbic acid is said to have a fundamental role in the formation of adrenocortical hormone. These functions indicate that these four vitamins play important roles in connection with recovery from shock, injury and acute infections since disturbances in the metabolism of carbohydrate, protein, and of adrenocortical hormones are caused by these conditions.

The authors present data concerning 6 patients with severe injuries, hemorrhage, or infection who had marked abnormalities in the metabolism of ascorbic acid, thiamin, riboflavin and nicotinamide. They were cared for by the members of the "Burn Assignment" in a metabolic ward which was supplied with special nurses, a research dietitian, and facilities for accurate determinations of vitamins as developed

in the Harvard Fatigue Laboratory. Low concentration of ascorbic acid in the plasma, fasting or after saturation tests, and low excretions of all four vitamins under the same two conditions were found.

The study gives some further support to the idea that large doses of ascorbic acid, thiamin, riboflavin, and nicotinic acid may serve a useful purpose in the care of acutely ill people. HARRY W. FINE, M.D.

Slabe, F. W.: Fibromyositis, Including Its Industrial Implications and with Special Reference to Referred Pain. *Occup. M.* 1946 320.

Fibromyositis includes conditions in which myositis (which is often an intramuscular fibrositis) and fibrositis, or both, predominate. It presents a localized or occasionally diffuse area of infiltration involving muscle or contiguous tissue. The observed pathological changes are inflammatory and minimal in the acute stage, but fibrotic and degenerative in the chronic stage. Firm, painful nodules, designated by the term "myogelosis," may occur in the affected muscle. The usual sites of involvement are the erector spinae muscles, extending from the neck to the pelvis, the glutei, and the muscles attaching to the shoulder girdle.

The mechanisms producing the symptoms of the disease are poorly understood, but many predisposing and associated factors are recognized. These include nutritional deficiencies, metabolic disturbances, foci of infection, fatigue, postural defects, exposure and constant repetition of given motions (as in the use of a screwdriver). The signs and symptoms may be difficult to elicit. In this respect a complete history is invaluable. Typically there is tenderness at the site of involvement with pain which is aggravated by use of the part, and often with referred pain which is greater than that felt in the primary site. Objectively the only finding may be an area of induration or muscle spasm. On occasion, a firm nodule may even be felt. In some cases, however, overlying muscles may obscure these findings. Isolation of the small area of tenderness which represents the primary site is so important as to justify a painstaking search. In making the diagnosis of fibromyositis, one is called upon to differentiate the condition from a strain of a ligament or muscle. The "pure" strain will give immediate pain experienced simultaneously with an incident or effort which is unusual and definite. It will produce some degree of immediate local incapacity and impairment of function. Under appropriate therapy its symptoms will subside. The "pure" instances of fibromyositis are those in which there is history of unusual effort for some time before the appearance of symptoms. There are mixed cases in which an acute strain may precipitate the symptoms of a fibromyositis, to which there has been a predisposition because of unusual heavy work, prolonged overuse of a part, or work in an unnatural position.

One of the most interesting features of this disease is the frequent occurrence of referred pain. This always arises from deeper structures, whether they be muscles, ligaments, fascia, or even peritoneum. It is diffuse and poorly localized pain which follows the dis-

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tribution of a spinal segment. There is usually tender-  
ness of the area to which the pain is referred. Although  
objective sensory changes may be absent, there fre-  
quently is slight diminution or increase in sensibility to  
light touch and pinprick. The patient may be able  
only to describe the area as feeling different or  
"tight." The referred pain originates in the primary  
afferents of the disease but how this "trigger zone" initiates  
it is not definitely known. Several interesting theories  
are advanced. The author describes in detail the char-  
acteristics of referred pain from the most frequent  
sites of origin: the dorsolumbar region, the lower part  
of the back, the shoulder girdle, and the lower part  
of the neck and the cervical region.  
Treatment is prophylactic to some extent especially  
in industry, where instruction in proper methods of  
lifting, avoidance of prolonged repetition of motions,  
and correction of working positions which are mechan-  
ically unsound will eliminate certain predisposing fac-  
tors. Specific therapy includes rest for the affected  
part, the application of heat, the local use of counter-  
irritants, deep massage, and the use of analgesics  
particularly of the salicylates. The injection of a  
local anesthetic into the "trigger zone" is a striking  
therapeutic procedure and frequently has diagnostic  
value.

The author recommends that the small isolated ten-  
der zone be injected with from 5 to 20 c.c. of 1 per cent  
procaine hydrochloride. He advocates injecting half  
of the solution rather rapidly. If this increases the re-  
ferred pain one may feel certain that the lesion is the  
primary one. The remainder of the solution should be  
injected slowly around the periphery of the area. The  
treatment is effective in most cases but not all pa-  
tients respond favorably. Some may experience severe  
"after pain."

Coman D. R.: Induction of Neoplasia In Vitro with  
a Virus. Experiments with Rabbit Skin Grown  
in Tissue Culture and Treated with Shope  
Papilloma Virus. *Cancer Res.* 1946 6 602

Since neoplasia has been induced in tissue cultures  
by a chemical carcinogen the question presented it-  
self as to whether similar neoplastic transformation  
of cells in vitro can be obtained by other types of  
experiments such as viruses. The author designed  
induced in tissue cultures of rabbit skin by papil-  
loma virus.

The following criteria were adopted for the induc-  
tion of neoplasia: (1) increased growth activity of  
the epithelial cells in cultures after introduction  
of papilloma virus and (2) the formation of relatively  
large tumors in the liver of the rabbit following the  
implantation of such tissue cultures. Both criteria  
were met by the author's experiments and he there-  
fore concludes that papilloma virus is capable of  
inducing neoplastic formations in vitro namely in  
tissue cultures of rabbit skin.

Tumors resulted in the author's experiments only  
when the skin treated with papilloma virus was im-  
planted in the rabbit from which it had been re-

moved originally. This indicates that the skin had  
not lost its individual specificity during tissue  
culture.

The use of papilloma virus and rabbit skin in  
vitro should serve as an excellent method for in-  
vestigations of virus-cell relationships.

JOSEPH K. NARAT M.D.

Burrows, H., and Hoch Liggett, C.: Effect of Pro-  
gesterone on the Development of Mammary  
Cancer in C3H Mice. *Cancer Res.* 1946 6 603.

The effect of progesterone on the incidence of  
spontaneous mammary tumors in the pure strain of  
mice was investigated by the authors because it had  
been previously found that the occurrence of mam-  
mary cancer in RIII mice was considerably reduced  
by progesterone, and because it has been repeatedly  
suggested that in addition to the hereditary factors  
in pure strain mice with a high incidence of mam-  
mary cancer an excessive secretion of estrogen may  
determine the incidence of these tumors.

Thirty mice of a high mammary cancer strain were  
given subcutaneous injections of 1 mgm. of proges-  
terone weekly. The authors were not able to establish  
any differences in the frequency of the tumors and  
the ages of these mice and of the 20 control animals  
receiving injections of the solvent only.

The different results obtained by other writers in  
similar experiments demonstrate the need for care in  
attempting to generalize the results in different  
strains of the same species. Obviously still greater  
care is indicated in attempts to carry over the results  
obtained in experimental animals to human pathol-  
ogy.

JOSEPH K. NARAT M.D.

## GENERAL BACTERIAL, PROTOZOAN AND PARASITIC INFECTIONS

Hartman T. L.: Sulfonamide Sensitivity Deter-  
minations of Hemolytic Streptococci Isolated  
from Patients before and after Treatment with  
Sulfadiazine. *Bull Johns Hopkins Hosp.* 1946  
79 343

Recent epidemics of streptococcal infections caused  
by sulfadiazine-resistant hemolytic streptococci fol-  
lowing mass chemoprophylaxis programs have aroused  
interest in this problem.

Naasopharyngeal cultures were taken from 40 pa-  
tients on admission to the hospital and following sulfadiazine  
therapy. With 1 exception all of these 40 de-  
veloped clinical evidence of scarlet fever. The bacteria  
were typed by the precipitin method. The bacteria  
were predominant group A hemolytic streptococci. Those  
of group C. Sulfadiazine was given as follows:  
a 20 gm. initially 1.0 gm. every 4 hours for at least 4  
days during the first day and 1.0 gm. every 4 hours  
for 5 days during the succeeding days. Most patients  
sprayed their nose and throat with a 5 per cent sulfadiazine  
in glycerine and saline solution, and gargled  
with a 5 per cent sulfadiazine. The total amount of  
sulfadiazine given varied from 14 to 75 gm. per pa-

tient, and resulted in blood levels from 2.0 to 12.0 mgm. per cent, with an average blood level of 7.3 mgm. per cent. After chemotherapy sulfadiazine sensitivity of the streptococci was tested by the method described by Wilson. No significant resistance against sulfadiazine was found in any instance.

Previously noted resistance to sulfadiazine by hemolytic streptococci is explained by the lower doses of sulfadiazine used for prophylaxis, and the longer period of administration. Resistance to drugs by bacteria is hypothesized as being due to mutation or adaptation to unfavorable environmental conditions.

C. FREDERICK KITTLE, M.D.

Lewis, L.: Therapeutic Trial of Penicillin in Tetanus. *Ann. Int. M.* 946 25 903.

Laboratory studies have indicated that penicillin is effective against the *Clostridium tetani*. Penicillin alone had not been clinically evaluated in human tetanus infection. An opportunity for such observation in civilian casualties became available in the Okinawa campaign.

Patients with recently developed symptoms of severe tetanus, and who were not treated with or were unaffected by tetanus antitoxin were selected. Fifteen, of whom only 4 had received tetanus antitoxin were given penicillin; these 4 were included because they apparently had failed to benefit from the antitoxin. Nine patients had multiple shrapnel wounds, 4 gunshot wounds, 1 patient had undergone amputation of the right arm, and 1 had an undetermined injury. All of the patients had open, infected wounds. One patient received a local injection of penicillin but all the others received the drug by the intramuscular route. About 20,000 units of penicillin were given every 4 hours, except from 3:00 P.M. to 6:00 A.M. when no trained nurses were on duty. The daily dose was, therefore, 100,000 units, and the average duration of treatment was 5 days. Most patients received a total of 500,000 units or more, and 1 patient was given 1,500,000 units in injections around her wounds. Of this group of 15 patients, 7 recovered, 3 were benefited (including the patient who received the local injection) and 5 died.

There was no sharp alteration of the clinical course noted during the penicillin treatment, nor immediately following the injections, although in most instances the local wounds became cleaner. The course of the tetanus infection seemed no different from that in the controls, who received only prophylactic antitoxin and there was no evidence of a reduction of mortality in severe tetanus. There was no further improvement in cases which had failed to respond to antitoxin. In general recovery and improvement were gradual.

Four patients who had received antitoxin 2 of whom received large doses, showed a striking clinical improvement in contrast to the result obtained with penicillin.

Of 27 patients treated with small probably inadequate amounts of antitoxin, 16 recovered completely, 7 were benefited, and 3 died.

On the basis of this study the author concludes that there was no evidence of an effect of commercial penicillin against human tetanus infection. However the dosage might have been inadequate, and therefore large booster doses, similar to those used in subacute bacterial endocarditis, should be tried. Also different fractions of penicillin will have to be analyzed.

ARTHUR J. LEMER, M.D.

Hoffman, R. S., Dingwall J. A. and Andrus, W. DeW.: Studies on the Effects of Adult Animal Tissue Extracts on Wound Healing. *Ann. Surg.* 946 124 25.

The process of repair proceeds through an ordinary sequence in healing. The work here presented is based on the assumption that this healing cycle may be accelerated. The authors prepared an extract of sterile adult sheep hearts which had been finely minced in a blender with Tyrode's solution, cooled, and centrifuged, the extract being decanted and kept refrigerated.

The authors used 5 human volunteers between the ages of 30 and 50 years in good nutritional state. Under novocain anesthesia and completely sterile precautions, wounds were made in both anterior thighs. After 48 hours the larger of the defects was selected for treatment with the extract, while the smaller one was treated by constant dakinization. There was no evidence of infection in either wound in any of the subjects studied, and at regular intervals the circumference of these wounds was measured. Four of the 5 treated wounds were healed before the controls and 1 healed simultaneously with the control. In the wounds that were somewhat deeper it was observed that the extract had a marked stimulating effect on the growth of granulation tissue.

In the discussion it is concluded that the nutritional state, the hematologic picture, metabolic diseases, and infection all influence the rate of healing of wounds. More recently there have been other growth-promoting properties mentioned in the literature, some of which are chlorophyll, allantoin, and creatine. Many of these substances, however, have not been proved to be active on cells growing in vitro, nor do some of the clinical cases treated meet the requirements necessary to draw conclusions.

The authors believe that extract of adult animal tissue contains a substance that exerts a growth-promoting effect, and that this effect is the result of direct action on the metabolic mechanism of cellular proliferation. It is not thermostable and it is nondialyzable; its activity does not vary greatly with the change in pH, nor does it change appreciably over a wide range of concentration. It is thought that the active factor is most probably a protein not necessarily a nucleoprotein, but rather an enzyme which plays a part in nucleoprotein formation. Exposure to ultraviolet light, and mixing with sulfadiazine or penicillin did not alter the growth-producing properties.

The article also includes a brief resumé of the method of preparation of the extract.

LOUIS T. BYARS, M.D.

## DUCTLESS GLANDS

Cesarelli A. The Surgical Treatment of Myasthenia Gravis (Tratamiento quirúrgico de la miastenia gravis) *Bol Soc cir Rosario* 1946 13 306

The author has observed that extirpation of the thymus gland has shown the existence in certain cases of a relationship between this gland and the symptoms of myasthenia gravis. Thymectomy is indicated in patients with myasthenia gravis when a tumor of the thymus is demonstrated for in these cases the best results were obtained. Pneumomediastinal x-rays were of great diagnostic value in the visualization of small tumors of the thymus. In special cases with lack of demonstrable tumors and in which medical treatment fails it is justifiable to operate although in the acute crisis of myasthenia gravis surgery is contraindicated and the administration of prostigmine is necessary. In 1 of 2 patients who tolerated the operation it was possible to observe a definite improvement in the condition and in the other the symptoms disappeared with apparent cure after a period of 9 months.

ARTHUR F. CIPOLLA, M.D.

## SURGICAL PATHOLOGY AND DIAGNOSIS

Issacson, N. H., and Rapoport P. Eosinophilia in Malignant Tumors: Its Significance. *Ann Int M.* 1946 25 893

The authors report 34 cases of pronounced eosinophilia associated with malignant tumors. Nineteen of these were reviewed from the literature and 15 were observed among 2,363 cases of malignant tumors at the Jewish Hospital of Brooklyn during the past 8 years. Six per cent of the total white count is considered the upper normal for eosinophile leucocytes. In the 19 case reports of eosinophilia with malignancy the eosinophil counts varied from 10 to 70 per cent. In the authors' 15 cases, the range was from 10 to 32 per cent but in most of the cases it was between 12 and 15 per cent.

In 90 per cent of all cases, metastases were present. In 7 they were suspected but not proved and in 1 case they were neither demonstrable nor suspected. The authors believe, however, that eosinophilia is indicative of dissemination of the malignant process when it is associated with a malignant tumor and other causes are ruled out.

The following causes of eosinophilia in malignant tumors have been suggested: (1) necrosis of tumor tissue with eosinophilic response; (2) bone marrow metastases with stimulation of eosinophile production at these sites; (3) the pressure of metastases on the vagus with vagal reflex; (4) the connective tissue surrounding the tumor; and (5) a familial eosinophile predisposition with the response to foreign protein of the tumor cells as a provocative agent. There is no satisfactory theory of pathogenesis and no definite cause for eosinophilia in malignant tumors has yet been established according to the authors.

FRANK B. QUICK, M.D.

## EXPERIMENTAL SURGERY

McCarthy M. D., Parkins, W. M., and Zerbe J. W.: Comparative Efficacy of Blood from Normal and from Burned Donors in Experimental Burns. *Arch Surg.* 1946, 53 570.

The experiments reported by the authors lend credence to the popular hypothesis that severe burns produce a circulating toxin. Previous experiments had demonstrated that a single transfusion of blood from burned rats was not lethal to a normal rat in amounts up to 2 per cent of its body weight. Therefore, it was decided to increase the potential sensitivity of the recipient animal to the hypothetical toxin contained in the donor blood by subjecting the recipient to a standardized burn before the transfusion.

Forty-eight rats were subjected to a standardized scalding burn of the back. Sixteen of these were not treated in any way. Sixteen were given an infusion of normal blood equivalent to 2 per cent of their body weight. Sixteen were given an equivalent infusion of blood withdrawn from burned rats. The donors had been subjected to a burn of 45 per cent of their body surfaces, which in every case proved fatal within 24 hours. Ten days after being burned the rats treated with normal blood had a survival rate of 100 per cent, and both the untreated group and that given post burn blood had a survival rate of 56 per cent. Hematocrit data obtained from the three groups did not indicate that increased mortality was a direct result of increased hemococoncentration.

To determine the culpable fraction of 'postburn blood' it was centrifuged and its cells suspended in normal saline solution. When this suspension was infused into burned animals, the survival rate (66%) was not significantly different from that of burned animals infused with suspensions of normal cells in saline solution (83%). This appeared to indicate that the cause of the ineffectiveness of whole post burn blood lay in the plasma. The plasma potassium level of 'postburn blood' was slightly higher than that of normal blood (33.1 mgm./100 c.c. as against 30.5 mgm.) but this difference was not significant. However there was a significant difference in hemoglobinemia. This was 407 mgm./100 c.c. for postburn plasma as compared to 75.0 mgm. for normal plasma.

The authors emphasize that blood from severely burned rats was completely ineffective when transfused into rats subjected to a standardized burn sufficiently severe to give a 44 per cent mortality in the untreated controls. The fact that other rats subjected to the same burn but transfused with normal blood had a 0 per cent mortality is statistically significant.

B. F. LOCKSBURY, M.D.

Jenkins, H. P., and Janda, R.: Studies on the Use of Gelatin Sponge or Foam as a Hemostatic Agent in Experimental Liver Resections and Injuries to Large Veins. *Ann Surg* 1946 123 952

In a series of 12 dogs operated on with aseptic technique and under ether anesthesia a considerable



portion of a lobe of the liver was resected by simply cutting it off with scissors. The gelatin sponge was prepared for use by moistening it in physiological saline solution expressing the air and removing the excess saline solution by compressing it between dry gauze. The large gelatin sponge was then placed over the freely bleeding stump of liver so that it overlapped the upper and lower surface of the liver. It was held in place with firm pressure for from 5 to 10 minutes. Good apposition of the sponge to the bleeding surface is necessary as this produces a relatively rapid adhesive effect between the raw surface of the liver and the sponge. In all of the animals, hemostasis was obtained by the application of the gelatin sponge alone without supplementary suturing. In several instances it was necessary to reapply a fresh gelatin sponge in order to obtain complete hemostasis.

In a series of 36 dogs, operated on in a similar manner the femoral jugular or renal vein or the vena cava was exposed. A stab incision was made with a scalpel or a portion of the wall of the vein was excised. The gelatin sponge was applied immediately to the bleeding vein and pressed firmly in place over the wound for a minute or two. It was found that pressure with the gloved finger directly on the sponge on the vein was satisfactory. The bleeding was completely controlled by this method in all the experiments but 1. In 1 case secondary hemorrhage occurred from the superior vena cava apparently because of dislodgment of the sponge after the chest wound was closed.

Gelatin sponge was also used on 76 patients in whom troublesome bleeding could not be completely controlled by other means. The extent of the bleeding in these clinical cases cannot be compared with

that obtained in the experimental animals, so that the value of gelatin sponge as a clinical hemostatic has yet to be demonstrated.

A substantial part of the hemostatic action of gelatin sponge may be due to the spongy material itself. It is possible that the enormous surface area of the myriads of interstices may attract and damage the platelets and thus liberate thromboplastin. This, in combination with the calcium and prothrombin in the blood may elaborate enough thrombin to initiate the clotting mechanism. In the clinical use of gelatin sponge it is recommended that thrombin be used to obtain the maximum hemostatic effect.

Although the absorption time of the sponge used may be more than adequate under favorable conditions the sponge may be rapidly liquefied in the presence of a large concentration of leucocytes. A somewhat tougher and stronger spongy material than is now available seems to be desirable. This would make it possible to suture the sponge in place by some sort of basting stitch.

The excellent protective cover which the sponge appears to offer to the healing process across the stump of the liver at the line of resection is of considerable interest as is also the structural support it seems to give to the reparative process.

The possibility that a propagating thrombus may arise from the sponge plugging a rent in a vein must be considered in the clinical application of this experimental work. Heparin and dicoumarol therapy may be required to prevent this.

The particular promise which such hemostatic substances offer is that they may make possible more extensive surgery with greater safety especially in the treatment of carcinoma than has been feasible in the past.

SAMUEL KAHN, M.D.

# SURGERY

## GYNECOLOGY AND OBSTETRICS

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### THE COMBINED THORACICOABDOMINAL APPROACH WITH PARTICULAR REFERENCE TO ITS EMPLOYMENT IN SPLENECTOMY

B NOLAND CARTER, M D Cincinnati Ohio

WHEN one reviews the literature dealing with splenectomy performed for an *enlarged* spleen and reflects on his own experiences in such operations it becomes evident that the technical difficulties encountered are chiefly those resulting from lack of completely adequate exposure. Various types of incisions have been advocated for splenectomy all aimed at providing an easier and freer access to the operative field. Among these are the T incision with one arm placed through the left rectus muscle and the other extending through the muscles of the abdominal wall toward the flank, the subcostal incision placed just below and parallel to the costal margin and the transverse incision beginning at the midline half way between the xiphoid and umbilicus and extending through the abdominal wall laterally to just above the crest of the ilium. In the case of a grossly enlarged spleen none of these incisions is adequate because they do not allow access to those portions of the operative field in which lie the most potent sources of danger and difficulty. These areas are the upper pole of the spleen, its diaphragmatic surface and its posterior aspect. At these points are found the dense adhesions, the dilated thin walled collateral vessels, and

some of the normal splenic ligaments. Until these structures are divided the spleen cannot be mobilized sufficiently to permit easy and safe management of the pedicle. It is however in attempts at blind mobilization of the large spleen that inaccessible vessels are torn and nearby structures damaged. In an attempt to meet this situation Singleton has advised the opening of the lesser peritoneal sac and ligation of the splenic vessels as they course along the upper surface of the pancreas as a first step in the procedure and having thus controlled the main blood supply to the spleen to proceed with its mobilization and removal.

When a large spleen is encountered its very size in comparison with the length of the abdominal incision which can be made over it is a potent factor militating against easy exposure. The spleen is so large that it fills the incision of its own accord, thus making easy access to remote portions of the operative field practically impossible. This is particularly true where there is a narrow costal angle with a rib cage covering the greater part of the upper left quadrant. Actually the enlarged spleen lies mostly beneath the ribs in contact with the diaphragm (Fig. 1) placing the surgeon at a distinct disadvantage when working through an abdominal incision.

Since 1939 it has been our practice to perform esophagogastrostomies through a trans-thoracic approach with division of the dia-

From the Department of Surgery of the College of Medicine, University of Cincinnati and the Cincinnati General Hospital, Cincinnati, Ohio.

phragm and it has become increasingly evident to us that such an approach offers an usually good exposure of the spleen. Consequently this type of approach was recently utilized in this clinic for the removal of a spleen of normal size which had been ruptured for several days before admission of patient to hospital and which was surrounded by a fibrous blood clot. In this instance the costal arch was extremely narrow and the diaphragm quite high so that it was considered simpler to approach the spleen through the chest. The thorax was opened by an incision placed in the seventh interspace, and the ribs were spread widely the diaphragm was opened and the spleen lying in clear view could be easily freed from its many adhesions and the pedicle brought into the operative field. The simplicity of this procedure immediately suggested the possibility of attacking an enlarged spleen by a transthoracic approach. It was felt however that when the spleen was grossly enlarged the incision through the diaphragm might not be adequate to permit easy delivery of the enlarged organ and that one would be handicapped in much the same way as he would be if he were using an abdominal incision. Therefore it seemed logical to utilize a combined abdominal and thoracic incision the thoracic portion of which would give a direct approach to those aspects of the spleen inadequately exposed by an abdominal incision while the abdominal portion would permit wide access to the lower portion of the spleen and also permit the thoracic cage to be spread more widely. The over all length of the combined incision would allow for easy delivery of the enlarged spleen.

The opportunity to utilize this proposed incision first presented itself in June 1946 in the case of a 37 year old white man with Banti's syndrome. On June 6 1945 he had been admitted to the Cincinnati General Hospital with a perforated duodenal ulcer for which he was operated upon with a simple closure of the ulcer. His convalescence was a stormy one complicated by a right subphrenic abscess and a right empyema. During this admission to the hospital he showed a slight degree of icterus with some ascites. Under bed rest and digitals these manifestations

rapidly disappeared. At the time of jaundice and ascites the laboratory findings were as follows: cephalin flocculation test  $2\frac{3}{4}+$  in 24 hours and  $3+$  in 48 hours bromsulphalein retention 65 per cent in 30 minutes and 100 per cent in 5 minutes blood phosphatase 5.9 hippuric acid excretion test 175 grams galactose tolerance test 3.5 grams excreted.

His second admission was on September 12 1945. The spleen was enlarged at this time being three fingerbreadths below the costal margin and had apparently been the site of an infarct causing pain in the upper left quadrant and tenderness over spleen. A diagnosis of probable Banti's disease was made and he was referred to the out-patient clinic. During the next 6 months he had repeated splenic infarcts and the previously noted enlargement of the spleen continued but there was no ascites.

He was admitted to the surgical service in the Cincinnati General Hospital on June 17 1946 complaining of weakness, jaundice and dull aching pain in the left upper quadrant. He showed evidence of considerable loss of weight and appeared chronically ill. There was a slight icterus present not accompanied by itching. The liver could not be felt. The spleen was grossly enlarged, with its lower pole 2 inches below the level of the umbilicus and was very firm. There was no ascites. The laboratory findings were as follows: cephalin flocculation test  $3+$  in 24 hours and  $3+$  in 48 hours prothrombin time 12 seconds (12 to 13 seconds normal) bromsulphalein test showed 100 per cent in 5, 30 and 45 minutes blood urea nitrogen 14 milligrams per cent Kahn negative icteric index 7. X-ray studies revealed varices scattered throughout lower half of esophagus. After suitable replacement therapy patient was operated upon June 20 1946.

The operative technique employed was as follows. Under infratracheal gas oxygen and ether anesthesia a transverse incision was made from a point midway between the xiphoid and the umbilicus to the costal margin at the site of the eighth costal cartilage and prolonged in the eighth interspace to the mid-axillary line (Fig. 2 insert). The rectus and oblique muscles were divided in line with the skin incision down to the peritoneum and the muscles on the chest wall were incised down to

the pleura (Fig 2) The peritoneum was now opened as far as the costal cartilage which was cut across and the pleura opened throughout the length of the thoracic portion of the wound Both the abdomen and the thorax having been thus entered, the diaphragm was incised from its attachment at the costal margin to the posterior angle of the thoracic incision (Fig 3) A rib spreader was inserted and a remarkably wide exposure of the greatly enlarged spleen resulted Actually one could see the organ from its superior to its inferior poles (Fig 4) The diaphragmatic surface could be visualized completely as well as the entire greater curvature of the stomach Many dense and vascular adhesions could be seen extending from the spleen to the diaphragm at the upper pole and on the posterior lateral surface of the spleen The splenic flexure of the colon was in plain view and the left kidney could be made out readily The splenocolic and splenorenal ligaments were ligated and divided (Fig 5) The vascular adhesions mentioned were ligated and divided with great ease since they were completely in the operative field and under direct vision The gastrosplenic ligament was like



Fig 1 The position of the enlarged spleen beneath the rib cage, necessitating blind dissection in order to mobilize it for delivery through the abdominal incision

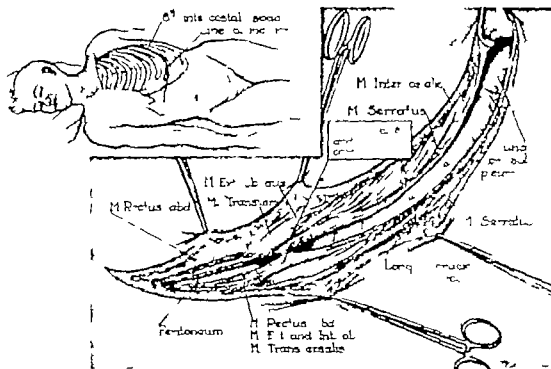


Fig 2 The incision has been made in the line shown in the insert, and has been deepened through the muscles down to the pleura and peritoneum The 8th costal cartilage has not been divided.

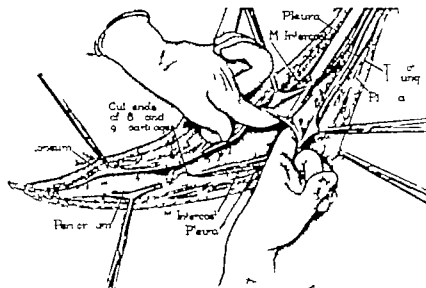


Fig. 3. The peritoneum has been opened, the costal cartilage divided, and the pleural cavity entered. The diaphragm is now being divided, thus throwing the peritoneal and pleural cavities into one.

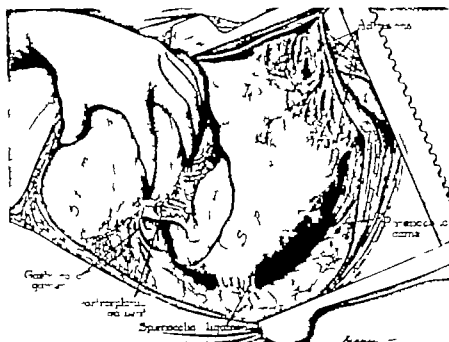


Fig. 4. The extent of the exposure obtained in the case of grossly enlarged and adherent spleen. Note the free access obtained to the diaphragmatic surface of the spleen with its many vascular adhesions.

wise ligated in segments and divided without difficulty (Fig. 6). The spleen was then delivered readily through the long widely spread incision and turned toward the right (Fig. 7). The tail of the pancreas was visualized and

the splenic pedicle freed from it. With the left hand beneath the spleen and its pedicle the latter was readily isolated into its artery and veins (Fig. 8). The artery was doubly ligated and divided and the spleen removed. There

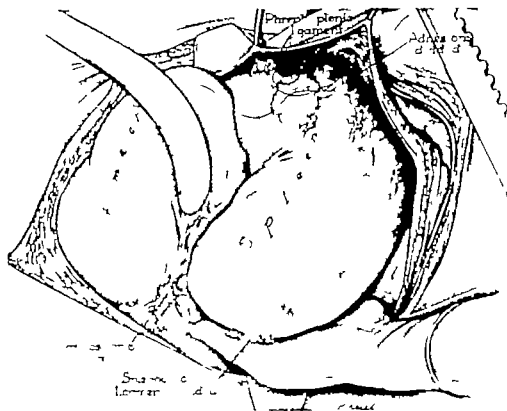


Fig. 5 The splenicocolic and splenorenal ligaments have been divided. The vascular adhesions between the spleen and the undersurface of the diaphragm are being ligated prior to division.

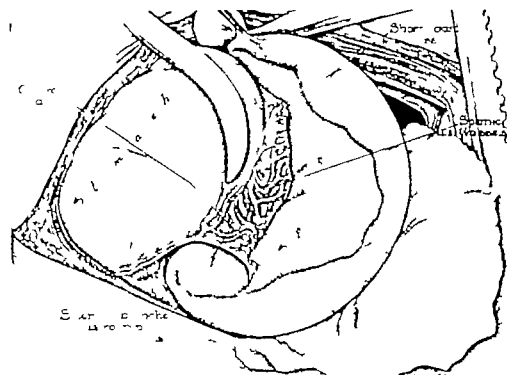


Fig. 6 The exposure of the gastrosplenic ligament, showing the ease with which the ligament can be isolated into segments and divided. The splenic vessels are likewise shown.

was virtually no loss of blood since all structures could be visualized before ligation and division. It was never necessary to perform blind dissection in an inaccessible re-

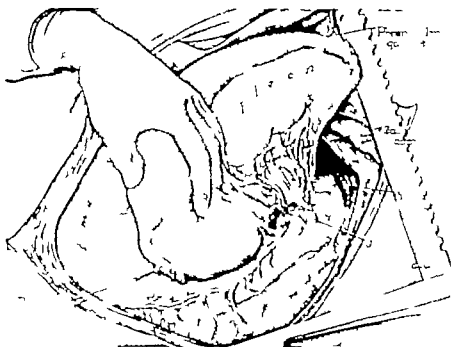


Fig. 7 The spleen having been mobilized is turned to the right and freed from the tail of the pancreas.

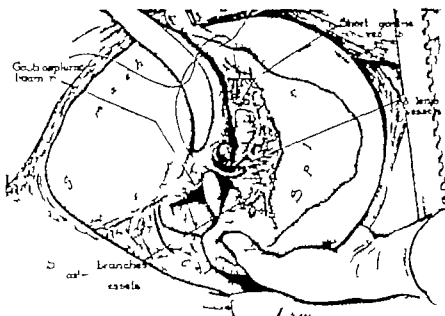


Fig. 8 Exposure of the pedicle. The arteries have been ligated and divided. A vein is being ligated.

gion the entire procedure was done with great ease.

The diaphragm was sutured with interrupted figure-of-eight sutures of silk (Fig 9A) the chest wall was closed by means of one peri-

costal suture of braided silk and a continuous suture of silk in the overlying muscles (Fig 9B). Two sutures of silk were placed in the perichondrium of the divided cartilage and gave a snug approximation of this structure.

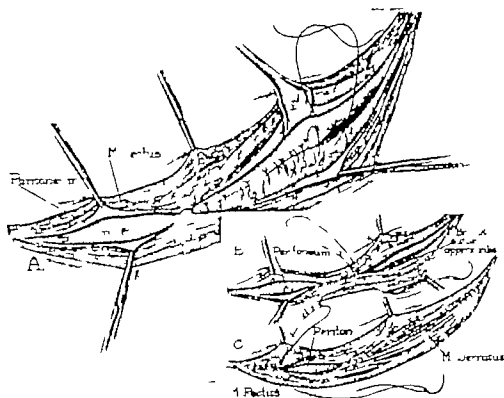


Fig. 9. A The diaphragm is being closed with figure-of-eight sutures. B One pericostal suture of braided silk has been tied and has approximated the ribs. The muscles of the chest wall are being closed with a continuous silk suture. C, The chest wall closure has been completed. The peritoneum has been closed with a continuous suture of silk and the sheath of the rectus muscle is being sutured with figure-of-eight stitches of silk.

The peritoneum was sutured with continuous silk and the sheaths of the divided abdominal muscles were closed with interrupted figure-of-eight sutures of silk (Fig. 9C). The skin was sutured with interrupted silk. No drainage of the pleural cavity or wound was instituted. The operation was well tolerated and at no time did the pulse go above 80. The blood pressure was 140/85 at start of the operation and 102/80 at end of procedure.

The convalescence was uneventful. The patient was singularly free from pain after operation and was ambulatory on the second postoperative day. The wound healed by first intention and 7 months after operation there was no evidence of postoperative hernia.

After this rewarding experience with the incision described it was decided that considerable advantages were afforded which would make it applicable to operations for other surgical conditions encountered in the left upper quadrant of the abdomen. It was next employed in the removal of a leiomyoma situated adjacent to the esophagus on the antero-

lateral aspect of the stomach. Again the access to the lesion was strikingly easy and the tumor was resected without the difficult vigorous and often futile attempts at retraction of the costal margin and the assumption of awkward positions by the surgeon. It has been utilized also in the resection of the cardiac portion of the stomach for carcinoma, and in removal of lesions of the lower end of the esophagus followed by esophagogastrostomy.

#### HISTORICAL REVIEW

In an effort to determine the experiences of others in the use of this approach which we had never seen utilized nor recalled having seen reported the literature was surveyed and was found sufficiently interesting to warrant a short historical review. The history of the combined thoracoabdominal approach dates back to the last decade of the nineteenth century and the efforts of Lannelongue and Michel to gain a wider exposure for operations on the cardiac portion of the stomach. Von Mikulicz as reported by Gottstein per-



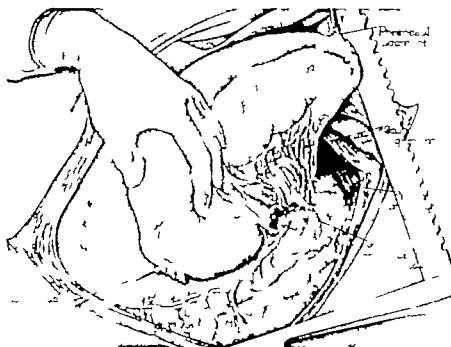


Fig. 7 The spleen having been mobilized is turned to the right and freed from the tail of the pancreas.

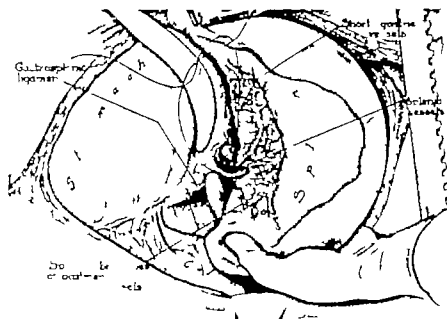


Fig. 8 Exposure of the pedicle. The arteries have been ligated and divided. A clip is being ligated.

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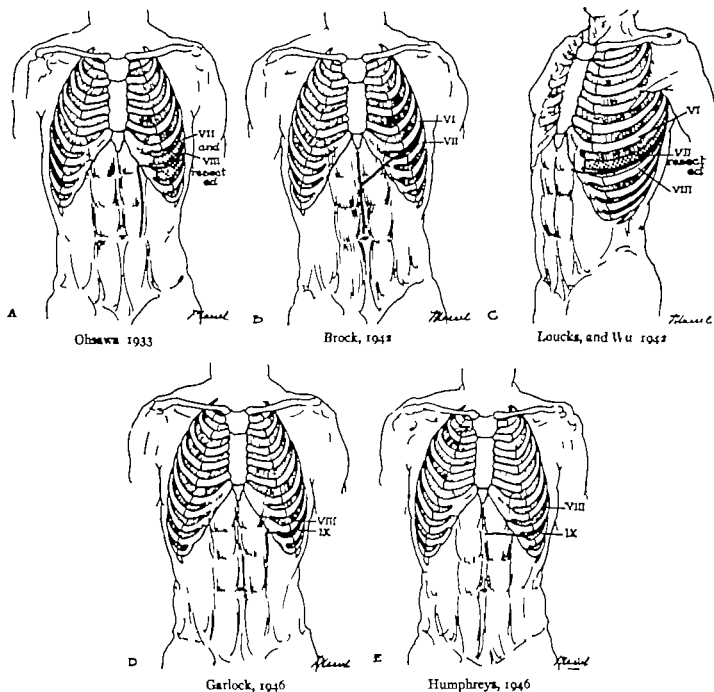


Fig 10. Types of combined thoracicabdominal incisions with authors and dates.

field for tumor of the cardia was obtained. The importance of abdominal exploration prior to opening of the chest was stressed.

In 1946 Humphreys reported 12 operations using the combined incision for carcinoma involving both the esophagus and the cardia with a 50 per cent mortality. He opened the abdomen through an oblique incision from the costal margin at the level of the eighth interspace to a point just right of the midline about 2 centimeters above the umbilicus. After determination of operability this in-

cision was extended directly upward into the chest over the eighth interspace to the posterior axillary line (Fig 10E). The diaphragm was divided from its origin at the costal margin between the eighth and ninth ribs as far as the esophageal hiatus. The esophagus was freed upward as far as necessary and the stomach freed toward the pylorus also as far as was necessary. Of the 6 patients surviving the operation 3 died of metastases and 3 were alive at the time of the report 5, 6 and 15 months after operation respectively. Five

formed the first operation leading to this approach to be done on a living patient in 1896. His procedure however was specifically designed to avoid damage to the pleura. After making an incision from the xiphoid to the umbilicus, then perpendicularly to the left and then perpendicularly upwards he resected the ribs and carefully laid back the pleura before extirpating a carcinoma of the lower esophagus and cardia. He modified the incision somewhat at a later operation (1899) so that after the initial midline incision the second started perpendicularly and then shifted to go obliquely upwards and out but he again retained the integrity of the pleura. Both patients died shortly after operation.

Marwedel recorded the next such attempt in 1903. After intensive study on the cadaver he successfully performed an operation for stenosis of the esophagus using an incision which followed the costal arch. He also avoided entering the pleura, and devised a complicated maneuver for securing wide exposure without entering that cavity.

In 1909 Tiegel (16, 17) reported a case of Henle in which a thoracoabdominal approach was carried out in two stages. Laparotomy was performed first, operability determined and the upper part of the stomach mobilized and incised below the tumor. A Murphy button was placed in the distal opening and the upper part closed by suture. After closure of the abdominal wound a left thoracotomy was performed and the esophagus severed above the tumor. An esophago-gastrostomy was then completed with the button. The patient died shortly after operation of collapse of the left lung.

Wendel performed a similar operation in 1909 however he performed thoracotomy first opening the pleura under pressure. A tumor was found on the posterior wall of the esophagus, partly above and partly below the diaphragm. Laparotomy was done after closure of the thoracic wound and tumor resected through abdomen. This patient also died shortly after operation autopsy a bloody effusion in the left pleural cavity.

In 1910 Janeway and Green carried out a two stage procedure performing laparotomy first followed by thoracotomy. Their patient

died 54 hours after operation of empyema. At that time in reporting the case they made the recommendation that in the future the operation should be performed through one incision rather than two suggesting the incision actually used by Ohsawa 23 years later.

Ohsawa (1933) was the first to report a combined incision with 8 survivals in 18 operations for tumors of the lower esophagus and cardia. He made a midline or a left pararectal incision from the seventh costal cartilage to just above the umbilicus and after opening the peritoneum to inspect the viscera continued this incision upward and laterally along the chest wall to the inferior angle of the scapula (Fig 10A). After resecting segments of the seventh and eighth ribs he incised the pleura in the seventh intercostal space. The costal arch in the seventh interspace was cut through and the diaphragm divided to the esophageal hiatus thus converting the abdominal and thoracic cavities into a single operative field.

This operation did not meet with immediate approval but rather was felt to be one of too great magnitude. In condemning the procedures of both Marwedel and Ohsawa Garlock (4, 5) suggested exploration through a small upper left rectus incision for determination of operability. After closure of this wound he preferred to operate through the thorax.

Loucks and Wu reported 6 successful resections of carcinoma of the esophagus via the thoracoabdominal approach in 1947. They began the incision in the lower part of the interscapular region and continued downward and anteriorly along the seventh rib, extending into the hypochondrium to the lateral border of the left rectus muscle (Fig 10C). After resecting the entire length of the seventh rib they entered the pleura and divided the costal margin through the cartilage. With the peritoneal cavity exposed at lower end of the incision a single operative field was made of pleural cavity and upper abdomen.

Brock (1942) made a midline supraumbilical incision with a second obliquely upwards along the sixth intercostal space from the middle of the first (Fig 10B). After dividing the costal margin and separating the diaphragm from the costal attachment, the operative

# REOPERATIVE SURGERY FOR RECURRENT PEPTIC ULCERATIONS

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**T**HIS report is based on 73 subtotal gastrectomies in 71 patients whose previous gastric operations proved unsuccessful

Five patients had their first operation by myself Three of these 5 original operations were subtotal gastrectomies with Finsterer's exclusion operation in which the antral mucosa was left intact These patients developed jejunal ulcers and were operated on again by me The fourth patient had a Billroth I resection for a gastric ulcer She developed symptoms because of severe adhesions The Billroth I operation was dismantled and turned into a typical retrocolic Hofmeister Finsterer procedure In the fifth patient a perforated duodenal ulcer was excised and a Judd pyloroplasty performed The patient underwent a resection later because of the recurrences of the duodenal ulcer Of the 66 patients with gastrectomies who had had their original operations elsewhere 2 were operated upon by me several times subsequent to their first operations elsewhere

The 71 gastrectomized patients had had 107 gastric operations of various types previous to the final gastrectomy

Epigastric pain particularly shifting to the left, following a gastrectomy frequently denotes a jejunal ulcer Hemorrhage or pain in a patient who has had any type of a Billroth II gastrectomy suggests a jejunal ulcer or jejunitis. The symptomatology of recurrent and jejunal ulceration is not necessarily characterized by the pain and food relief syndrome X ray and gastroscopic examination and even abdominal exploration often fail to give positive evidence of the presence of a frank jejunal ulcer unless the gastrojejunal anastomosis is dismantled during the exploration

Epigastric pain nausea and vomiting may also be caused by motor disturbances from severe adhesions or a faulty technique

A brief analysis (Tables I and II) is also made of 300 personally performed primary gastrectomies for benign gastroduodenal ulcerations

TABLE I — ANTECEDENT GASTRIC  
PROCEDURES IN 71 PATIENTS

No of patients	71
No of previous gastric operations	107
Total No of gastric operations	178
No of personally performed secondary radical gastrectomies	73
No of patients originally operated upon elsewhere	66
No of patients originally operated upon by me	5

TABLE II — TYPE OF ANTECEDENT GASTRIC  
PROCEDURES WHICH RESULTED IN FAILURE

	No. Cases
Gastroenterostomy with enteroanastomosis	1
Gastroenterostomy (retrocolic)	30
Von Eiselsberg exclusion operation with gastroenterostomy	4
Finsterer's original exclusion operation (mucosa not ablated) with radical gastrectomy	6
Finsterer's original exclusion operation (mucosa not ablated) with a minimal resection	1
Finsterer's original exclusion operation (mucosa not ablated) with radical gastrectomy and enteroanastomosis	1
Dismantling of gastroenterostomy	1
Conservative retrocolic gastrectomy	1
Billroth I gastrectomy	1
Duodenojejunosotomy	1
Excision of duodenal diverticulum	
Excision of gastric ulcer	6
Excision of chronic and perforated duodenal ulcers and various pyloroplastic procedures	36
Miscellaneous and undetermined procedures, such as gastrotomy closure of perforation with pyloroplasty exploration and postoperative obstruction	11
Jejunostomy	1
Closure of perforated jejunal ulcer	7
Radical retrocolic gastrectomy	0

## THE ETIOLOGY AND PREVENTION OF POSTOPERATIVE JEJUNAL ULCERS

Postoperative jejunal ulcers take place after a gastroenterostomy and also following a Billroth II gastrectomy Only a few primary jejunal ulcers have been reported It is evident

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combined incision procedures were carried out for carcinoma involving the cardia only with no operative mortality. Two of these operations were carried out entirely through the abdomen and in the other 3 the thoracic esophagus was not disturbed. Two of these patients were living at the time of the report 2 and 2½ years after operation respectively.

The most recent report of the thoracoabdominal approach is that of Garlock (6) (1946). His procedure adopted after discussion with Humphreys began with a 3 inch incision along the outer edge of the rectus muscle. After completion of the abdominal exploration the first incision was extended over to and along the line of the eighth interspace (Fig 10D). The intercostal muscles and pleura were divided and the diaphragm cut across as far as the esophageal hiatus. This procedure produced a wound which could be opened as widely as necessary by a rib-spreader

#### COMMENTS

There are several distinct advantages in the use of the combined thoracoabdominal incision. The chief one of these is that it affords a wide and ready access to portions of the abdomen not obtainable when abdominal or thoracic approaches alone were utilized. Unless one has actually used or seen the operative procedure it is difficult to realize the ease with which operations can be performed on organs situated high in the upper quadrants of the abdomen. We have not used it on the right side but it should be extremely useful in an attack on certain lesions of the right lobe of the liver. The performance of the abdominal portion of the incision first permits exploration to determine operability after which the thoracic incision may be added if indicated.

Though the operative approach appears to be one of considerable magnitude and is more time-consuming both in its performance and in its closure. In our experience it is as well tolerated under intratracheal positive pressure anesthesia, as are extensive abdominal incisions. The ease of access afforded with consequent more rapid performance of operative procedures compensates for the additional time required to make and to close the in-

cision. The patients on whom this combined incision has been used have been remarkably comfortable after operation and certainly have not had more pain than those with large abdominal incisions. The intercostal incision without rib resection has been adequate in the way of exposure though there is no good reason why a rib should not be resected or why short segments of the ribs bordering the incision should not be removed if additional exposure is needed. None of our patients has shown instability of the chest wall after division of the eighth costal cartilage which is quite small at its point of division and which can be well approximated by sutures in the perichondrium after the pericostal suture has been tied. No postoperative hernias have been observed though the longest time since operation has been only 8 months.

#### CONCLUSIONS

1. The combined thoracoabdominal approach described has been well tolerated under intratracheal anesthesia with positive pressure.
2. A remarkably good exposure is afforded which permits easy surgical attack on lesions high in the upper quadrants of the abdomen.
3. The postoperative course of the patients thus operated upon has been striking in lack of pain or discomfort and no postoperative hernias have occurred although the follow up period has been only a few months.

#### REFERENCES

1. BIRD, C. E. *Surgery*, 930, 6 7 2-80.
2. B. OCK, R. C. *Brit. J. Surg.* 912, 30 16-50.
3. DOWNEY, J. E. *Am. J. Surg.*, 946, 71 450-460.
4. GARLOCK, J. H. *Surg. Gyn. Obst.* 94 73 244-250.
5. *Ibid.* 942, 74 555-560.
6. *Ibid.*, 946, 83 737-741.
7. GOTTSTEIN, G. *Mitt. Grenzgeb. Med. Chir.* 90 8 5-305.
8. HUMPHREYS, G. H. *Ann. Surg.*, 946, 124 285-300.
9. JAMES, Y. H. H., and GREEN, N. W. *Ann. Surg.* 9 9, 5 67-83.
10. LAUNGLONGUE, Quoted by MARWEDL ( ).
11. MARWEDL, G. *Zbl. Chir.* 903, 30 935-94.
12. MICHIELI, Quoted by MARWEDL ( ).
13. OGDEN, A. and DEBAKEY, M. *J. Thorac. Surg.* 94 40-445.
14. ODAWA, Quoted by Bird ( ).
15. SINGLETON, A. O. *Surg. Gyn. Obst.*, 1940, 70 05 1053.
16. TIKOKI, M. *Beitr. klin. Chir.* 900, 65 314-357.
17. *Idem.* *Munch. med. Woch.* 9 9, 57 896-898.
18. WEDDEL, W. *Arch. klin. Chir.*, 9 93 3 390.
19. WU, Y. K., and LOVICK, H. H. *J. Thorac. Surg.* 94 5 6-328.



Fig. 1. No. B 37555 E. H. About three fourths of the remaining gastric tissue was removed following a previous gastrectomy for a duodenal ulcer. An acutely perforated jejunal ulcer took place within 1 year following the original gastrectomy which was presumed to have been radical.

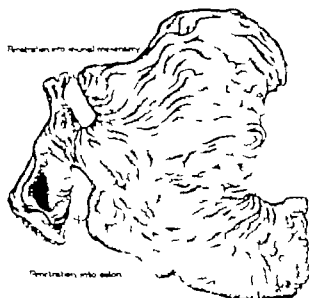


Fig. 2. No. B-641870-E. H. About three fourths of the remaining gastric tissue including a jejunal segment was removed following a previous gastrectomy for a duodenal ulcer. Jejunal ulcerations with repeated hemorrhages took place within 1 year following the first gastrectomy which was presumed to have been radical.

of the stomach. It has been suggested that it is not necessary to resect three fourths or four fifths of the stomach tissue since a certain percentage of jejunal ulcerations will take place irrespective of the amount of stomach resected. There is more than slender evidence to refute this assertion. It has already been mentioned that animals cannot be uniformly protected against jejunal ulcers by minimal resections (18). It was conclusively demonstrated that a subtotal resection of the stomach with a wide stoma performed according to the Billroth II method (Finsterer Hofmeister) has never been followed by a peptic ulcer in our experiments even in the presence of an artificial kink in the jejunum. This we consider of scientific and clinical interest and importance. On the other hand the Billroth I anastomosis end-to-end and the minimal resection of the stomach according to the Billroth II method have given rise to jejunal ulcers (18). Lorenz and Schur pioneers in gastric resection have reported that the reduction in acidity after gastrectomy parallels the amount of gastric tissue removed. Jejunal ulcerations were not infrequent following minimal resections. Some surgeons of experience have abandoned the retrocolic type of resection because of postoperative difficulties or because of possible injury to the middle colic artery if reoperation should become necessary for a jejunal ulcer. Although the antecolic anastomosis is easier to perform and is less time-consuming it is my opinion that the frequency of jejunal ulcerations following the

antecolic minimal resection will either approximate or exceed the frequency of jejunal ulcerations following the posterior gastroenterostomy. In a series of 260 consecutive antecolic conservative gastrectomies Rienhoff reports 83 cases or 32 per cent of patients who developed such complications as pain, hemorrhage or jejunal ulcers. Pain or hemorrhage which follows a gastrectomy most frequently denotes jejunal ulcer or jejunitis. Kiefer reports 6.9 per cent jejunal ulcers and 4.6 per cent hemorrhage in 173 patients who have undergone extensive gastric resections for duodenal ulcer. The percentage of the proved and presumed jejunal ulcers is not as high as in the Rienhoff report because of the more radical type of the resections in the Lahey technique. The 11.5 per cent of unsatisfactory results however is high in comparison to the subtotal standard retrocolic resection. The discrepancy between the results in the subtotal retrocolic resection and the results in the Lahey subtotal antecolic resection is in all probability due to the long proximal jejunal loop which is a predisposing factor to jejunal ulcerations (9). Rienhoff and Kiefer's reports are of significance since the technique of gastrectomy in both instances has been described in detail.

then that it is the new environment at the jejunal segment following the gastrojejunal anastomosis which is responsible for the jejunal ulcerations. Exalto, Mann and Williamson, Ivy and Dragstedt, Steinberg and Proffitt as well as numerous other investigators have succeeded in producing jejunal ulcers with regularity by diverting the alkaline duodenal contents away from a newly created gastrojejunal anastomosis. Though the efforts of these numerous investigators have been important, the surgeons preceded the experimental workers by unwittingly performing operations on patients which were similar to the experimental methods of Exalto and others. The gastroenterostomy, the Y anastomosis of Roux, the enteroanastomosis and the Von Eiselsberg exclusion operation were frequently followed by jejunal ulcerations. Such postoperative ulcerations are more significant than the ulcers produced by the various experiments. Under parallel conditions of research, animal experimentation cannot hope to compete with the importance of careful investigations carried out on patients. The short-circuiting operations of Exalto are mutilating in the manifest physiological changes which they produce (18). In order to mitigate the mutilating short-circuiting operations of Exalto and also of Mann and Williamson, I have sidetracked the alkaline duodenal contents 60 centimeters or less from the pylorus in all the animal experiments previously reported. The introduction of histamine beeswax by Code and Varco for the production of experimental ulcers has now replaced all the unphysiological short-circuiting operations. The grave nutritional and metabolic disturbances which are brought about by animal experiments do not follow the usual surgical procedures used in the treatment of peptic ulcerations.

It becomes apparent that the failures after gastric operations are more important than the animal experiments when it comes to evaluating the conditions under which postoperative ulcers develop. Statistics reporting jejunal ulcerations are of no value unless careful and detailed descriptions of the operative procedures are given. In reporting the disappointments and failures following gastrectomy it is

not a matter of indifference simply to group the resections into Billroth I or Billroth II. From the experimental evidence and from clinical experience certain modifications of the Billroth II procedures are destined to result in a great many more failures than the standard subtotal retrocolic gastric resection popularized by Finsterer. It is quite obvious that if minimal resections, subtotal retrocolic resections or antecolic resections and also exclusion operations or resections combined with the Y anastomosis or enteroanastomosis are all placed in one group, the percentage of failures will be credited to the gastrectomy irrespective of the method used. It is also my impression that the original Billroth II procedure which creates a blind terminal sac will compare unfavorably with the typical Hofmeister-Finsterer method in spite of a radical resection.

The analysis of the failures after gastric operations parallels the lessons learned from the experimental laboratory. Using the modified Exalto short-circuiting operation I was able to demonstrate in a large series of experimental animals that only a subtotal resection is able to protect the animal against jejunal ulcerations. However, if the gastrojejunal stoma is very small, a jejunal ulcer will take place in spite of a major resection. Some few years ago while visiting a gastroenterologist, a patient was presented who had had repeated stomach resections and who still harbored a jejunal ulcer in spite of the fact that only a very small part of the stomach was left. The gastroenterologist was at a loss not only as to the prognosis but also as to the cause of this tragic condition. It was suggested that a Murphy button anastomosis which would result in a very small stoma could well have explained the repeated jejunal ulcerations. The surgical record actually showed a Murphy button had been used in the gastrojejunal anastomosis. Kinks and narrowing of the lumen of the jejunum distal to the gastrojejunal anastomosis should also be avoided. A kink distal to the jejunal anastomosis may produce a stasis in the jejunum and create a favorable condition for the development of a jejunal ulcer (18).

Again it is not a matter of indifference whether one removes a smaller or a larger part

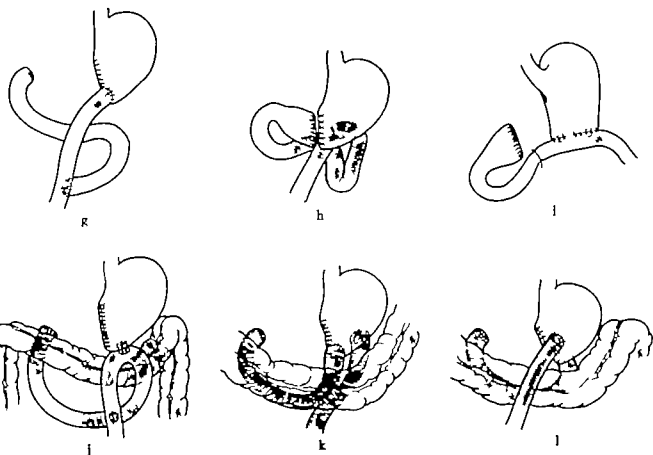


Fig. 3. g, This represents the typical and original distal "Y" anastomosis of Roux. It is most likely to result in a recurrent jejunal ulcer. h, This represents a type of exclusion operation recommended by Von Eiselsberg and Devine. The proximal gastric segment is closed at its distal extremity creating a pouch. This type of an operation will rarely escape a jejunal ulcer. i, This is another type of the Von Eiselsberg or the Devine procedure. A jejunal ulcer is also most likely to take place following this procedure. j, A long loop antecolic anastomosis is a predisposing factor to jejunal ulcerations. An enteroanastomosis diverts the alkaline duodenal secretions away from the gastrojejunal anastomosis. A Murphy button anastomosis creates a small gastrojejunal stoma which will produce a jejunal ulcer in spite of a radical resection. The original Billroth II method with the closure of the cut end of the stomach produces a blind pouch which also creates favorable conditions for a jejunal ulcer. k, There are 5 errors in this operation, any one of which would be sufficient to create favorable conditions for a renewed jejunal ulcer: (1) the gastric remnant is too large; (2) the closure of the distal end of the stomach creates a blind sac; (3) the end-to-side anastomosis creates a small stoma; (4) The enteroanastomosis diverts the alkaline contents from the gastrojejunal anastomosis; (5) the Schmillinsky procedure is most likely to result in a jejunal ulcer and also dyspeptic symptoms from the regurgitation of the duodenal contents into the stomach. l, This is another Schmillinsky procedure which is most likely to bring recurrence of a je-

junal ulcer and also to result in severe dyspeptic symptoms from the regurgitation of bile and pancreatic juice into the stomach. m, The author's proximal "Y" anastomosis with a temporary jejunostomy. Nine such reconstructive procedures resulted in 2 jejunal ulcers. Even if the proximal "Y" anastomosis allows the alkaline duodenal contents to bathe the gastrojejunal anastomosis, its construction requires a longer proximal jejunal loop than in the standard retrocolic method. The proximal "Y" anastomosis is more complicated than the other methods of reconstruction.

9 patients 2 of whom returned with jejunal ulcers. Of the 339 personally performed short afferent loop radical retrocolic gastrectomies not 1 patient returned with a jejunal ulcer.

Wangensteen reported 350 short afferent loop subtotal gastrectomies. Of these only 1 patient developed a jejunal ulcer (Figs 1 and 2).



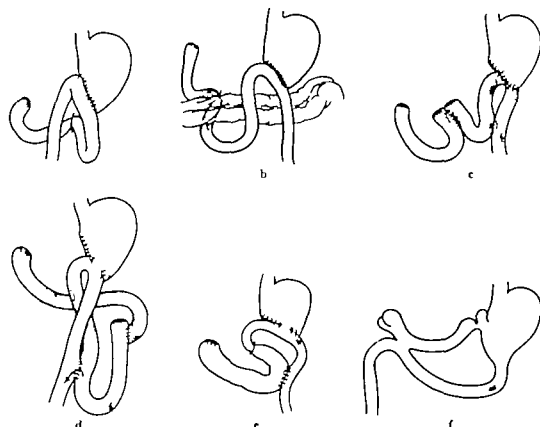


Fig. 5. An analysis of operative procedures which have been used for the cure of jejunal ulcers. a, A split of its correct anatomical relationship, the antecolic resection with a long proximal jejunal loop attached to the greater curvature will have tendency to dump the gastric contents into the proximal jejunal loop. Such an anatomical relationship may cause dyspeptic symptoms and vomiting from the sudden emptying of dilated proximal jejunal loop into the lumen of the gastric remnant. Many surgeons of experience attach the proximal jejunal loop to the greater curvature because such arrangement allows for no rotation of the jejunum on its axis as in the Hofmeister Finsterer technique where the proximal jejunal loop is attached to the lesser curvature angle. b, An antecolic anastomosis with more than one half of the gastric remnant remaining will not prove as successful in preventing jejunal ulcerations as retrocolic subtotal resection. c, A gastric resection with

an enterostomy. An enterostomy placed close to the gastrojejunal opening may not have the evil effects of the total diversion of the alkaline duodenal contents. In order to insure against further jejunal ulcerations, no type of enterostomy is recommended distal to the gastrojejunal anastomosis. d, A gastric resection with long jejunal loop anastomosis and also an enterostomy. e, A duodenojejunal anastomosis will have a tendency to divert the alkaline duodenal contents from the gastrojejunal stoma and, therefore, create favorable conditions for a new jejunal ulcer. f, Another type of a duodenojejunostomy which will also have tendency to divert the alkaline duodenal contents away from the gastrojejunal anastomosis. This type of reconstructive surgery does not satisfy the physiological concepts for successful gastrectomy.

Before I had the opportunity to witness the technique of gastrectomy performed by two European surgeons of high reputation I was puzzled at their published results which were not as favorable as those reported by Finsterer. One of the two above mentioned surgeons used the original typical retrocolic Billroth II method which produced a blind terminal sac the other surgeon used a long loop antecolic anastomosis. Neither of these surgeons, however reported his particular technique. My own

disappointing results with the original Finsterer exclusion operation and with the proximal Y anastomosis are of more importance than carefully controlled animal experimentations. Of the 14 patients who had undergone exclusion operation with a radical gastrectomy performed by me 3 returned with jejunal ulcers. Proximal Y anastomoses, in which the gastrojejunal anastomosis was usually placed about as far from the ligament of Treitz as in the antecolic method were performed in

perforated ulcer and a gastroenterostomy. Death was due to massive atelectasis, edema, and fluid in the pleural cavity. Contributing cause in this case was the injudicious use of saline. Death in this case was preventable.

CASE 47. No 65060 male 38 years old had a gastrectomy for a jejunal ulcer which followed a gastroenterostomy. Death was due to perforation of the transverse suture line in the jejunum and to the injudicious use of too much saline and fluids. Death was preventable.

CASE 48. No 3846 male 48 years old had a gastrectomy for gastric and duodenal ulcer following 3 operations including a gastroenterostomy. Death was due to shock and gangrene of jejunal loop. Death was preventable.

TABLE III.—REOPERATION FOR JEJUNAL ULCERS FOLLOWING 373 PERSONALLY PERFORMED GASTRECTOMIES (371 PATIENTS)

	N. of gastrec- tomies	J. jejunal ulcers	Per cent jejunal ulcers
Primary and secondary gastrectomies with short either removed or left by various methods (exclusion*) No. patients who survived	330		
Primary and secondary subtotal gastrectomies combined with original Finsterer exclusion operation† No. patients who survived	4	3	7
Subtotal gastrectomies with the proximal Y anastomosis‡ No. patients who survived	0		

\*The gastric mucosa was ablated in the distal remaining gastric segment.

†Gastric mucosa was not ablated in remaining distal gastric segment.

‡The proximal jejunal loop was long.

Though a jejunal ulcer may make its appearance many years following any type of gastrojejunal anastomosis, thus far not 1 of the 330 patients with primary and secondary standard short proximal loop retrocolic gastrectomies came to me for reoperation because of a jejunal ulcer. I have learned that 1 of the 330 patients who has had an exclusion operation with the mucosa ablated was reoperated upon elsewhere. It is possible that in this patient a remnant of gastric mucosa has regenerated along the denuded pyloric mucosa. Another patient has advised us that he has left to consult a clinic because of epigastric pain and distress.

TABLE IV.—REVIEW OF 373 PRIMARY AND SECONDARY GASTRECTOMIES (371 PATIENTS)

	N	Mortality	Per cent
Primary gastrectomies including operations for acute massive hemorrhage	300	4	1.3
Secondary gastrectomies	73	3	4.
Primary and secondary gastrectomies which includes every gastrectomy since 1924	373	7	1.8

All 4 deaths in the group of the primary gastrectomies occurred in patients who were admitted to the hospital for acute massive hemorrhages. All 4 patients were operated

upon several days after admission. Only 2 of the 4 patients came to the operating room with the hemorrhage arrested. One of the 2 died 14 days after the operation from a coronary infarction. The other died from an overlooked perforated duodenal ulcer on the posterior wall. If the 2 fatalities which occurred in those patients who were exsanguinated and who came late for the operation with the hemorrhage unarrested were subtracted the corrected mortality would be reduced to 0.8 per cent, or 2 deaths in 308 primary gastrectomies.

TABLE V.—END-RESULTS IN 71 PATIENTS WITH SECONDARY GASTRECTOMIES

(Period of observation from 1 to 20 years)	No.
Patients having had multiple operations	71
Previous gastric operations in 71 patients	107
All gastric operations in 71 patients	178
Died from the operation in hospital	3
Died later	
Cancer of the stomach	1
Cancer of the prostate	1
Jejunocolic fistula following exclusion operation with mucosa not ablated	1
Not returned for observation	6
Returned for observation	59
Performed jejunal ulcer following the proximal Y anastomosis (long proximal anastomotic loop)	1
Hemorrhage following the proximal Y anastomosis (long proximal anastomotic loop)	1
Satisfactory results (no pain or hemorrhage)	57

#### SUMMARY AND CONCLUSIONS

Seventy-one patients with 107 antecedent gastric operations have been subjected to 73 gastrectomies. The most common antecedent gastric operations were gastroenterostomies, pyloroplasties, excision of ulcers, and the various types of atypical gastric resections. Thus far no patient has been operated on for a jejunal ulcer following a radical standard retrocolic resection. Altogether these 71 patients have had 178 gastric operations. Five of the 71 patients with recurrent ulcers were originally operated upon by myself.

An additional 300 patients were subjected to a primary gastrectomy because of a duodenal or gastric ulcer. The 371 patients who have been subjected to a gastrectomy because of a duodenal jejunal or gastric ulcer have had 95 previous gastric operations of various types performed elsewhere.

**Mortality.** The mortality in 71 patients with secondary gastrectomies was 4.1 per cent in 300 primary gastrectomies, 1.3 per cent and in 373 primary and secondary gastrectomies 1.8 per cent. This does not represent a selected group of patients since it includes all the gastrectomies performed for any type of

# OPERATIVE PROCEDURES USED FOR THE CURE OF JEJUNAL ULCERS AND LIKELY TO RESULT IN FAILURE

1 All types of short circuiting operations which divert the alkaline duodenal contents away from the gastrojejunal anastomosis. The outstanding examples of such operations are the original Y anastomosis of Roux and the enteroanastomosis of Braun particularly if the latter is placed some distance from the gastrojejunal anastomosis.

2 Minimal gastrectomy

3 The Schmilinsky operation

4 The various types of the exclusion operation in spite of a radical gastrectomy unless the gastric mucosa is completely ablated. However it is not always possible to know whether the gastric mucosa is completely removed in the Wilmanns modification of the Finsterer exclusion procedure in the presence of induration and edema. A part of the pyloric mucosa may be inverted into the duodenal lumen and it may later regenerate along the muscular walls of the pyloric remnant. This actually happened in 1 of our patients who developed a fistula following this type of exclusion operation. No jejunal ulcer resulted in this instance. In another exclusion procedure with much cartilaginous induration there is reason to believe that not all of the pyloric mucosa was removed. The patient was later operated upon elsewhere presumably for a jejunal ulcer. My modified pyloroplasty closure of the duodenum enables one to remove all of the pyloric mucosa.

5 Gastrectomy with a gastrojejunal anastomosis placed antecolic some distance from the duodenojejunal angle particularly if the resection is minimal.

6 My proximal Y anastomosis.

7 A small gastrojejunal stoma (Murphy button operation) in spite of a major resection.

8 Kinks resulting in jejunal stenosis and stasis proximal or distal to the gastrojejunal anastomosis.

9 The original Billroth II anastomosis which may result in a blind sac distal to the gastrojejunal stoma.

10 Other operations which are likely to prove ineffectual for the cure of jejunal ulcers

(a) dismantling of the gastroenterostomy  
(b) excision of the jejunal ulcer (c) pyloroplasty (d) a new gastroenterostomy and (e) gastroduodenostomy

## ANALYSIS OF POSTOPERATIVE DEATHS

There were 4 postoperative deaths in 300 primary gastrectomies and 3 deaths in 73 secondary gastrectomies. The combined operative mortality in 373 primary and secondary gastrectomies was 1.8 per cent. After reporting 117 primary gastrectomies in 1940 with a mortality of 2.6 per cent there followed another group of 163 primary consecutive gastrectomies with 1 death (mortality 0.6). This death occurred in a patient operated on for acute massive hemorrhage from a duodenal ulcer. This analysis of mortality statistics represents no selected group of cases and includes all of the gastrectomies performed for peptic ulcers since 1924. Not a single gastroenterostomy was performed after 1946.

## CASE REPORTS OF PATIENTS WHO SUCCEDED FOLLOWING A PRIMARY GASTRECTOMY

CASE 42. A male between 40 and 50 years old was operated upon in a small private hospital for a large bleeding ulcer on the posterior wall of the duodenum which had perforated into the pancreas. The patient expired on the fifth day following the gastrectomy. No blood was available for transfusion in the hospital. The death could be considered as avoidable.

CASE 43. A 8340, male 69 years old had a primary gastrectomy for a bleeding gastric ulcer. Patient died weeks after the operation from a coronary infarctio. This death was unavoidable.

CASE 44. N 4-8156 male 36 years old had a primary gastrectomy for an acutely bleeding ulcer. He had 7 blood transfusions previous to operation. Death was due to an overlooked perforation of a posterior duodenal ulcer caused by a finger which was introduced into the pylorus during the exploration. It is dangerous to force the finger through a stenosed duodenum since it may penetrate the posterior wall without being recognized. This death is to be considered as avoidable.

CASE 45. N B-60712 female 60 years old had a primary gastrectomy for an acutely bleeding ulcer. This death was due to a fulminating enteritis. It is possible that timely and generous use of plasma and blood might have prevented this fatal ty.

## FATALITIES FOLLOWING SECONDARY GASTRECTOMIES

CASE 46. N B 54227 male 58 years old had a secondary gastrectomy following an operation for a

other was operated upon for a perforated jejunal ulcer. In spite of the fact that this type of a Y anastomosis allows the alkaline duodenal secretions to bathe the gastrojejunal anastomosis, it places the anastomosis some distance from the duodenojejunal angle. It therefore creates the same potential danger for a new jejunal ulcer as does the antecolic anastomosis. The proximal Y anastomosis with a temporary jejunostomy is also more difficult and time-consuming. It may however find an occasional indication.

*Results of radical gastric resection in patients with recurrent peptic ulcerations who were subjected to 107 antecedent gastric procedures of various types which resulted in failure.* Three patients died in the hospital, 2 died later from carcinoma, 1 died from a jejunocolic fistula following the Finsterer exclusion operation in which the gastric mucosa was not ablated. Two patients developed jejunal ulcers following my reconstructive gastrectomy with a proximal Y anastomosis. Six patients did not return for the follow up study. Fifty seven patients who have been operated upon for recurrent peptic ulcers and who were observed from 1 to 20 years have thus far, remained free from any symptoms such as epigastric pain or hemorrhage suggestive of jejunal ulcerations.

*Prevention of jejunal ulcer.* Of the 339 patients upon whom I performed primary and secondary radical gastrectomies of the standard retrocolic type and who were observed from 1 to 24 years, not 1 has returned for reoperation because of a jejunal ulcer. The jejunal ulcers were found following the gastroenterostomy, the exclusion operation, the minimal gastrectomy, the antecolic radical gastrec-

tomy, the short-circuiting operations such as the enteroanastomosis, the gastrectomy with a small stoma, and also the proximal Y anastomosis gastrectomy. The standard radical proximal short loop retrocolic terminolateral gastrectomy with a sufficiently wide stoma gives maximum protection against the dreaded jejunal ulcer. The ulcer diathesis has not been found to be a factor in the recurring jejunal ulcer. Every jejunal ulcer and its recurrence were found to follow the inadequate type of operation.

## REFERENCES

1. BABKIN, B. P. *Secretory Mechanisms of the Digestive Glands*. P. 409ff. New York: Paul B. Hoeber Inc. 1944.
2. CODE, C. F. and VARCO, R. L. *Proc. Soc. Exp. Biol. N. Y.*, 1940, 44: 475-477.
3. EBELING, W. W. *Ann. Surg.* 1933, 47: 857-874.
4. EXALTO, J. *Mitt. Grenzgeb. Med. Chir.* 1911, 23: 13-41.
5. FINSTERER, H. *Zbl. Chir.* 1918, 45: 434.
6. HEUER, G. J. *Treatment of Peptic Ulcer*. Philadelphia: J. B. Lippincott Co. 1944.
7. KIRPER, E. D. *J. Am. M. Ass.*, 1942, 120: 814-824.
8. LAHEY, F. H. and MARSHALL, S. F. *Surg. Gyn. Obst.* 1943, 76: 641-648.
9. LANNIN, B. G. *Surgery* 1945, 17: 712-741.
10. LORING, H. and SCHUR, H. *Arch. Klin. Chir.* 1922, 119: 239-276.
11. RICHGOTT, W. P. JR. *Ann. Surg.* 1945, 121: 583-599.
12. SCHUR, H. and PLASCHKE, S. *Mitt. Grenzgeb. Med. Chir.* 1915, 28: 795-815.
13. STEINBERG, M. E. *Surg. Gyn. Obst.* 1936, 63: 625-631.
14. *Idem.* *Am. J. Surg.* 1934, 23: 137-147, 183.
15. *Idem.* *West. J. Surg.* 1941, 49: 301-303.
16. *Idem.* *Surg. Gyn. Obst.* 1940, 71: 317-333.
17. STEINBERG, M. E., BROUGHTON, J. D., and VINGOFF, I. J. *Arch. Surg.* 1927, 15: 749-761.
18. STEINBERG, M. E. and PROFFITT, J. C. *Arch. Surg.* 1932, 25: 819-849.
19. STEINBERG, M. E. and STARR, P. H. *Arch. Surg.* 1934, 29: 895-906.
20. WANGENSTEEN, O. H. *Minnesota M.* 1945, 28: 66.
21. WILMANN, R. *Zbl. Chir.* 1926, 53: 1874-1875.

simple or complicated case since 1924. The last gastroenterostomy was performed in 1926.

Since at least 5 of the 7 deaths were avoidable, the risk of the gastrectomy operation cannot be considered as contingent upon some insurmountable or unpredictable condition but rather on the lack of supreme diligence in the technical execution of the operation or in the preoperative and postoperative care. No patient succumbed to the operation because of the many hours spent on the operating table. With the advent of contemporary supportive treatment during the anesthesia the additional time which the patient spends in the operating room should no longer disturb a considered planning and a considered execution of the operation.

**Morbidity.** There was not a single serious postoperative hemorrhage. The contents in the drainage bottle are frequently blood stained in the first 24 hours. The double ligation of most of the mesenteric blood vessels and the introduction of hemostatic sutures along the gastrojejunal anastomosis prevents any serious postoperative bleeding.

There were 2 patients with postoperative gastric retention who were operated on. There is reason to believe that these 2 patients would have recovered without additional surgery. There were 2 other patients with gastric retention who recovered without further surgery.

**Postgastrectomy symptoms and disabilities.** Following the gastrectomy operation the greatest majority of the patients display no serious or disabling symptoms. Such complaints as intolerance to certain foods, the feeling of fullness, perspiration and rapid pulse following the ingestion of a meal, disappear or become less annoying at various periods after the operation. Fatigue, irritability and nervousness are not as common as the postprandial symptoms but these may persist for a longer period. Most of these symptoms also vanish in time. The failure to gain weight is most persistent in a good number of these patients. The postgastrectomy syndrome though at times annoying in a few patients has thus far incapacitated only 1 because of frequent spells of syncope. Thus far no patient has been hospitalized because of the postgastrectomy syndrome.

**The exclusion operation.** The exclusion operation of Finsterer in which the pyloric mucosa was removed according to the method of Wilmanns resulted in sinus or fistula formation in 7 instances. Of the 14 personally performed radical gastrectomies for duodenal ulcer in which the original Finsterer exclusion operation was employed and the mucosa was not removed 3 patients developed jejunal ulcers. Of the 10 patients with gastrectomies who were originally operated upon elsewhere and who were later reoperated upon by me because of jejunal ulcers, in 8 the original operation represented some type of the exclusion procedure in which the pyloric mucosa was not removed. Even the Wilmanns type of the Finsterer exclusion operation in which the gastric mucosa is removed cannot always be considered as the ideal procedure. In the presence of edema and induration it is not always possible to determine whether all of the gastric mucosa is removed. A remnant of the gastric mucosa may regenerate along the denuded gastric musculature and bring about the same condition for the development of a jejunal ulcer as after the original exclusion operation. The modification of my original pyloroplastic closure of the duodenum prevents such complications.

It first seemed incredible to indict a small fragment of the remaining pyloric mucosa as the sole cause of jejunal ulcerations. The frequency of jejunal ulcers which follow all sorts of exclusion operations (Von Eiselsberg, Devine and Finsterer methods) condemns this procedure and unless it is combined with a major retrocolic short proximal loop gastrectomy it is not necessary to remove the duodenal ulcer but it is important to be certain that no gastric mucosa is left in the excluded part of the musculature.

**Proximal Y anastomosis with temporary jejunostomy.** There have been 11 patients who were subjected to secondary gastrectomies by this method. One patient died, another was found to have a gastric carcinoma. Of the 9 remaining patients with jejunal ulcerations who were subjected to the proximal Y anastomosis with a temporary jejunostomy 1 patient had had a gastric hemorrhage about 2 years following the operation and an-

tics to control generalized infections. Properly placed incisions will lessen the frequency of chondritis following operations for the drainage of intrathoracic or upper abdominal suppuration. When an empyema or pulmonary abscess requires drainage it is advisable to resect a portion of rib rather than a cartilage, if such a procedure will provide an adequate approach. When the suppurative area lies beneath the cartilage thus requiring its resection several points should be borne in mind. If one of the upper five cartilages is to be resected the entire cartilage should be removed. For drainage of a suppurative lesion in the middle lobe resection of the fourth or fifth costal cartilage is usually sufficient. The costal arch therefore may be left intact. It is rarely necessary to resect a cartilage below the fifth for intrathoracic drainage anteriorly. Cartilage is often needlessly exposed because the surgeon does not determine the site of the costochondral junction before the rib segment is cut anteriorly. Pricking through the perichondrium with a needle or the point of a clean knife will readily and accurately show where the softer cartilage begins.

If a costal cartilage is partly resected in an infected wound and complete removal of the remainder of that cartilage is considered undesirable the denuded part of the cartilage should be covered by perichondrium. A simple method to accomplish this is to resect the cartilage subperichondrially for about 1 centimeter back of the line of division of the perichondrium. A curette may be used to break off pieces of the cartilage within the perichondrial envelope. The redundant perichondrium is then sutured over the exposed cut surface of the cartilage so as to cover it completely. If other tissue such as muscle is available it may also be employed to cover the cartilage. When incisions are made in the upper abdomen care should be taken that the perichondrium of the lower margin of the costal arch is not exposed if a suppurative focus is being drained. If cartilage is inadvertently denuded it should be well covered with soft tissues preferably muscles and no drainage material should come in contact with it.

Infections of the costal cartilages are likely to become chronic unless certain fundamental

principles of surgical therapy are appreciated. Although chemotherapy plays an important rôle in the treatment of chondritis the problem is predominantly surgical. The surgeon must realize that procedures adequate for the treatment of localized infection in bone do not suffice for the treatment of chondritis. If only the involved portion of the cartilage and diseased soft tissue is removed, persistent sinus formation may occur. The surgical treatment of chondritis is subperichondrial resection of the entire involved cartilage. This principle was clearly demonstrated by Moschowitz. The resection should extend from the bony rib to the bony sternum and not even a small bit of cartilage should be allowed to remain. Whereas this surgical procedure can be readily applied to the cartilages from the first to the fifth inclusive the situation is far more complicated when the chondritis affects the seventh, eighth, ninth or tenth cartilages. Since these four costal cartilages articulate with each it is not possible to remove one of these cartilages without exposing a portion of denuded cartilage adjacent to it. For this reason radical treatment of chondritis of the seventh to the tenth cartilages involves complete resection of the costal arch with removal of all four cartilages from the rib to the medial termination. Resection of the sixth cartilage may also be necessary because of fusion with the seventh. Whereas this radical procedure is more certain of producing complete and permanent healing than a more localized cartilaginous resection recent personal experience suggests that healing may occur if a flap of viable tissue is sutured over that portion of the adjacent cartilage which is bared of perichondrium and local penicillin therapy is employed. The less radical operation certainly justifies a trial especially in cases in which the patient is in poor general condition or is on the verge of cardiac or respiratory insufficiency. Resection of the costal arch results in considerable abnormal mobility of the thoracic cage temporarily and therefore may be a serious intervention for a patient who has marked pulmonary emphysema or a serious cardiac lesion. In cartilaginous resections for infection care should be taken to avoid injury to the underlying pleura.

# INFECTIONS OF THE COSTAL CARTILAGES AND STERNUM

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**I**NFECTIONS of the costal cartilages and sternum present special problems in surgical treatment. Although the advent of chemotherapy has lessened the frequency and severity of suppuration of the chest wall, costal chondritis and sternal osteomyelitis still not infrequently require operative intervention. If the special problems concerned with the surgical management of infections of the costal cartilages and sternum are not properly understood, the results are often unsatisfactory and complete healing fails to occur. The present communication is concerned therefore with an analysis of the subject on the basis of personal experience and a review of the literature. A few illustrative cases are presented in detail.

## INFECTION OF THE COSTAL CARTILAGES

The special problems associated with infection of the costal cartilages are due to certain characteristics of hyaline cartilage as well as to the anatomic arrangement of these cartilages forming the anterior thoracic wall. Hyaline cartilage does not contain any blood vessels or nerves and derives its nutrition from the lymph. Because of its avascularity, this tissue is very vulnerable to infection. When denuded of its perichondrium and left exposed in an infected wound, cartilage acts much like a foreign body. When only a portion of a cartilage is resected, the cut surface of the remaining segment is not covered by perichondrium. Similarly, removal of only one of two or more fused cartilages will leave an area denuded of perichondrium at the site of fusion. Whenever a piece of cartilage, any part of which is denuded of perichondrium, projects into an infected wound, a persistent sinus may occur. Only if infection is minimal or the exposed part of the cartilage is covered with viable tissue before the necrosis begins, can sinus formation be avoided. In clean wounds, however, partial resection of cartilages may be done.

The upper seven ribs are connected to the sternum by costal cartilages which are a direct bridge between the anterior end of the bony rib and the sternum. The perichondrium encasing the cartilages is continuous with the periosteum of the rib. Fusion between any of the upper five cartilages is rare. The sixth and seventh cartilages sometimes articulate with each other lateral to the sternum. The eighth, ninth, and tenth cartilages do not reach as far as the sternum, but end in the lower margin of the preceding cartilage. The seventh to the tenth costal cartilages inclusive constitute the costal arch. It is usually possible, therefore, to remove one of the upper five cartilages without denuding the adjacent cartilage of its perichondrium. Exposed cartilage would project into the wound, however, if only one of the seventh, eighth, ninth, or tenth cartilages were removed, since each of these, and sometimes the sixth, has an area of fusion with the adjacent cartilage.

Chondritis due to pyogenic organisms may occur as a result of wounds, as a direct extension from an adjacent infection following operation for drainage of suppurative foci, and as a result of systemic infection. The staphylococcus and streptococcus are the most frequent pyogenic organisms found in costal chondritis. In past years, however, the typhoid and paratyphoid organisms were not infrequent causes of chondritis. Tuberculous involvement of the cartilages is still common, but the process is usually secondary to tuberculosis of adjacent structures, especially the pleura and the mediastinal lymph nodes. Various fungi, particularly actinomyces and blastomyces, may be the cause of chondritis. Extensive wound infection following radical mastectomy may result in costal chondritis and even osteomyelitis of the sternum.

The incidence of chondritis and perichondritis will undoubtedly be considerably diminished by the use of sulfonamides and antibio-

may be secondary to disease originating with in the mediastinum. There is a high incidence of pulmonary complications associated with sternal osteomyelitis.

The treatment of sternal osteomyelitis consists of chemotherapy and resection of the involved portion of the sternum. If the osteomyelitis of the sternum is localized the diseased portion may be readily removed with the rongeur. Care must be taken to avoid injury to the pleura and the underlying mediastinal structures. In some instances the posterior periosteum may be preserved. If the sternal involvement is very extensive and especially if the patient has impaired cardiac or respiratory function, it may be advisable to perform the operation in stages in order to lessen the temporary abnormal mobility of the thoracic cage. In some cases the paradoxical motion of the chest wall is lessened as the result of the inflammation of the soft tissue. In 1 of my cases there was clinical evidence of involvement of the sternoclavicular joints but penicillin therapy resulted in subsidence of the infection without surgical intervention. The possibility of an anterior mediastinal abscess in association with substernal osteomyelitis must be borne in mind. Care should be taken to avoid needless entry into the mediastinal tissues. Because resections of the sternum for osteomyelitis are usually incomplete some bony regeneration occurs and provides stability of the anterior portion of the thorax after the postoperative period.

#### ILLUSTRATIVE CASES

**CASE 1.** A. E. female, aged 64 years had a carcinoma of the right breast complicated by diabetes mellitus and cardiac decompensation. A radical mastectomy was performed under local anesthesia in November 1943. Infection of the operative wound with *Staphylococcus aureus* followed. In January 1944 a portion of the third rib and cartilage was resected and the following month portions of the fourth and fifth ribs and cartilages were resected. It should be noted that only parts of the costal cartilages were removed in each instance. The infection of the chest wall progressed. Sulfonamide therapy and penicillin were given without avail. In March 1944 when the patient first came under my observation at Memorial Hospital there was an extensive suppurating wound in the anterior portion of the chest wall. There was obvious chondritis of several of the costal cartilages on both the right and left side. There was marked tenderness over the entire sternum and over



Fig. 1, left. Infected mastectomy wound with costal chondritis and sternal osteomyelitis.

Fig. 2. Healed wound after multiple operative procedures for bilateral costal chondritis with sternal osteomyelitis.

both sternoclavicular joints. The patient had high fever and was obviously acutely ill. A diagnosis of multiple suppurative chondritis osteomyelitis of the sternum and sternoclavicular arthritis was made (Fig. 1). Because the patient was on the verge of cardiac decompensation it was most important to avoid any respiratory difficulty such as might follow paradoxical motion caused by extensive resection of the chest wall in one stage. Multiple stage operations were therefore undertaken. Systemic and local penicillin therapy was also employed. In the course of 4 operative procedures spaced over a period of several months most of the costal cartilages on the right, the body of the sternum and some of the costal cartilages on the left side were removed. In addition pinch grafts were employed because of the large skin defect. At the first operative procedure the soft tissue abscesses, especially the large abscess overlying the body of the sternum were drained and some of the resected cartilages on the right side were completely excised. At the second stage operation the entire body of the sternum was resected and at the third procedure the right costal arch was resected with removal of the sixth seventh eighth ninth and tenth costal cartilages. Following these procedures the entire area healed with the exception of two persistent sinuses, one near the lower end of the manubrium and the other leading to the fourth left costal cartilage. This costal cartilage was then removed in its entirety and healing of the entire wound finally occurred (Fig. 2). There was good stability of the chest wall without any paradoxical motion on respiration.

If the infected costal cartilages had been radically removed at an early stage of the thoracic wall suppuration it is quite likely that extensive spread of the infection, especially into the body of the sternum and across to the opposite side might have been avoided.



Infections of the costal arch of one side may extend to the opposite side either through involvement of the xyphoid process or as a result of secondary osteomyelitis of the sternum. The xyphoid process is cartilaginous in early life but becomes partly ossified in adults. The risk of involvement of the xyphoid is greater when the structure is chiefly cartilaginous. An example of the drastic complications that may follow infection of the costal arch occurring as a sequela of the drainage of a subphrenic abscess is illustrated in a case reported by Siler. The patient developed chondritis of the left costal arch which required radical operation. The infection spread from the left to the right costal region through the cartilaginous tissue of the xyphoid process. In spite of further surgery the process extended upward so that three more operations were required with the result that eventually all twenty costal cartilages and the entire sternum were resected. It should be noted that the patient had serious respiratory difficulty in the postoperative period following the last procedure.

Following subperichondrial resection of a cartilage osseous tissue may develop and result in the formation of a rigid structure (1). If the perichondrium is sacrificed in the removal of a cartilage a permanently flaccid area in the chest wall will result. Unless care is taken to preserve the perichondrium extensive removal of the cartilaginous structures of the chest wall will result in an undesirable instability of the thoracic cage. The formation of osseous tissue after subperichondrial resection of cartilage is well illustrated in Figure 4. Plastic procedures of varying magnitude may be required to obtain complete healing if there has been much loss of skin due to severe infection.

#### OSTEOMYELITIS OF THE STERNUM

Osteomyelitis of the sternum as a result of septicemia is an uncommon occurrence (4) and constitutes only  $\frac{1}{3}$  of 1 per cent of all forms of osteomyelitis. Considerably more common is involvement of the sternum as the result of direct extension of infection from adjacent areas. Osteomyelitis of the sternum is often secondary to costal chondritis. Because

of the relative infrequency of operative procedures which involve direct exposure of the sternum osteomyelitis is rarely seen as a result of infected wounds of the chest wall except when the infection has extended from adjacent structures, such as the costal cartilages. The incidence of osteomyelitis of the sternum can therefore be drastically reduced by proper early treatment of costal chondritis. The bacteriological findings in sternal osteomyelitis and costal chondritis are similar.

The clinical picture of osteomyelitis of the sternum resembles that of involvement of other bony structures. When the infection is due to pyogenic organisms there are usually systemic signs of infection combined with local tenderness, swelling and perhaps fluctuation. Roentgen examination is usually of little aid in the early diagnosis of sternal osteomyelitis but is occasionally helpful in the more chronic stage of the disease. Lateral and oblique views are most satisfactory for roentgen visualization of the sternum. The absence of changes on the roentgenogram does not exclude an extensive osteomyelitic process. If the involvement of the sternum is due to the tubercle bacillus there may be little pain or tenderness and a cold abscess may be the presenting sign. A tuberculous abscess overlying the sternum does not necessarily indicate involvement of the underlying bone. The tuberculous process may have arisen in the mediastinum and broken through the interspace lateral to the sternum and then extended superficially to the midline. There may be difficulty in distinguishing between chronic osteomyelitis and a tumor of the sternum. When the sternum has been destroyed by a pyogenic or neoplastic process, the pulsation of the underlying great vessels may be transmitted to the skin and closely simulate an aneurysm. Gumbo of the sternum must be considered in the differential diagnosis.

When sternal osteomyelitis occurs as a result of septicemia, the mortality rate is much higher than when the infection has extended from adjacent costal cartilages. Anterior mediastinal abscesses may occur in association with sternal osteomyelitis, due to the infection breaking through the posterior pericostum. Occasionally the sternal involvement

This case is one of osteomyelitis of the sternum as part of a general septicemia. The destruction of the sternum was unusually rapid. The pulsation of the abscess overlying the sternum was so pronounced that some observers thought it might be an aneurysm. The anterior mediastinal abscess and pneumonia which were present in this case are two of the common complications of an osteomyelitis of the sternum and are associated with a high mortality. Death in this case was undoubtedly due to uncontrolled suppurative foci elsewhere. Osteomyelitic involvement of the sternum at the synchondrosis between the manubrium and gladiolus is uncommon.

CASE 3. B. M. male aged 51 years was stabbed in the chest near the junction of the second costal cartilage and the left border of the sternum. When admitted to the thoracic service of Kings County Hospital a week after injury, the patient was dyspneic, cyanotic, and disoriented. The wound discharged a foul pus. There was fluid in the left pleural cavity and within the pericardium. An abscess of the chest wall at the site of the stab wound was incised and drained. The culture from this abscess grew out *Staphylococcus aureus*. Thoracentesis of the left pleural space yielded thick pus containing staphylococci, and the bloody fluid obtained on pericardial tap also yielded hemolytic *Staphylococcus aureus*. The empyema and suppurative pericarditis were treated by aspiration and direct instillation of penicillin into the pleural and pericardial cavities respectively. The patient's condition improved progressively. The empyema and pericarditis cleared without surgical intervention but the original infected stab wound continued to drain. Probing of this wound demonstrated the presence of necrotic bone and therefore operation was undertaken for suppurative osteomyelitis and chondritis. The partly infected second costal cartilage was completely removed and the involved portion of the sternum in the same region was resected with a rongeur. There was no evidence of a mediastinal abscess. Following this procedure the patient made an uneventful recovery and the wound was healed a little over a month later.

This patient had an extensive staphylococcus infection involving two serous cavities which responded to penicillin and sulfonamide therapy. The local wound failed to heal however because of the involvement of bone and cartilage. Following surgical removal of the osteomyelitic portion of the sternum and the entire involved cartilage healing occurred without further incident.

CASE 4. A. K. male, aged 38 years. When the patient was first seen at Bellevue Hospital in Decem-

ber 1940 he gave a history of having had repeated abscesses in the right lower anterior thoracic region for 19 years. Although the abscesses were opened surgically on a few occasions they usually ruptured spontaneously and sinuses persisted for varying periods of time. In December 1940 there was a large fluctuating area overlying the right costal arch with skin necrosis. A large superficial abscess was drained. Lipiodol injection of the sinus tract revealed an abscess cavity extending beneath the costal arch but not communicating with the pleural cavity. In January 1941 a radical resection of the entire costal arch was performed with removal of the sixth through the tenth costal cartilages inclusive from the rib to the sternum. The postoperative course was uneventful but the wound granulated in slowly because of the large skin loss caused by the previously neglected superficial abscess. In December 1941 the patient complained of tenderness and pain in the region of the lower end of the sternum. Roentgenograms suggested osteomyelitis of the lower sternum. Operation was again performed and the lower end of the sternum and some regenerated bone at the site of the previously resected cartilages were removed. A sinus tract was followed inward and a chronic abscess was found overlying the upper portion of the pericardium. Pathological examination of the wall of the abscess showed only chronic inflammation. All pathological material obtained during the various operative procedures showed nonspecific inflammation. Tuberculosis was never demonstrated. The operative wound healed gradually except for one small sinus. About this time the patient had recurrent attacks of cholecystitis. In August, 1942, cholecystectomy was performed for cholecystitis and cholelithiasis. Since that time the patient has had no further symptoms referable to the biliary tract.

The small sinus which persisted in the anterior thoracic region would sometimes close for several weeks and then reopen spontaneously. The patient also had some cough productive of mucopurulent sputum and several attacks of pneumonitis. Lipiodol injected into the sinus entered the tracheobronchial tree and demonstrated the presence of a bronchocutaneous fistula (Fig. 3). Bronchograms showed bronchiectasis of the right middle lobe. Therefore in May 1944, another operation was undertaken. Through a posterolateral incision on the right the pleural cavity was entered. The middle lobe was found to be a dense fibrotic mass. It was firmly adherent to the mediastinum and pericardium at the site of the old mediastinal abscess. The middle lobe communicated with the chest wall sinus. A middle lobe lobectomy was performed. There was marked infiltration of the anterior thoracic wall in the region of the thoracic sinus, and several cubic centimeters of thick yellow, nonodorous pus was present. The operative wound healed by primary union except at the site of drainage. This area did not heal permanently for nearly 4 months. All wounds have remained healed the patient now 2½ years later has no cough or sputum and is in excellent condition.



Fig. 3. (left, Posteroanterior film. b, Lateral film. Lipiodol injected fist sinus at lower right border of sternum has entered the right middle lobe through a previously unsuspected bronchocutaneous fistula. There is bronchiectasis of the right middle lobe. Some Lipiodol has spilled over into the left lung.

Failure to appreciate the importance of complete removal of an infected costal cartilage was at least partly responsible for the serious situation which developed.

**CASE 2.** F. McN., 1 male aged 19 years gave a history of cough and chest pain of 11 days' duration. The onset began with a severe sore throat, fever, dysphagia, and progressive prostration. Substernal pain was noted 5 days later. The cough was produc-



Fig. 4. X-ray film taken years after resection of the costal arch shows bone formation at the site of the previously resected cartilages.

tive of rusty sputum. Sulfonamide therapy had been given without response. On admission to Kings County Hospital the patient was acutely ill, markedly dyspneic, somewhat disoriented and icteric. There were dullness and rales at the bases of both lungs. A soft, fluctuant, raised area was present over the sternum at the junction of the manubrium and gladiolus. The cardiac pulsation was transmitted through the mass. Three days after admission crepitation was evident at the junction of the manubrium and gladiolus. Aspiration of the abscess revealed thin, light brown, nonodorous pus which cultured hemolytic streptococci. On incision and drainage an abscess cavity overlying the lower portion of the manubrium and upper portion of the gladiolus was found. There was complete interruption of the continuity of the sternum at the site of the synchondrosis. A fairly large anterior mediastinal abscess communicated directly with the site of involvement of the sternum. A small amount of the involved manubrium and gladiolus was removed with a rongeur. Although the second costal cartilage on each side projected into the abscess cavity, these two cartilages were not completely removed at this time because of the patient's very poor condition. Following operation the wound drained profusely. The patient showed slight signs of improvement, but the blood culture continued to be positive for hemolytic streptococci in spite of continued penicillin and sulfonamide therapy. The liver was enlarged and tender and the icterus progressed. Two days following operation the patient coughed up a large amount of bright red blood and died very suddenly. It is thought that the bleeding occurred from the rupture of a suppurative intrapulmonary focus because no blood appeared in the operative wound. No autopsy was obtained.

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This patient had an extensive staphylococcus infection involving two serous cavities which responded to penicillin and sulfonamide therapy. The local wound failed to heal however, because of the involvement of bone and cartilage. Following surgical removal of the osteomyelitic portion of the sternum and the entire involved cartilage healing occurred without further incident.

CASE 4 A. K. male, aged 38 years. When the patient was first seen at Bellevue Hospital in Decem-

ber 1940 he gave a history of having had repeated abscesses in the right lower anterior thoracic region for 19 years. Although the abscesses were opened surgically on a few occasions, they usually ruptured spontaneously and sinuses persisted for varying periods of time. In December 1940 there was a large fluctuating area overlying the right costal arch with skin necrosis. A large superficial abscess was drained. Lipiodol injection of the sinus tract revealed an abscess cavity extending beneath the costal arch but not communicating with the pleural cavity. In January 1941 a radical resection of the entire costal arch was performed with removal of the sixth through the tenth costal cartilages inclusive, from the rib to the sternum. The postoperative course was uneventful but the wound granulated in slowly because of the large skin loss caused by the previously neglected superficial abscess. In December 1941 the patient complained of tenderness and pain in the region of the lower end of the sternum. Roentgenograms suggested osteomyelitis of the lower sternum. Operation was again performed and the lower end of the sternum and some regenerated bone at the site of the previously resected cartilages were removed. A sinus tract was followed inward and a chronic abscess was found overlying the upper portion of the pericardium. Pathological examination of the wall of the abscess showed only chronic inflammation. All pathological material obtained during the various operative procedures showed nonspecific inflammation. Tuberculosis was never demonstrated. The operative wound healed gradually except for one small sinus. About this time the patient had recurrent attacks of cholecystitis. In August 1942, cholecystectomy was performed for cholecystitis and cholelithiasis. Since that time [the patient has had no further symptoms referable to the biliary tract.

The small sinus which persisted in the anterior thoracic region would sometimes close for several weeks and then reopen spontaneously. The patient also had some cough productive of mucopurulent sputum and several attacks of pneumonitis. Lipiodol injected into the sinus entered the tracheobronchial tree and demonstrated the presence of a bronchocutaneous fistula (Fig 3). Bronchograms showed bronchiectasis of the right middle lobe. Therefore in May 1944 another operation was undertaken. Through a posterolateral incision on the right the pleural cavity was entered. The middle lobe was found to be a dense fibrotic mass. It was firmly adherent to the mediastinum and pericardium at the site of the old mediastinal abscess. The middle lobe communicated with the chest wall sinus. A middle lobe lobectomy was performed. There was marked infiltration of the anterior thoracic wall in the region of the thoracic sinus and several cubic centimeters of thick yellow nonodorous pus was present. The operative wound healed by primary union, except at the site of drainage. This area did not heal permanently for nearly 4 months. All wounds have remained healed. The patient now 2½ years later has no cough or sputum and is in excellent condition.

This case is an example of infection of the costal cartilages and sternum secondary to chronic disease of the anterior mediastinum. Tuberculous lymphadenitis may have been the underlying factor although the etiology was never proved. There was considerable calcification present in the hilar lymph nodes. The infection of the structures of the chest wall recurred as long as the underlying intrathoracic suppuration remained. The pulmonary involvement with bronchocutaneous fistula further complicated the situation.

#### SUMMARY

1 If any portion of one of the upper five costal cartilages is the seat of a suppurative chondritis, surgical removal of the entire cartilage from rib to sternum is indicated. If no chondritis is present but a portion of the normal costal cartilage has been resected in an infected wound the cut surface of the cartilage should be covered by perichondrium.

2 If any portion of the sixth seventh eighth ninth, or tenth costal cartilages is the seat of suppurative chondritis, the entire involved cartilage or cartilages should be removed and a flap of perichondrium and muscle

sutured over the area or areas of adjacent cartilages denuded of perichondrium. Local penicillin therapy should be employed. Should these conservative measures fail or should the initial involvement of the costal arch be fairly extensive radical removal of the entire arch is indicated.

3 Osteomyelitis of the sternum can usually be avoided by adequate early treatment of the infection in the adjacent costal cartilages. Most infections of the sternum begin in the adjacent structures and extend to the sternum secondarily. If osteomyelitis of the sternum develops only the diseased portion of bone need be removed.

4 If extensive osteomyelitis of the sternum exists, the operative procedure for removal of the diseased bone should usually be done in stages to minimize serious abnormal mobility of the chest wall. The possibility of an anterior mediastinal abscess must be borne in mind.

#### REFERENCES

1. HAAS, S. L. *Surg. Gyn. Obst.*, 914, 19 604.
2. MOSCOWITZ, A. V. *Ann. Surg.*, 1918 68 163.
3. SULLIVAN, V. E. *Surgery* 1942, 3 407.
4. WILENSKY, A. O. and SAMUELS, S. S. *Ann. Surg.* 1926, 83 206.

# THE ESTIMATION OF ACUTE BLOOD LOSS BY THE TILT TEST

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THE fundamental therapeutic problem in hemorrhage other than direct arrest of bleeding is the determination of the amount of blood required to restore circulatory volume to normal.

An acute blood loss exceeding 40 per cent is likely to be fatal (1, 2). Lesser grades of bleeding may be compensated by vasoconstriction, hemodilution and maintenance of cardiac output through tachycardia. Replenishment of proteins and cells follows more slowly (4).

In the absence of acute bleeding, reductions as great as 80 per cent in hemoglobin and 60 per cent in serum proteins may be encountered in ambulatory patients who present few evidences of critical illness. In hemorrhage, therefore, the major hazard is a decrease in circulatory volume which exceeds the limits of compensability. Attendant disturbances in oxygen carrying capacity, blood viscosity and osmotic pressure are not directly responsible for fatalities. A successful outcome depends fundamentally on the maintenance of an adequate blood volume, regardless of etiology, location or surgical remediability of the hemorrhage.

Direct measure of blood loss rarely is possible. The patient's concept of the quantity is unreliable and vomited or defecated blood is diluted with variable amounts of other fluids. Retention within body cavities or tissues may conceal all external evidences of bleeding (7).

The appraisal of hemorrhage by the red count, hemoglobin and hematocrit values is subject to two sources of error. These values are reduced by preexisting anemia, despite negligible acute blood loss and are unaffected by massive hemorrhage until hemodilution has occurred.

Pulse rate and blood pressure also are used as criteria of severity (6). Frequently, however, no individual base line standards are available. Pulse rates are influenced by fear and by antecedent disease, particularly in the heart. Blood pressure levels within normal limits may represent materially reduced values for the hypertensive patient, while relatively low levels have lessened significance in the hypotensive person.

Ideally, it would be desirable to estimate the severity of hemorrhage by direct measurement of the remaining blood volume (7). However, this procedure has not found common use in the three decades which have elapsed since the introduction of dye methods, apparently because it is too time-consuming or technically difficult for routine clinical practice.

Finally, where the presence of obvious shock indicates a hemorrhage of major proportions, the amount of blood to be given still remains the fundamental problem.

The amelioration of frank hemorrhagic shock by the head-down position is a matter of common experience. Less familiar perhaps is the contrary phenomenon that hemorrhage patients who are able to maintain a relatively normal blood pressure while lying flat, often may be thrown into shock on sitting or standing up (8, 11). The frequency with which these effects may be observed suggested the possibility that cardiovascular reactions to change in posture could be related quantitatively to blood loss and diminished circulatory volume. Accordingly, determinations were made under standardized conditions of the normal response to tilting and its modification by old age, cardiovascular disease, and anemia. Subsequently, the tilting reactions which followed controlled acute blood loss of varying amount were compared with those manifested by a series of patients who were admitted because of recent gastrointestinal hemorrhage.

From the Department of Medicine, University of Washington School of Medicine, and the Division of Surgery, King County Hospital.

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#### REFERENCES

1. HAAS, S. L. *Surg. Gyn. Obst.*, 914, 9 604.
2. MOSCOWITZ, A. V. *Ann. Surg.*, 9 8, 68 68.
3. SLICK, V. E. *Surgery* 1942 18 457.
4. WILKINSON, A. O. and SAMUELS, S. S. *Ann. Surg.* 1936, 83 306.

# THE ESTIMATION OF ACUTE BLOOD LOSS BY THE TILT TEST

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The amelioration of frank hemorrhagic shock by the head-down position is a matter of common experience Less familiar perhaps is the contrary phenomenon that hemorrhagic patients who are able to maintain a relatively normal blood pressure while lying flat may be thrown into shock on sitting or standing up (8 11) The frequency with which these effects may be observed suggests the possibility that cardiovascular reactions to change in posture could be related quantitatively to blood loss and diminished circulatory volume. Accordingly determinations were made under standardized conditions of normal response to tilting and its modification by old age cardiovascular disease and anemia Subsequently the tilting test which followed controlled acute hemorrhage of varying amount were compared and manifested by a series of patients recently admitted because of recent gastrointestinal hemorrhage.

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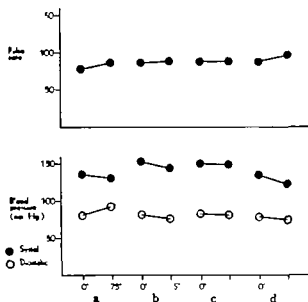


Fig. Responses to tilting in normal subjects and in the presence of old age, cardiovascular disease, and anemia. a Normal group, 25 subjects b, aged group, 3 subjects, average age 80 years, c, cardiac group, subjects d, anemia group, 11 subjects, average hemoglobin 7.8 grams.

#### TILT TEST

The response to tilting was determined as follows. The subject was moved in a supine position to the x ray department of the hospital and placed horizontally on the fluoroscopy table. Pulse rate and blood pressure measurements were made and repeated until constant. Stable readings were obtained within three trials. The table then was tilted to minus 30 degrees, plus 30 degrees and plus 75 degrees and similar measurements carried out. Finally the subject was maintained in a position of plus 75 degrees for 3 minutes and the pulse rate and blood pressure were determined at intervals of 1 minute unless the occurrence of syncope dictated the interruption of the test.

TABLE I—SUPINE PULSE RATES FOLLOWING ACUTE BLOOD LOSS AS COMPARED WITH THE RANGE OF VARIATION IN NONBLEEDING PATIENTS

	Normal	Aged	Cardiac	Anemic	Total non-bleeding	Vasectomy 9-14 g. Hg	Vasectomy 14-18 g. Hg	Vasectomy 18-24 g. Hg	Recent post-operative hemorrhage
No. of subjects	5	3	3	3	56	9	1	3	11
Average rate	76	87	84	87	84	8	85	91	90
S.D.		9	6	3	7	5	22	5	14

\*Standard deviation, corrected for small samples

The responses of practical significance were the ones observed at plus 75 degrees as compared with those at 0 degrees.

*Responses to tilting in normal subjects* The responses of a group of 25 normal subjects varying in age from 18 to 46 years (Fig 1a) are typical of those described in standard texts of physiology (1). Tilting was marked by a small consistent cardiac acceleration slight fall in systolic pressure and a moderate rise in diastolic pressure. No unusual subjective changes were reported.

*Responses to tilting in the aged* Observations were made on a group of 13 individuals with a mean age of 80 years (Fig 1b). The group differed from the normal in displaying a higher mean level of pulse rate and systolic pressure while supine. On tilting changes in pulse rate were not marked. The blood pressures varied moderately averaging a small net systolic and diastolic fall.

*Responses to tilting in the presence of cardiovascular disease* Reactions to tilting were studied in a group of 11 individuals suffering from cardiovascular diseases (Fig 1c). The majority of these patients belonged in the arteriosclerotic or hypertensive classifications and were decompensated in varying degree. The supine levels of pulse and systolic pressure were somewhat above normal. On tilting all circulatory changes were small and inconstant.

*Responses to tilting in the presence of chronic anemia* Tilting responses were measured in 13 patients presenting anemia as an intercurrent feature of a variety of disease conditions including metastatic carcinoma, nephritis, subacute bacterial endocarditis and meliorrhagia (Fig 1d). The hemoglobin value varied from 5 to 11 grams the average being 7.8 grams.

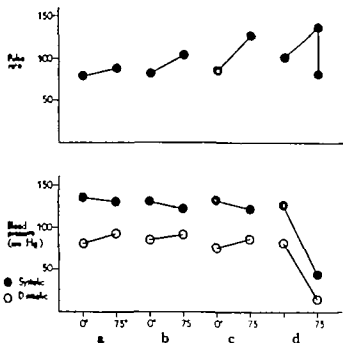


Fig. 2. Dominant responses to tilting in normal subjects before and subsequent to rapid blood loss by venesection. a, Normal, 25 subjects; b, blood loss, 5 to 9 c.c./kg primary reaction, 17 of 19 subjects; c, blood loss, 9 to 14 c.c./kg primary reaction, 9 of 11 subjects; d, blood loss, 14 to 21 c.c./kg secondary reaction, 4 of 5 subjects.

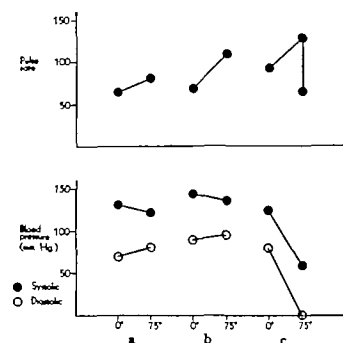


Fig. 3. Progression of tilting response in same subject from primary to secondary type with increasing blood loss. Subject T, weight 73 kilograms. a, Before venesection; b, blood loss, 1000 c.c. primary reaction; c, blood loss, 1500 c.c. secondary reaction.

The increase in pulse rate with tilting was comparable to that noted in normal individuals but the actual rates were higher. A fairly consistent but moderate drop in systolic pressure was observed. Diastolic variations were inconstant, averaging a small net fall. One subject complained of slight dizziness upon being maintained in the plus 75 degrees position. Abnormality of response roughly paralleled the severity of the anemia.

The trend suggests that the stress of tilting is less adequately compensated in the presence of anemia but the observed variations were not statistically significant. This trend may be associated with the decreased peripheral resistance and augmented resting cardiac output observed in anemia, manifestations which can be corrected by transfusion (2).

**Responses to tilting following rapid removal of known quantities of blood.** Tilting responses were measured in three groups of normal individuals before and immediately following rapid removal of blood by venesection. The subjects consisted of blood donors, residents, interns and hospital orderlies who volunteered their services. Five to 9 cubic centimeters per kilogram were withdrawn from the

19 subjects in group I, 9 to 14 cubic centimeters per kilogram from the 11 subjects in group II and 14 to 21 cubic centimeters per kilogram from the 5 subjects in group III, corresponding respectively to 500, 1000 and 1500 cubic centimeters for the average individual. The time which elapsed between start of venesection and completion of posthemorrhagic tilting varied from 30 minutes to 1 hour depending on the quantity of blood withdrawn.

During and following venesection blood pressures were maintained within normal limits and no unusual subjective reactions were reported as long as the patients remained in the supine position. Comparison of pulse rates with those recorded prior to bleeding indicated that cardiac acceleration was not marked, averaging plus 3, plus 7, and plus 17 beats per minute respectively for the three groups. The actual pulse rates failed to show statistically significant differences in range from those observed in nonbleeding groups (Table I).

On tilting two types of reaction were observed. The primary type and the dominant response in which the blood loss did not exceed 14 cubic centimeters per kilogram was char-

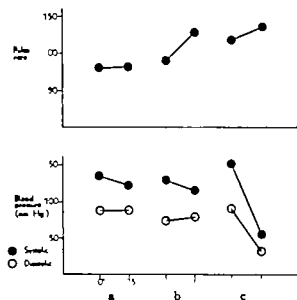


Fig. 4. Reactions to tilting in patients admitted for recent gross gastrointestinal bleeding. Normal response 3 subjects, hematocrit (av.) 37 per cent. b, primary reaction, 5 subjects, hematocrit ( ) 30 per cent. secondary reaction, 6 subjects, hematocrit (a ) 29 per cent.

acterized by a well marked cardiac acceleration without significant variation from the systolic pressure drop and diastolic rise associated with tilting normal subjects. The cardio-acceleration on tilting was proportional to the extent of blood loss and averaged 70 beats per minute in group I 42 per minute in group II (Fig. 2b and 2c). Those individuals who had lost the larger quantities of blood showed somewhat increased respiratory depth and definite pallor.

A secondary type of reaction to tilting was observed in 2 of the 19 subjects in group I 2 of the 11 in group II and 4 of the 5 in group III. In these individuals, maintenance in the plus 75 degree position was accompanied by marked tachycardia, air hunger and faintness, succeeded by a rapidly progressive fall in blood pressure to shock levels slowing of the pulse rate ashen pallor cold sweat unconsciousness and transient muscular twitches (Fig. 2d). This type of response was reversible immediately on lowering the subject to the supine position although slow pulse rates sometimes persisted for periods up to several hours.

The primary type of reaction appears to represent a blood volume deficit which is still compensable under the stress of tilting. The

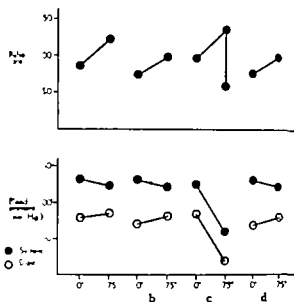


Fig. 5. Tilting responses following acute blood loss (1000 cc) with return to normal on hemodilution. Time interval 1 24 to 72 hours. a, Primary reaction of tachycardia 5 subjects, hematocrit ( ) 46 per cent. b, return to normal following hemodilution, hematocrit (a ) 38 per cent. secondary reaction of syncope 2 subjects, hematocrit (a ) 40 per cent. d, return to normal following hemodilution, hematocrit ( ) 38 per cent.

secondary response occurs when this additional stress causes a break in compensation. The relation is illustrated in Figure 3 which depicts the progression from the primary to secondary response in the same individual on withdrawal of an additional 500 cubic centimeters of blood following an initial venesection of 1000 cubic centimeters.

The mechanism responsible for posthemorrhagic syncope on tilting to the upright position is not entirely clear. However a change from supine to upright posture lowers the cardiac output in normal individuals approximately 25 per cent presumably due to reduced venous return secondary to pooling of blood in the extremities (10). This reduction superimposed on the diminished venous return due to hemorrhage may produce a net fall in intracardiac pressure below the critical level for venous filling with rapidly progressive circulatory failure cerebral anemia and vasovagal syncope as a consequence.

**Hemodilution and tilting responses.** On the assumption that reduced circulatory volume is responsible for the abnormal responses to tilting observed in controlled blood loss, then

TABLE II.—THE MEAN DIFFERENCES (D) IN PULSE RATE AND BLOOD PRESSURE VALUES FOLLOWING TILTING IN BLEEDING AND NONBLEEDING SUBJECTS

Group	Normal	Aged	Cardiac	Anemic	Total non-bleeding	1 connection 5-10 c.c. kg	1 connection 10-14 c.c. kg	1 connection 14-2 c.c. kg
N. of subjects	3	3	1	13	56	171	91	3
d (pulse)	+9	+		+8	+6	+20	+4	+102
S.D.	7	5.5	5.4	8.6	7.8		8.3	8.0
No. of subjects	3	3	1	13	56	7	9	41
d (systolic BP)	-5	-9	-	-3	-6	-9	-	-8
S.D.	8			7	11		3	3
No. of subjects	3	3		13	56	7	9	4
d (diastolic BP)	+	-5	-	-4	+4	+6	+	-66
S.D.	9.3	7.7	7			8	7.1	27

\*Standard deviation, corrected for small samples.

†Two secondary reactors excluded to permit comparison of homogeneous groups. ‡Primary reactors

§Based on pulse rates prior to bradycardia

||One primary reactor excluded to permit comparison of homogeneous group of secondary reactors

replenishment of circulatory volume through compensatory hemodilution should be associated with return of tilting responses to normal.

Accordingly, a study was made of the relation between successive tilt test results and hemodilution in 7 subjects subsequent to withdrawal of 1000 to 1500 cubic centimeters of blood. The reduction in the hematocrit was used as the index of hemodilution (4).

A return to normal tilting responses required from 24 to 72 hours and was associated with a drop in the average hematocrit value from 47 to 38 per cent (Fig. 5). The apparent therapeutic paradox of a patient who improved as the hematocrit fell was seen in each instance.

**Responses to tilting in gastrointestinal hemorrhage.** The tilt test was carried out in a group of 11 individuals admitted because of a history of recent gross gastrointestinal hemorrhage but free of obvious evidences of shock at the time of initial observation.

The responses of 3 individuals were within normal limits and no emergency transfusions were given. All recovered uneventfully. One of the 3 received 500 cubic centimeters of blood prior to discharge to accelerate the treatment of a secondary anemia.

Two patients developed reactions similar to the primary response observed following controlled blood loss. One of the 2, a woman aged 48 years, was given 1500 cubic centimeters of blood. A subsequent gastric resection was performed without incident. The

other, an acutely alcoholic male, aged 32 years, developed delirium tremens shortly after admission. Because of the likelihood that an abnormal tilting response had been produced by the anesthetic and vasodilator actions of the alcohol, blood was withheld and intensive treatment with intravenous fluids, glucose, insulin and vitamins was substituted. Recovery was uneventful.

The remaining 6 patients manifested secondary reactions with reductions in blood pressure to shock levels. They were given an average of 2000 cubic centimeters of blood. Five recovered satisfactorily. The sixth, whose source of hemorrhage was a ruptured esophageal varix, ultimately died of hepatic failure.

# COMMENTS

The standard deviations of the values for the circulatory changes observed in this study (Table II) indicate that significant differences in the responses to tilting were associated only with acute blood loss exceeding 9 cubic centimeters per kilogram.<sup>1</sup>

The actual limits of change in pulse rate and blood pressure under the conditions of the test were found to be somewhat narrower both in normal persons and in those suffering from nonhemorrhagic diseases than the ranges which have been reported when similar classes

<sup>1</sup>True orthostatic hypotension as a rare but possible cause of abnormal tilting responses may be ruled out by history. Abnormal responses are produced also by morphine (3) and general anesthetic agents (3).

of individuals have been made to stand up (9). This difference may be due to the essentially passive nature of the change in position produced by tilting. In contrast the act of standing is complicated by the necessity for complex voluntary motor activity. The expenditure of muscular energy which the act requires may overtax the limited resources of certain patients. Whatever the explanation the data obtained to date suggest that acute blood loss is manifested more specifically by the response to tilting than by the reaction to standing up.

The variation in ability of normal individuals to compensate for blood loss is compatible with the expected scatter in distribution of responses to any physiological stress. However certain circulatory changes on tilting from 0 to 75 degrees were sufficiently characteristic of definite grades of blood loss for their selection as potentially useful standards.

1 The pulse rate increase on tilting individuals in the normal aged, cardiovascular or anemic groups never exceeded 25 beats per minute. It always exceeded this figure following a blood loss of 1000 cubic centimeters. An increment of 30 beats or more was noted in 10 of 11 subjects in this latter group while only 1 of 19 subjects who had lost 500 cubic centimeters manifested a similar rise.

2 The secondary syncope reaction was observed in 4 of 5 individuals who lost an average of 1500 cubic centimeters of blood, while it occurred in but 4 of 30 deprived of 500 to 1000 cubic centimeters and in none in whom acute blood loss had been absent.

3 Within the extremes of the range of blood loss explored the manifestations of shock were noted in no subject prior or subsequent to tilting as long as the supine position was maintained.

#### CONCLUSIONS

From the total of these observations certain tentative guides to therapy seem applicable to the patient who has had a hemorrhage.

1 An increase in cardiac rate less than 25 beats per minute on tilting in the absence of a syncope reaction indicates either a negligible or a compensated acute blood loss. Transfusion is not required as an emergency therapeutic measure although the degree of anemia or possibility of recurrent bleeding may sug-

gest its desirability as a prophylactic means.

2 An increase in cardiac rate on tilting of 30 beats or more per minute over that observed in the supine position suggests a blood volume deficit of 9 to 14 cubic centimeters per kilogram and a probable transfusion requirement of 1000 cubic centimeters.

3 The occurrence of a syncope reaction to tilting suggests a probable blood volume deficit of 14 to 20 cubic centimeters per kilogram and the advisability of a transfusion of 1500 cubic centimeters.

4 The presence of shock in patients maintained in the supine position indicates a probable blood volume deficit in excess of 20 cubic centimeters per kilogram and a need for transfusion of 2000 cubic centimeters or more. This figure agrees with the average quantity found to restore blood volume to normal in studies of hemorrhagic shock by the dye method (7).

5 The hematocrit value bears no direct relationship to the magnitude of recent hemorrhage. A falling hematocrit level indicates only that hemodilution is occurring not the continuation or recurrence of hemorrhage.

Due to the normal variation in response to hemorrhage it is estimated that in 15 per cent of patients the transfusion requirements postulated will exceed the minimum needed to prevent further hemodilution and restore the circulatory volume to normal. This occasional excess is considered to represent a reasonable margin of safety for the majority of cases.

#### REFERENCES

1. BEST, C. H., and TAYLOR, N. C. *Physiological Basis of Medical Practice*, 4th ed. Baltimore: The Williams & Wilkins Co. 1945.
2. BRADSHAW, E. S., McNEILL, A. J., WARREN, J. V. and STEAD, E. A. *J. Clin. Invest.* 1945 24:33.
3. DREW, J. H., DRIFFE, R. D. and CORROTT, J. H., Jr. *Anesthesiology* 1946 7:44.
4. EHRST, R. V., STEAD, E. A., J. and GIBSON, J. C. *Arch. Int. M.* 1946 68:378.
5. GORDON, T. *Acta chir. scand.* 1945 Suppl. 103, 927.
6. GREEN, D. M. *Northwest M.* 1946 45:35.
7. NOBLE, R. P. and GREENBERG, M. L. *J. Clin. Invest.* 1946 25:178.
8. SHEDDEN, H. A., CRITCHER, R. H., GOTTSCHE, S. R., and STARR, J. *Am. J. M. Sc.* 1943, 106:808.
9. STARR, J. *J. Clin. Invest.* 1945 24:33.
10. STEAD, E. A., J., WARREN, J. V., McNEILL, A. J. and BRADSHAW, E. S. *J. Clin. Invest.* 1945 24:325.
11. WARREN, J. V., BRADSHAW, E. S., STEAD, E. A. J. and McNEILL, A. J. *J. Clin. Invest.* 1945 24:337.
12. WOODS, H. C., and INGRAM, R. C. *J. Clin. Invest.* 1946 25:30.

## CIRCULATORY AND RESPIRATORY DISTRESS FROM EXTREME POSITIONS ON THE OPERATING TABLE

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THE proper position of the patient on the operating table in conjunction with well balanced anesthesia should facilitate the surgical procedure and allow only minimal interference with the physiological processes of respiration, circulation and neurogenic control. In many instances however the position requested is so extreme that few normal conscious individuals can voluntarily assume such for as long as 30 minutes. If the anesthesia is not too profound the majority of anesthetized patients will temporarily adjust themselves to these physiologically poor positions by the utilization of compensatory vasomotor and respiratory changes. Many individuals with systemic disease are unable to make adequate adjustments and within a short time manifest signs of distress by either respiratory or cardiovascular changes or a combination of the two. From the standpoint of the proper functioning of these two systems the supine horizontal position is the one best tolerated by the anesthetized patient.

The studies of Case and Stiles on the effects of surgical positions on vital capacity show that reductions of about 15 per cent occurred in lithotomy, Trendelenburg, kidney and jackknife positions (3). If such a decrease in vital capacity occurs in unnarcotized subjects within 3 minutes after being placed in these positions greater changes in the same direction may occur over longer periods of time. Since vital capacity studies presuppose a conscious subject the test is not directly applicable to anesthetized patients. In our own studies of the effects of different positions upon the tidal volumes of anesthetized patients we have noted changes in the residual air volumes which are in keeping with the changes reported by Case and Stiles for vital

capacity. If the patient with a low vital capacity due to systemic disease is placed in a position which further reduces his respiratory volume serious complications may arise.

In normal breathing the thoracic cage enlarges in all directions except posteriorly. With the deeper planes of anesthesia the intertercostal part of respiration tends to be abolished and most of the load of breathing is shifted upon the diaphragm. The excursion of the diaphragm during the expiratory phase is impaired by the loss of abdominal muscle tone. If during such conditions the patient is so placed that he rests upon his lower ribs either in the prone or lateral position respiratory embarrassment will be evidenced by either rapid and shallow breathing or apnea and by secondary circulatory changes. Abnormal shallow breathing has been shown to result in incomplete ventilation which in turn may cause hypoxemia (5). Moreover any factors which cause elevation of the diaphragm such as increased abdominal pressure due to abdominal packs, tight abdominal binders, flat prone or steep Trendelenburg positions predispose to the development of atelectasis during or following the surgical procedure.

Circulatory distress most often begins as the result of venous and capillary stasis in dependent extremities or as the result of the splanchnic pooling of blood. There are four factors which normally aid the venous return in raising the blood against gravity. If any or several of these factors fail the accumulation of blood in the dependent parts is likely to occur.

The first factor of venous return is the impetus given the blood by the contraction of the left ventricle. Myocardial depression may result directly from high concentrations of most any of the anesthetic drugs when used for profound anesthesia. It may also occur as the result of hypoxia accompanying respi-

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Fig. 1 Jackknife position without blocks beneath pelvis.

ratory distress or secondary to low arterial pressure.

A second factor is the support of the vein walls due to the tonus of the abdominal and limb muscles. The intermittent contractions of the skeletal muscle fibers which in conjunction with the valves of the veins, propel the blood in the upward direction is decreased and often abolished by anesthetic drugs.

A third factor is the suction and force-pump action on the great veins produced by normal respiratory movements. This function of breathing is reduced by (a) profound anesthesia (b) interference with intercostal activity due to pressure upon the lateral or ventral surface of the thorax and (c) interference with diaphragmatic excursion as the result of increased intra abdominal pressure.

As a fourth factor the vasopressor and capillary tonus mechanisms control the caliber of the venocapillary vessels of the splanchnic area and prevent the venous blood from becoming pooled in this area at the expense of the effective circulatory volume in other regions. Autonomic response to surgical manipulation or to severe pressure occasioned by the acute angulation of the body in the Jackknife or kidney position may produce stagnation of blood in the splanchnic area. Low oxygen tensions, high carbon dioxide tensions and various anesthetic agents will dilate capillaries and venules with the same result.

As long as the deeply anesthetized patient is in the supine horizontal position the effects of gravity are annulled but at least three of the four compensatory controls are depressed

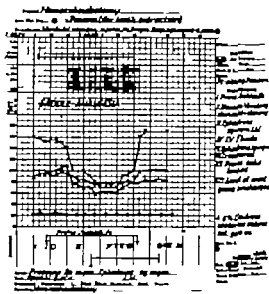


Fig. 2 Circulatory distress from acute Jackknife position. Case No. 2751.

so that changes from the horizontal position may be fraught with serious complications.

Records showing the harmful effects of improper position are not always clear cut because of the complicating factors of hemorrhage, trauma, obstructed airway, anesthetic overdose, procaine reactions, etc. which in themselves cause marked variations in respiration and circulation. Leveling of the table will usually relieve the distress of malposition more effectively than a blood transfusion.

Figure 1 demonstrates the Jackknife position. Here, it is noted that the dependent position of the legs, arms, and head would tend to reduce the venous return to the heart. If to this pull of gravity is added the effects of spinal anesthesia or deep general anesthesia with the accompanying loss of skeletal muscle tonus and sympathetic vasomotor control a venous and capillary stasis would occur. Costal excursion is reduced by pressure on the ventral surface of the thorax. The increased intra abdominal pressure resulting from the ventral compression of the abdomen and the weight of the viscera in the head low position interfere with the respiratory exchange and the pumping action of the diaphragm as an aid in venous return.

The anesthesia record shown as Figure 2 is that of a 58 year old male with a physical

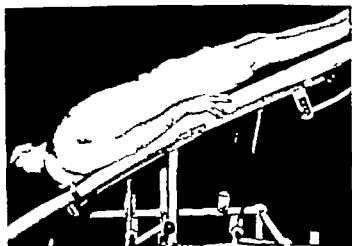


Fig 3. Steep Trendelenburg position.

status of 1. Previous testing had shown the patient not to be hypersensitive to procaine. Eighty milligrams of this drug were injected at the fourth lumbar interspace with the patient in the sitting position so that saddle analgesia for a hemorrhoidectomy would be obtained. Five minutes later the patient was placed in the prone position and 10 minutes later he was flexed to the extreme jackknife. Twenty minutes after assuming the latter position the blood pressure dropped markedly and the skin became cold and clammy. The patient became nauseated and vomited. The level of the analgesia did not rise above 12 dorsal at any time during the course of the operation. The administration of an infusion 25 milligrams of ephedrine intramuscularly and oxygen gave no significant improvement. When the table was raised to the horizontal position there was a prompt return of systolic diastolic and pulse pressures to comparatively normal levels. We have noted similar distress when only local infiltration anesthesia was being used and similar improvement in these cases by leveling the table.

Our recommendations for procedures which are best accomplished with the patient in this position are (a) use small pillows or blocks under the pelvis and upper chest in order to minimize interference with respiratory exchange (b) if general anesthesia is employed avoid the deeper planes (c) flex the table only far enough to allow satisfactory exposure of the operative site.

Steep Trendelenburg position is demonstrated by Figure 3. The diaphragm during

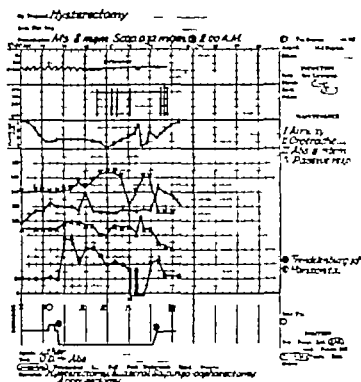


Fig 4. Respiratory distress associated with steep Trendelenburg position. Case No. 2039.

the inspiratory phase must lift the weight of the abdominal contents. Profound anesthesia which is accompanied by partial or complete intercostal paralysis therefore would leave an inhibited diaphragm to carry the load of breathing. The decrease of the functional residual air in the Trendelenburg position suggests that changes in intrapleural pressure occur in this position which tend to make respiration more difficult and impair the return of venous blood to the heart (1). In the head down position the cardiac output per minute and per beat is decreased and the arteriovenous oxygen difference increased over the values obtained with the patient horizontal (4).

It is unlikely that the circulation through the brain is increased in patients in the head down position. Venous and cerebrospinal fluid pressures are increased in the brain thus interfering with the inflow of the arterial blood into the rigid confines of the cranial vault. Animal experimentation has shown that this results in an initial slowing of the circulation followed by a return to normal (2).

Obese individuals do not tolerate steep Trendelenburg positions. In Figure 4 the record shows marked respiratory distress





Fig. 5. Kidney or lateral jackknife position.

beginning immediately after the patient was so placed. The depth of anesthesia was varied during the next hour without relief of symptoms. The distress continued until the table was brought back to the horizontal plane.

Our suggestions for this position would be (a) do not use a 30 degree Trendelenburg position if the procedure can be done adequately with one of only 15 degrees (b) do not use this position to compensate for blood loss (c) if the extreme position is indicated limit its use to that part of the surgical procedure which demands it. The reflex abdominal pos-

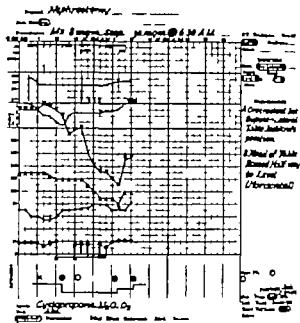


Fig. 6. Circulatory and respiratory distress from kidney position for nephrectomy. Case No. 1745.

ture (6) favors relaxation of the abdominal muscles and may well be chosen for most abdominal operations.

The lateral kidney position is demonstrated in Figure 5. Intercoastal breathing is interfered with on the dependent side by pressure on the thorax and on the upper side by increased tension on the lumbar and intercoastal muscles. Venous return to the heart from all the extremities is retarded by gravity. Trauma due to this position and to surgical manipulation is transmitted to the splanchnic nerves and related plexuses causing an autonomic imbalance. Figure 6 presents the record of an individual aged 50 physical status 3 who did not compensate satisfactorily for the harmful effects of being placed in this position. When head of table was raised toward the horizontal level an immediate rise in systolic, diastolic and pulse pressures occurred and supplementary breathing was no longer necessary.

Figure 7 is the anesthesia record of a 27 year old patient with a physical status of 1. She was placed in the lateral acute kidney position in order to secure maximum exposure for a nephrolithotomy. Her previous respiratory rate during anesthesia of 20 apparently normal breaths per minute changed to

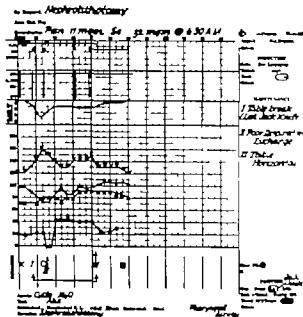


Fig. 7. Respiratory embarrassment, lateral jackknife position for nephrolithotomy. Case No. 57.

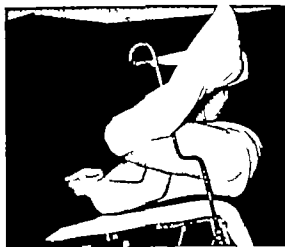


Fig. 8. Extreme lithotomy with thighs flat on abdomen

apnea as soon as the patient was laterally flexed. After 5 minutes of passive respiration spontaneous breathing returned at a rate of 44. Fast shallow respiration persisted for the next 30 minutes until the table was raised to the horizontal position. The respiratory rate slowed to 24 and remained thus with good exchange for the duration of the surgical procedure. It was believed that the distress in this case was primarily due to pressure interference with respiratory movements. Nervous factors due to unusual stress in the splanchnic areas and circulatory embarrassment undoubtedly contributed to the condition.

Our suggestions relative to the lateral jack knife or kidney position are (a) avoid extreme flexion of the patient on the table whenever possible (b) confine the use of braces or kidney rest to the crest of the ilium and do not allow pressure against the ribs on the dependent side, (c) avoid the deeper planes of anesthesia (d) employ supplemental breathing to avoid hypoxia if the exchange is poor

The lithotomy position with extreme flexion of the thighs plus Trendelenburg (Fig 8) is poorly tolerated by the obese patient due to the respiratory impairment resulting from the increased intra abdominal pressure. Figure 9 shows the record of a 239 pound hypertensive female aged 43 when placed in the lithotomy position for a brief gynecological operation. Respiratory distress was marked throughout

When the legs are lowered following the completion of the perineal portion of a perineoabdominal resection of the rectum, circulatory embarrassment may occur due to the

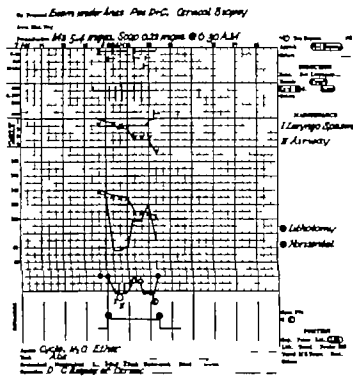


Fig. 9 Cardiovascular and respiratory changes of an obese patient in the lithotomy position. Case No. 688

disparity between the increased functional volume of the vascular bed and the volume of circulating blood. Figure 10 shows a marked drop in blood pressure and pulse pressure occasioned by this change of position.

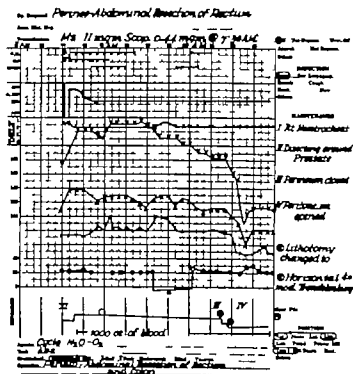


Fig 10 Circulatory distress occasioned by abruptly changing from the lithotomy to the horizontal position  
Case No. 2771



Fig. 9 Gall-bladder position with high elevation of the rest.

The high gall bladder rest used with the cholecystectomy position (Fig. 10) necessitates profound anesthesia in order to relax the tension of the stretched abdominal muscles. In dogs we have noted an interference with the venous return from the kidneys and lower extremities due to partial collapse of the inferior vena cava as it is stretched against the hyperextended vertebral column. A similar condition with patients in the extreme gall bladder position appears to be possible. Figure 12 illustrates a circulatory response to the elevation of the gall bladder rest.

Vigorous retraction on the lower ribs plus the trauma occasioned by the relaxation of the back muscles while the rest acts as a fulcrum against the suspended back probably cause as much discomfort and hesitancy to breathe deeply after the operation as does the pain from the actual site of the surgical procedure.

A folded sheet under the lower ribs plus good abdominal relaxation affords sufficient exposure so that this rest is never needed for upper abdominal surgery in our hospital. Block of the anterior divisions of the lower intercostal nerves facilitates abdominal muscle relaxation and allows the maintenance of light surgical anesthesia with good respiratory exchange. A further advantage of an intercostal block is that patients can breathe deeply in the immediate postoperative period without pain. With the use of the opiates thus reduced respiratory depression and atelectasis are minimized.

The prone horizontal position (Fig. 13) is tolerated satisfactorily by patients of average

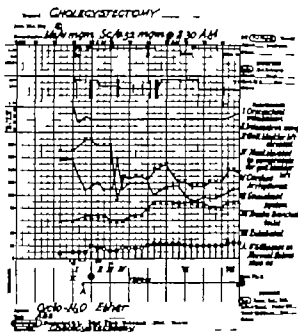


Fig. 12 Cardiovascular changes associated with elevation of gall-bladder rest. Case No. 862.

build however the individual with a protruberant abdomen and poor abdominal muscle tone soon shows signs of distress. If an obese individual lies flat on the table, the intra-abdominal pressure will interfere with diaphragmatic action. If the pelvis is elevated with blocks so that the abdomen with weak muscular support swings free the systemic blood pressure often drops abruptly. In some such instances the pulse and pressure have not been detectable until the blocks have been removed and the patient turned back to the supine position. This circulatory failure occurs most frequently when a deeply anesthetized patient is suddenly turned from the supine to the prone position or when the visceral vessels have poor sympathetic tonus such as accompanies the second stage of thoracolumbar sympathectomy. The effective factor appears to be the pooling of blood in the visceral vessels due to inhibited splanchnic tonus and the uphill drainage from these dependent vessels into the overhanging inferior vena cava.

The record shown in Figure 14 is that of an obese female aged 43 scheduled for the second stage of a bilateral thoracolumbar sympathectomy. The patient was given identical dosages of premedication and avertin for basal



Fig. 13. Flat prone position without the advantages of properly placed blocks.

narcosis as she had received for the first stage procedure which was well tolerated. The induction with cyclopropane was uneventful. The patient was turned to the prone position and a pelvic rest elevated until the abdominal wall swung clear of the table. Within 5 minutes the respiration ceased, the pulse and the blood pressure were not obtainable. The operation was postponed. Two days later the patient was again prepared for the surgical procedure but the premedication was less than on the previous occasions and the avertin was omitted. Cyclopropane was used for the anesthetic and the pelvic elevator was not raised. The course of the operation was uneventful. We have learned to respect the decreased tolerance of the patient in the prone position after the splanchnic nerves have been sectioned or depressed.

The sitting position affords the least interference with costal respiration. An abdominal binder is recommended for patients with visceroprosis or relaxed abdominal musculature as these conditions inhibit the excursion of the diaphragm by permitting the viscera to exert an increased downward pull. Since the breathing then is largely costal, deep surgical anesthesia must be avoided. A further contraindication to the use of profound anesthesia is the tendency of the blood to accumulate in the lower extremities and visceral area. The application of elastic bandages to the feet and legs while the patient is still in the supine position is desirable.

In the sitting position even short periods of anoxia resulting from low arterial pressure may damage the cerebral cortex. For this reason personality changes following neuro-

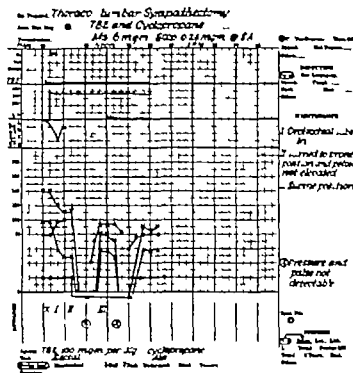


Fig. 14. Vascular collapse and respiratory failure occasioned by a rapid change from the supine to the prone position and high elevation of the pelvic rest. Case No. 2703.

surgical procedures should not always be attributed to the trauma and edema coincident with the operation.

#### SUMMARY

The supine horizontal position is the one best tolerated by the anesthetized patient. Circulatory embarrassment due to the increased effects of gravity upon venous return are directly proportional to the variation from the horizontal plane. Other causes of circulatory embarrassment are (a) loss of muscle tone (b) loss of autonomic tone (c) abnormal intrathoracic pressure (d) respiratory depression (e) abnormal intra abdominal pressure (f) systemic disease. Respiratory embarrassment occurs with depression of nervous control whether central or peripheral and with mechanical interference with respiratory excursion. With extreme positions of Trendelenburg or lithotomy, the increased abdominal pressure upon the diaphragm may markedly inhibit its activity while lateral or prone positions with improperly placed blocks and pressure interfere with intercostal excursions.

Adequate respiratory exchange should be maintained thereby avoiding the muscle tension accompanying hypoxia. If the anesthetist

produces the degree of relaxation afforded by the anesthetic drugs available, he will find that the surgeon will usually co-operate and not demand extreme variations of position from the horizontal for patients with poor reserve. If respiratory and circulatory depression can be forestalled by avoiding the extremes of position more time may safely be used for the surgical procedure. The patient also will benefit by experiencing a less stormy postoperative course.

## REFERENCES

- ALTSCHULE, M. D. and ZAMCHECK, N. *Surg. Gyn. Obst.* 1942, 74, 66-664.
- BERT, C. H. and TAYLOR, N. B. *The Physiological Basis of Medical Practice*. 3d ed., p. 495. Baltimore: Williams & Wilkins, 1930.
3. CARY, E. H., and STILLER, J. A. *Anesthesiology* 9:4, 7, 29-31.
4. DOXAL, J. S., J. GAMBLE, C. J. and SHAW, R. *Am. J. Physiol.* 93:4, 109 666-682.
5. HALDANE, J. S., MERRINS, J. C., and PRIESTLY, J. J. *J. Physiol.* 19, 9, 3 433.
6. MILLER, A. H. *Anesthesiology* 9:0, 241-245.
7. WOLF, H. G. and BLUMHART, H. L. *Arch. New. Psychiat.* 9:0, 21 703.

# THE EFFECT OF MECHANICAL ARTIFICIAL RESPIRATION UPON MAINTENANCE OF THE CIRCULATION

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THE two principal functions of resuscitation are oxygenation of the blood and the circulation of this oxygenated blood to the vital centers. Oxygenation of the blood takes place through pulmonary ventilation. Pulmonary ventilation has long been considered to be the sole requisite of resuscitation and indeed up to the time of circulatory cessation adequate pulmonary ventilation may be all that is necessary for resuscitation to be successful. Once the circulation has stopped however the situation is drastically changed and pulmonary ventilation alone cannot be expected to bring about a successful resuscitation. The oxygenated blood in the lungs is of little or no value unless it can be transported to the vital centers and distributed over the body.

This brings us up to the second function of resuscitation namely the transportation and distribution of the oxygenated blood to the cells of the cardiac and central nervous systems. In past experimental work (2) we gained the clinical impression that the inflation and deflation of the lungs had a very definite effect upon the movement of the blood column in addition to and beyond the effect of the active heart beat.

Not until recently has it been possible to demonstrate whether or not a given resuscitation procedure could produce any actual movement of the blood itself. The purpose of this paper is to describe a method for determining the effect of various resuscitative procedures upon the circulation. Essentially the method consists in the introduction of a tracer substance into the blood stream of an animal immediately following death by asphyxiation and recording any movement of this substance during the application of a resuscitative procedure.

From the thoracic surgical service of the New York Medical College, Flower and Fifth Avenue Hospitals and the Metropolitan Hospital.

The tracers which have been used are radioactive sodium which we have previously reported (3) fluorescein and oxygen. This report concerns the use of oxygen only.

While pulmonary ventilation has received most of the emphasis in the investigative work of modern authors it remained for the Russians to attack this problem of resuscitation from the viewpoint of circulation rather than ventilation. Negovski and his co-workers have demonstrated in dramatic fashion the value of circulatory movement by the intravascular injections of oxygenated blood and glucose under positive pressures. While these authors emphasize the transportation or circulation of oxygenated blood nevertheless they call attention to the absolute necessity of adequate pulmonary ventilation being provided at the same time.

The degree and efficiency of pulmonary ventilation varies in each method of resuscitation. All methods produce ventilation by one of three ways (1) inflation of the lungs and return to the starting point (2) deflation of the lungs and return to the starting point (3) a combination of inflation alternating with deflation of the lungs.

The manual methods are inefficient, inconstant and uncontrollable. The mechanical methods are more efficient and are controlled by a constant volume or pressure. Only those resuscitating apparatuses employing a controlled pressure can be safely used.

The use of oxygen as a tracer substance differs from the intravascular injection of other tracers in that oxygen is not injected but is brought into contact with the blood in the pulmonary capillaries by means of a closed ventilating system. In a condition of anoxia, a stream of oxygen directed into the terminal air sacs of the lung will come into contact with the red blood cells. These cells take up the oxygen and are then transported over the

produces the degree of relaxation afforded by the anesthetic drugs available he will find that the surgeon will usually co-operate and not demand extreme variations of position from the horizontal for patients with poor reserve. If respiratory and circulatory depression can be forestalled by avoiding the extremes of position more time may safely be used for the surgical procedure. The patient also will benefit by experiencing a less stormy postoperative course.

## REFERENCES

- ALTSCHULF, M. D. and ZAMENHECK, N. *Surg. Gyn. Obst.*, 94:2, 74, 106, 1064.
2. BEAT, C. H., and TAYLOR, N. B. *The Physiological Basis of Medical Practice*, 2d ed. p. 495. Baltimore: Williams & Wilkins, 1939.
3. CASE, E. H., and STELLER, J. A. *Anesthesiology* 1946, 7: 29-3.
4. DOYLE, J. S., J. GAMBLE, C. J. and SHAW R. *Am. J. Physiol.*, 1934, 99: 666-682.
5. HALDAN, E. J. S., MCKENZIE, J. C., and PRIDDY, J. J. *J. Physiol.*, 9: 9: 52-433.
6. MILLER, A. H. *Anesthesiology* 1940, 24: 245.
7. WOLF, E. G. and BLUMGART, H. L. *Arch. New. Psychiat* 929, 2: 795.

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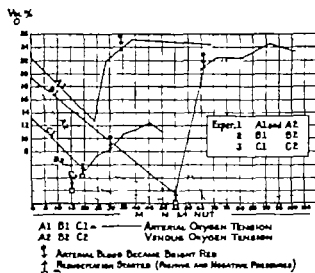


Fig. 1. Alternating positive and negative pressures with 100 per cent oxygen used on 3 dogs. The vertical line shows the blood oxygen tension in volume per cent. The horizontal line indicates the time in minutes.

Experiment 1: The arterial blood oxygen tension has regained its preasphyxia level in approximately 10 minutes after resuscitation was started.

Experiment 2: The arterial blood oxygen tension rose rapidly and has passed its preasphyxia level in 10 minutes after resuscitation was started.

Experiment 3: There was a rapid rise of the arterial blood oxygen tension in the first 10 minutes of resuscitation followed by a more gradual rise. The blood became bright red in 15 minutes.

TABLE I—VENOUS AND ARTERIAL BLOOD OXYGEN TENSION WITH ALTERNATING POSITIVE AND NEGATIVE PRESSURE RESUSCITATOR USING 100 PER CENT OXYGEN

Dog 1			Dog 2		
Time of collection of blood	Volume per cent oxygen		Time of collection of blood	Volume per cent oxygen	
	Venous	Arterial		Venous	Arterial
Prior to asphyxiation	0.07	4	Prior to asphyxiation	7.13	19.42
5 minutes after resuscitation started	64	50	Following asphyxiation	37	21
10 minutes after resuscitation started	8	5	5 minutes after resuscitation started	53	54
5 minutes after resuscitation started	68	70*	10 minutes after resuscitation started	66	60*
10 minutes after resuscitation started	57		15 minutes after resuscitation started	70	73.36
15 minutes after resuscitation started	7	5.02	20 minutes after resuscitation started	7	
20 minutes after resuscitation started	24.30		25 minutes after resuscitation started	75	24.3
			30 minutes after resuscitation started	63	5

A range of experiments 1, 2, and 3

Dog 3			A range of experiments 1, 2, and 3		
Time of collection of blood	Volume per cent oxygen		Time of collection of blood	Volume per cent oxygen	
	Venous	Arterial		Venous	Arterial
Prior to asphyxiation	8.66	12.0	Prior to asphyxiation	36	3.30
5 minutes after resuscitation started	5	2.4	Following asphyxiation	37	53
10 minutes after resuscitation started	7.51		5 minutes after resuscitation started	2.34	20
5 minutes after resuscitation started	66	8	10 minutes after resuscitation started	20.87	
10 minutes after resuscitation started	5	53	15 minutes after resuscitation started	77	5
15 minutes after resuscitation started	66		20 minutes after resuscitation started	2.4	20.70
20 minutes after resuscitation started	20		25 minutes after resuscitation started	67	20.64
25 minutes after resuscitation started	20		30 minutes after resuscitation started	9.1	1.09

\* Arterial blood became bright red.

vascular network of the body by means of the circulatory movement. When circulatory movement no longer exists the stream of oxygen directed into the terminal air sacs cannot now relieve the anoxia for the oxygenated

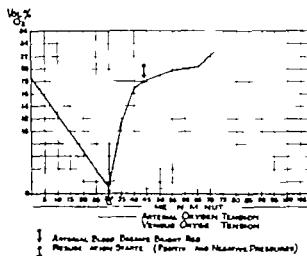


Fig. 2. This is a composite of the 3 experiments in Figure 1. The oxygen tension of the arterial blood rose rapidly in the first 15 minutes of resuscitation continued to rise and 145 minutes was much higher than the preasphyxia level. The arterial blood became bright red in 14 minutes. This charted curve is superior to those shown in Figures 4 and 6 and indicates a more efficient movement (volume and speed) of the blood column by this method.

TABLE II.—VENOUS AND ARTERIAL BLOOD OXYGEN TENSION WITH NEGATIVE PRESSURE RESUSCITATOR USING 60 PER CENT OXYGEN

Dog 4			Dog 5		
Time of collection of blood	Volume per cent oxygen		Time of collection of blood	Volume per cent $\text{O}_2$	
	Venous	Arterial		Venous	Arterial
Prior to asphyxiation		22	Prior to asphyxiation	8.7	20.8
Following asphyxiation	7.5	3	Following asphyxiation	2.63	4
5 minutes after resuscitation started	8.4	15	5 minutes after resuscitation started	1.36	1.05
10 minutes after resuscitation started	0.8	5	10 minutes after resuscitation started	4.4	2.01
15 minutes after resuscitation started	1.00	18	15 minutes after resuscitation started	9.2	.36
20 minutes after resuscitation started	7	1.07	20 minutes after resuscitation started		45*
25 minutes after resuscitation started	8.5	20	25 minutes after resuscitation started	0	20.76
30 minutes after resuscitation started		95	30 minutes after resuscitation started	79	8.67
			60 minutes after resuscitation started		.3

Dog 6			Average of experiments 4, 5 and 6		
Time of collection of blood	Volume per cent oxygen		Time of collection of blood	Volume per cent $\text{O}_2$	
	Venous	Arterial		Venous	Arterial
Prior to asphyxiation	8.33	5.85	Prior to asphyxiation	9.7	0.05
Following asphyxiation	7.4	4	Following asphyxiation	.38	.39
5 minutes after resuscitation started	80	7.3	5 minutes after resuscitation started	.36	7.4
10 minutes after resuscitation started	.01		10 minutes after resuscitation started	.08	.81
15 minutes after resuscitation started	2.4	8.90*	15 minutes after resuscitation started	.05	7.04
20 minutes after resuscitation started	8.5	6	20 minutes after resuscitation started	0.80	4.56
25 minutes after resuscitation started	7.1	6.3	25 minutes after resuscitation started	8.5	4.14
30 minutes after resuscitation started	0.85	8	30 minutes after resuscitation started	4.1	0.0

\*Blood (arterial) became bright red.

cells remain in the pulmonary capillaries where they are of no value

The mechanical inflation and deflation of the lungs produces a regular dilatation and compression of the pulmonary capillaries

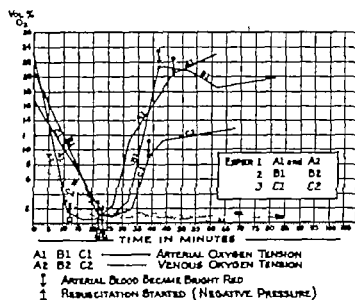


Fig. 3. Negative pressures and release with 60 per cent oxygen was used in 3 experiments.

Experiment 1. The arterial blood oxygen tension was lowered at first and later began to climb. It gained its pre asphyxia level in approximately 30 minutes after resuscitation was started.

Experiment 2. The arterial blood oxygen tension reached its preasphyxia level in approximately 20 minutes after resuscitation was started.

Experiment 3. The arterial blood oxygen tension did not reach its preasphyxia level in 45 minutes, although the blood became bright red in 9 minutes.

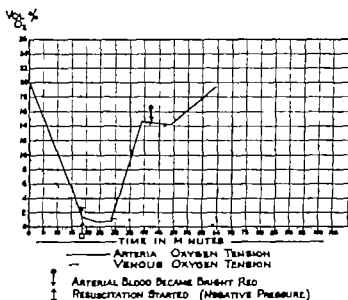


Fig. 4. This is a composite of the 3 experiments in Fig. 3. The arterial blood oxygen tension fell at first and later rose but required approximately 45 minutes to regain the preasphyxia level. This curve is inferior to that of Figure 2 where positive and negative pressures were used.

which results in a movement of the blood contained in these capillaries. Since the valves of the heart and veins prevent a back flow any movement of the circulation must be in one

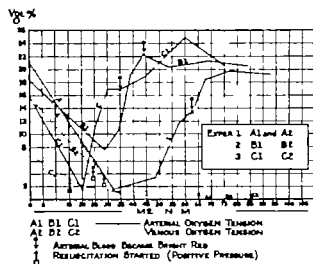


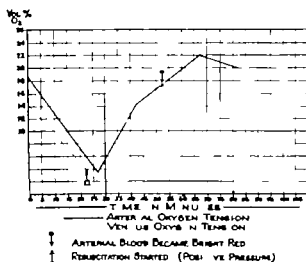
TABLE III.—VENOUS AND ARTERIAL BLOOD OXYGEN TENSION WITH POSITIVE PRESSURE RESUSCITATOR USING 100 PER CENT OXYGEN

Dog 7			Dog 8		
Time of collection of blood	Volume per cent oxygen		Time of collection of blood	Volume per cent oxygen	
	Venous	Arterial		Venous	Arterial
Prior to asphyxiation	21	43	Prior to asphyxiation	18.7	15.4
5 minutes after resuscitation started		57	5 minutes after resuscitation started	2.06	7.6
10 minutes after resuscitation started	66	5.3	10 minutes after resuscitation started	1.4	10.41
30 minutes after resuscitation started	43	63	30 minutes after resuscitation started	4.3	10.18
35 minutes after resuscitation started	40	12.5*	30 minutes after resuscitation started	3.4	11.2*
40 minutes after resuscitation started	44	18.34	30 minutes after resuscitation started	7.3	10.31
50 minutes after resuscitation started	—	58	45 minutes after resuscitation started	8.1	11.44
65 minutes after resuscitation started	—	66	60 minutes after resuscitation started	5	10.1

Dog 9			A range of experiments 7, 8, and 9		
Time of collection of blood	Volume per cent oxygen		Time of collection of blood	Volume per cent oxygen	
	Venous	Arterial		Venous	Arterial
Prior to asphyxiation	6.6	5.7	Prior to asphyxiation	14.13	18.51
5 minutes after resuscitation started	00	3.8	5 minutes after resuscitation started	7.3	5.33
10 minutes after resuscitation started			10 minutes after resuscitation started	8	6.1
15 minutes after resuscitation started	29	6.8	30 minutes after resuscitation started	6.1	6.1
20 minutes after resuscitation started	34	6.76	45 minutes after resuscitation started	6.5	6.6
30 minutes after resuscitation started	76	66	60 minutes after resuscitation started	4.7	10.95
5 minutes after resuscitation started	7	14.8	The arterial blood became bright red in 30 minutes		
60 minutes after resuscitation started	4.1	10.06			

Arterial blood became bright red.

tion of the body may produce a corresponding movement of the blood column ahead of and behind that section where the movement was initiated



direction and if of sufficient magnitude would complete the circuit from the lungs to the left heart to the arteries to veins to right heart and back to lungs again. When the heart is no longer beating the mechanical movement of the blood column (by any means) in any sec-

We have been able to demonstrate that the situation described does take place and that the mechanical inflation and deflation of the lungs does produce a movement of the blood column and in this manner the blood can be circulated over the entire body //

#### TECHNICAL PROCEDURE

All of the experimental procedures were done on dogs. The animal was anesthetized with intraperitoneal nembutal. One femoral artery and one femoral vein was cannulized and the cannula left in site. An endotracheal tube with occlusion cuff was then inserted and the cuff inflated to make a leak proof and closed connection with the lungs. A sample of blood was collected from one of the femoral arteries and femoral veins for determination of its oxygen saturation or tension. The specimens were collected under oil and the oxygen tension was determined by the Van Slyke manometric method. This first specimen was labeled as 'preasphyxia,' and was used for comparison. To prevent the intravascular clotting of the blood which occurs soon after death, 2 to 5 cubic centimeters of heparin was injected intravenously. Five to 10 minutes after the heparin was injected the endotracheal tube was clamped off and the animal was allowed to succumb by obstructive asphyxia. Clinical death took place in about 8 to 10 minutes. In order to insure complete (biological) death with no subsequent cardiac activity the tube remained clamped for an additional 20 to 30 minutes. At the end of this time a second specimen of blood was collected from the femoral artery and vein for analysis of the oxygen tension and this was labeled postasphyxia. The endotracheal tube was now unclamped and connected to a resuscitator. A resuscitative procedure was begun and continued for 45 to 60 minutes. At approximately 5 minute intervals additional specimens of blood were taken from the femoral artery and vein for analysis of the oxygen tension.

This method of frequent analysis of the blood in the femoral vessels made it possible to determine any change in the oxygen tension while the lungs were being mechanically inflated and deflated with oxygen. If this in-

flation and deflation of the lungs produces a forwarding movement of the oxygenated blood cells in the pulmonary capillaries there would be a gradual increase in the oxygen tension of the blood in the femoral vessels since the blood in the pulmonary capillaries is now thoroughly oxygenated. A total of 15 experiments were done. Alternating positive and negative pressures were used in 5 experiments positive pressure and release was used 4 times and negative pressure (suction and release) was used 6 times. From each group 3 typical experiments were charted.

The resuscitators delivered a positive pressure of 14 millimeters of mercury and a negative pressure of minus 9 millimeters of mercury. A separate resuscitator was used for the positive pressure and the negative pressure and the alternating positive and negative pressures. The resuscitators for the alternating pressures and for the positive pressure delivered 100 per cent oxygen. The resuscitator for the negative pressure used a mixture of equal parts of atmospheric air and 100 per cent oxygen. This would make the oxygen content of the gas delivered by the negative pressure resuscitator only 60 per cent. The rate of the inflation and deflation of the lungs was approximately 20 per minute.

#### DISCUSSION

The only place where blood cells can become oxygenated is in the pulmonary capillaries and the only way these oxygenated cells can be transported is through the vascular system. The gradual appearance and increase, after asphyxia of oxygenated cells in the femoral artery constitutes definite proof of the forwarding movement of the blood from the pulmonary capillaries to the femoral artery. As the heart is no longer beating or active this forwarding movement of the blood is produced by the mechanical inflation and deflation of the lungs. Therefore in mechanical artificial respiration we have a method of producing pulmonary ventilation as well as circulation of the blood.

The type of resuscitation seems to make a considerable difference in the pulmonary ventilation and also in the speed of the circulation. A study of the tables and charts shows that

when alternating positive and negative pressures are used the oxygen tension of the blood in the femoral artery regains its preasphyxia level in approximately 17 minutes and the blood as it is withdrawn from the femoral artery changed in color from a dark blue (black) to a bright red color in approximately 14 minutes. This visual color test varies from time to time and is subject to criticism because of its lack of complete accuracy however we believe it does have some value.

When the positive pressure resuscitator was used the oxygen tension of the blood in the femoral artery regained its preasphyxia level in approximately 31 minutes, and the blood was visibly bright red in approximately 25 minutes. Both of these times are considerably longer than when alternating positive and negative pressure resuscitation was used.

When the negative pressure resuscitator was used the oxygen tension of the blood in the femoral artery regained its preasphyxia level in approximately 35 minutes and the blood became visibly bright red in 23 minutes. This also is longer than the results obtained when the alternating pressure resuscitator was used. There is little difference in the comparison of the results obtained by the use of the positive pressure resuscitator and the negative pressure although the latter machine delivered only 60 per cent of oxygen therefore these figures would be subject to an upward revision if 100 per cent oxygen had been delivered. Both are inferior to the alternating pressure resuscitator.

It will be noted that the oxygen tension of the blood in the femoral vein in no instance regained its preasphyxia level and on the contrary the longer the resuscitation the lower the oxygen tension of the venous blood. The only explanation we can offer for this is that the blood column was moving so slowly that in the passage through the tissue capillaries the oxygen was more or less completely removed and utilized by the anoxic tissues.

The movement of the blood column by the mechanical inflation and deflation of the lungs

is in no way comparable to the volume or speed of the normal circulation. However the fact that such movement of the blood can be produced seems to be of definite clinical importance.

In a previous report (3) we called attention to the value of heparin in resuscitation. This prevents clotting and keeps the blood in a fluid state. As a result the blood can be more effectively circulated and this increases the possible survival time. Once the blood is clotted there is no possibility of any further circulatory movement.

#### CONCLUSIONS

We have described a method for determining the effect of mechanical artificial respiration upon the circulation when the heart is no longer beating. This is done by the introduction of tracer substances into the vascular system of animals immediately after death, and observing the movement of these tracers while the lungs are inflated and deflated. The tracer which was used in this series of experiments was oxygen.

By this method we have shown that the mechanical inflation and deflation of the lungs produces an actual movement of the blood column and that the blood can be circulated over the entire body without the benefit of any heart action whatever.

Mention is again made of the value of heparin in resuscitation.

Those mechanical resuscitators employing positive and negative pressures were more efficient in circulating the blood than were those employing only positive pressure and release or negative pressure and release.

#### REFERENCES

1. NEKOVRNI, Y. A. *Vostanovlenie Zhsimoticheskikh funktsii organizma nakhozogochesvoysa v sostoyanii agonii* 55 v periode Klinicheskoi Smerti, Moscow Narzons dra 943.
2. THOMPSON, SAMUEL A., and BURBAUM, G. L. J. *Thorac. Surg.* 1943, 3: 627-637.
3. THOMPSON, S. A., QUINCY, E. H., and SATTIN, BEVERLY C. *Surg. Gyn. Obst.*, 946: 83: 387-391.

# A STUDY OF PROTEIN HYDROLYSATES, OSSEIN GELATIN AND GLUCOSE IN PARENTERAL NUTRITION

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**I**n the belief that the maintenance of nitrogen equilibrium would reduce the period required for convalescence in surgical patients an intensive study of a number of available products for parenteral nutrition was undertaken. The usefulness of parenteral feeding is confined to those patients in whom oral feeding cannot be accomplished safely. Such patients are usually those with lesions of the gastrointestinal tract as peptic ulcer or neoplasm in esophagus, stomach, or intestine.

We were concerned on the one hand with the effectiveness of the various feeding programs in producing a positive nitrogen balance and on the other hand with the various practical difficulties such as thrombosis, pyrexia or nausea which tend to interfere with the success of the method.

Among the objectives of the study were the following: (1) to determine what the nitrogen and caloric requirements for equilibrium would be after major operations; (2) to determine whether they would be substantially different from the amounts required enterally; (3) to determine whether there were any striking differences in the response of patients to the different preparations of hydrolyzed protein tested; (4) to determine the value of ossein gelatin as a constituent of a nutritive mixture for intravenous administration.

Inasmuch as the studies were carried out in patients, there were too many uncontrolled variables to permit the detection of small differences.

## METHODS

The collection of specimens and the analytical methods were the same as those reported

in an earlier paper (6). The intravenous infusions were given continuously when possible and it was seldom that any patient received his infusion less than 22 hours per day. Thus the rate of infusion could be reduced to about 125 cubic centimeters per hour. In every instance the administration was carried out by a closed system and, in general, the infusion was not allowed to run into the same vein for more than 24 hours. The period of study was 5 days beginning within 24 hours after operation unless otherwise indicated.

The preparations used were as follows:

1. Parenamine (15 per cent solution) an acid hydrolysate of casein fortified by the addition of tryptophane.
2. Amigen (5 per cent with 5 per cent glucose) an enzymatic hydrolysate of casein and pork pancreas.
3. A similar hydrolysate from which certain substances had been removed by extraction with acetone sent to us in powder form by Doctor Olaf Rask of Johns Hopkins School of Public Health and made up by us in sterile solution of the desired concentration.
4. Casein aminosol (5 per cent with 5 per cent glucose) enzymatic hydrolysate of casein and pancreas.
5. Fibrin aminosol (5 per cent with 5 per cent glucose) an enzymatic hydrolysate of fibrin.
6. Gelatin Knox P 20 6 per cent.

A volume of one or more of these solutions containing sufficient nitrogen to give the patient 0.3 gram of nitrogen per kilogram daily was used as the starting point for the feeding mixture.

An average figure of several analyses was used to calculate nitrogen content of each of the various preparations.

Sufficient amounts of sterile 50 per cent solution of glucose were added to give a caloric intake of 30 calories per kilogram daily and

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the total daily volume was made up to 3 000 cubic centimeters. The salt content was varied in accordance with the needs of the patient and additional fluid was given when necessary to compensate for abnormal losses.

The gelatin appearing unchanged in the urine during the period of the infusion was determined and included in the total nitrogen loss. Also the gelatin nitrogen occurring in the urine during the 3 days after the infusion ended was added to the total nitrogen excretion for the period of infusion. The excretion of gelatin after this 3 day period was so small that it could not be determined accurately by the method used (5 6)

#### RESULTS

The metabolic data obtained are presented in Table I. A nitrogen balance of  $\pm 1.0$  gram per day was considered as equilibrium, and figures outside of this range were classified as positive or negative as the case might be. The first 22 patients were fresh postoperative cases. The last 4 were nonoperative patients or were studied before operation.

Three patients who received gelatin as the sole source of nitrogen in amounts ranging from 0.25 to 0.29 gram of nitrogen per kilogram per day remained in negative nitrogen balance. Only 1 of them however received a reasonably good caloric intake (28 calories per kilogram per day). It was to be expected that this incomplete protein would fail to produce nitrogen equilibrium. In fact larger negative nitrogen balances had been expected, and the results suggested the possibility of partial utilization during the 5 day trials.

Twelve patients received 4 preparations of hydrolyzed protein. Eight of these received from 0.26 to 0.31 gram of nitrogen per kilogram per day. One was in equilibrium, and 7 were in negative nitrogen balance. One additional patient who received only 0.20 gram of nitrogen per kilogram per day was in equilibrium. In 3 instances the nitrogen intake was increased to 0.54, 0.62 and 0.69 gram of nitrogen per kilogram per day respectively and all were in strongly positive nitrogen balance.

Seven patients received half the nitrogen intake in the form of gelatin and half in the form of hydrolyzed protein. Five of these re-

ceived 0.30 gram of nitrogen per kilogram per day or less, and in this group 3 were negative and 2 were in equilibrium. One of the 3 who was negative had a very deficient caloric intake. The other 2 patients in this group received 0.40 and 0.47 gram of nitrogen per kilogram per day and both were strongly positive although their caloric intakes were low. In view of the fact that gelatin is deficient in certain of the essential amino acids it is surprising that the substitution of this material for one half of the protein hydrolysate was followed by comparable results.

Finally 4 nonoperative patients were studied. Nitrogen intake ranged from 0.30 to 0.49 gram per kilogram per day. All were in positive nitrogen balance in spite of the fact that 2 of them had relatively low caloric intakes.

#### UNTOWARD REACTIONS

Apart from hyperpyrexia two types of reactions were encountered with the intravenous administration of protein hydrolysates, a systemic reaction and phlebitis. The systemic reaction was usually associated with rapid administration of one of the hydrolysates. It consisted of a sensation of flushing over the neck and face accompanied by a sense of constriction about the nose, upper lip and temples. Nausea and vomiting sometimes followed if the infusion was continued at a rapid rate. A number of patients in addition to those having nitrogen balance studies, were tested for the systemic reaction with various hydrolysates. The addition of 1 per cent or more of gelatin protein usually prevented the systemic reaction.

Thrombophlebitis occurred with considerable regularity in the vein employed for the infusion after a number of hours of continuous administration. It sometimes involved tributary veins as well. It was not influenced by the addition of gelatin nor were any of the preparations of hydrolyzed protein free from the tendency to produce it. The use of a plastic tube instead of a needle considerably delayed the onset of thrombosis.

The problem of thrombophlebitis is a serious one because patients who need the benefit of parenteral protein are frequently those who will also need their veins for other infusions.

TABLE I.—METABOLIC DATA

Patient	Infusion	Intake					Output					Balance	
		Total nitrogen	Nitrogen /gm./day	Hydrolyzate nitrogen /gm./day	Gelatin nitrogen /gm./day	Calories /gm./day	Total nitrogen	Urine nitrogen	Gelatin nitrogen	Drainage nitrogen	Feces nitrogen	Total	Daily
		GRAMS	GRAMS	GRAMS	GRAMS		GRAMS	gms	GRAMS	GRAMS	GRAMS	GRAMS	GRAMS
Gelatin													
MI	Knox Pao 6%	04.7	5	—	5	7	136.7	88	37	6.5	5.0*	-43	-8.4
Ma.	Knox Pao 6%	86	8	—	8	28	0	58	44.4	2.4	5.0*	-24.9	-4.0
Ra.	Knox Pao 6%	7.7	20	—	20	8	70.6	33.7	8.8	—	5.0*	-6.9	-3
Hydrolyzed protein													
Ta.	Rask AA	60.3	26	26	—	34	7.1	65.9	—	3	5.0*	-8	-2.3
KL	Rask AA	86.7	0.8	0.28	—	30	08	90.6	—	3.5	5.0*	-4	-4.2
McL.	Amigen 5%	90	30	30	—	0	7.4	5	—	0	5.0*	-27.4	-5.4
De	Amigen 5%	3.8	0.30	0.30	—	30	33.6	24.7	—	3.0	5.0*	-20.8	-5.0
Ja.	Casein aminoacetal 5%	77.0	27	0.27	—	3	80.8	83.8	—	—	5.0*	-40	-2
Al.	Casein aminoacetal 5%	07	30	30	—	36	08	84.4	—	8.7	5.0*	—	-0
Ge.	Fibrin aminoacetal 5%	00.5	3	3	—	33	3	00.3	—	0	5.0*	-7	-3
Wh.	Amigen 5%	64	20	30	—	3	64.9	18	—	8	5.0*	-0.7	-0
Ha.	Amigen 5%	87.0	20	0.30	—	7	3.8	3.5	—	4.3	5.0*	-44.0	-8.0
Pa	Casein aminoacetal	80	60	60	—	40	148.6	43.6	—	—	5.0*	+40.4	+8
Ca.	Fibrin aminoacetal	140.5	6	6	—	38	0	13	—	9	5.0*	+4	+4
McC.	Fibrin aminoacetal	30.5	54	34	—	30	105	98	—	—	5.0*	+5.4	+5
Hydrolyzed protein + gelatin													
Er	Rask AA + Knox Pao	83.7	3	8	0.5	6	144.6	—	3.8	6	5.0*	-60.0	—
MI	Casein aminoacetal + Knox Pao	86	20	14	3	20	98	67.9	0.6	5.1	5.0*	—	-4
Ta.	Fibrin aminoacetal + Knox Pao	7	30	5	5	34	74.6	53.4	3.0	—	5.0*	-6	-0.5
F	Casein aminoacetal + Knox Pao	73.0	30	3	3	34	73.7	20.6	14.4	3.7	5.0*	-0.7	-0
May	Fibrin aminoacetal + Knox Pao	83.3	7	0.14	3	27	3.6	96.1	—	4	5.0*	—	-4.2
Th	Rask AA + Knox Pao	47.3	40	30	30	—	0	8.6	5.3	4.5	7.8	+8.3	+5.6
Ry	Rask AA + Knox Pao	13.0	47	0.1	5	—	0	80	8.0	—	5.0*	+1.8	+3.6
Unoperated													
Mat	Rask AA + Knox Pao	64.6	30	0.24	06	9	47.3	33.8	4	—	7.3	+7.3	+5.4
Ha.	Rask AA + Knox Pao	23	0.40	0.38	0.13	43	73.7	53.6	3.0	—	5.0*	+40.3	+9.8
McK. <sup>aa</sup>	Stomax AA + Knox Pao + Hesp	8	0.45	0.30	5	43	77	7.1	—	—	5.0*	+33.6	+6.7
Po	Amigen 5%	73.3	3	0.01 <sup>aaa</sup>		0	60.4	35.4	—	—	5.0*	+2.8	+2.5

\*Theoretical— gm./day

<sup>aa</sup>This patient received food by mouth in addition to i.v. to this extent.

@Gelatin excretion after infusion stopped not determined.

†Gelatin nitrogen excretion not done, only total nitrogen.

over long periods. The occurrence of thrombophlebitis following infusion with a casein hydrolysate is mentioned in some of the early papers concerned with its intravenous use, but most of the later reports on this subject fail to mention its occurrence. Thrombophlebitis appeared so important in this study that

biopsies were taken of several veins after infusion to observe the character of the reaction.

The extent of the thrombophlebitis seen 3 days after infusion is shown in Figure 1 while Figure 2 illustrates an organizing thrombus 9 days after infusion. These infusions lasted 48 and 17 hours respectively. Many thromboses





Fig. E. Test of thrombophilic test seen 3 days after infusion.



Fig. A. Organizing thrombus present 9 days after infusion.

were seen following infusions of shorter duration. The individual tendency to thrombophlebitis seemed to be a more important factor than the degree of hypertonicity of the solution in determining how soon thrombophlebitis would occur. To cite extreme cases thrombosis occurred with 5 per cent glucose solutions in a few hours in a susceptible individual whereas another individual tolerated a 14 per cent solution of glucose hydrolyzed protein and gelatin for over 4 days without changing the infusion site.

#### DISCUSSION

It appears from these data, as from the data of others that positive nitrogen balance is obtainable by parenteral means alone even in the early postoperative period after extensive abdominal procedures. Comparison of the figures in Tables I and II does not indicate that hydrolyzed protein and glucose introduced by vein are any more efficient in bringing about nitrogen equilibrium than when they are given by mouth. In fact, it seemed to be a little more difficult to achieve equilibrium by the parenteral route with these materials.

It should be noted that not all patients can tolerate the intravenous infusion of 6 per cent gelatin solution in the amounts used here. Gelatin is a macromolecular colloid and increases plasma volume to a marked degree (4). When large amounts are used there is danger of producing pulmonary edema and in patients with poor cardiac reserve even small quantities may be harmful. In patients without circulatory symptoms however no difficulty was encountered in giving 0.15 gram of nitrogen per kilogram per day of gelatin nitrogen (about 1,000 c.c. of 6 per cent solution in 24 hours). The suggestion that gelatin might be utilized in the presence of the constituents of a complete protein was made by Brunschwig (1). The fact that the mixture of gelatin and hydrolyzed protein gave slightly better results than when all of the nitrogen was in the form of the derivatives of the complete protein is more surprising when one considers that about one-third of the gelatin was recovered unchanged in the urine. The amino nitrogen appearing in the urine, as determined in 5 patients with an intake of approximately 0.3 gram of nitrogen per kilogram per day amounted

to only 7 per cent of the total nitrogen given in the 5 day period. This is somewhat greater than the amount of amino nitrogen found in the urine (4 per cent) of patients fed enterally at the same intake level. Elman, Charnas and Davey have reported relatively low figures for amino nitrogen after infusion of hydrolyzed casein in experimental animals.

When the nitrogen intake was increased to 0.40 gram of nitrogen per kilogram per day by the parenteral route, positive nitrogen balance resulted for the 5 day period of study even when the caloric intake was low. This confirms at least for the 5 day period the findings of Elman (3).

The serum protein figures in the patients who received gelatin were low after infusion reflecting the presence of the unnatural macromolecular colloid in the circulation. As the gelatin disappears from the circulation the serum protein concentrations rise toward their former levels (5).

One lot of hydrolyzed protein had a very marked tendency to produce nausea and vomiting in each patient who received it. After the addition of gelatin it was given to many of the same patients without causing this reaction.

With later commercial preparations such reactions were not troublesome, however, nor were pyrogenic reactions frequent. Occasionally after prolonged administration fever still occurs. The susceptibility of these nutrient solutions to contamination is very great. Even the so called closed systems are not entirely safe.

In our experience, however, the most frequent complication of the continuous intravenous infusion of nutrient mixtures in amounts sufficient to meet fully the nitrogen and caloric requirements of the postoperative patient is thrombosis. At present this appears to be the limiting factor preventing the extension of the method to a number of other problems such as that of producing a preoperative weight gain in individuals with pyloric obstruction.

Although some patients develop thrombosis even with isotonic solutions, in general it may be said that the more hypertonic the solution the greater the tendency to thrombosis. From

TABLE II—ENTERAL FEEDING AT LEVELS TO COMPARE WITH PARENTERAL FEEDINGS\*

Patient	Feeding	Intake			Out-pet Total nitrogen	Balance Total nitrogen 5 days
		Total nitrogen	Nitrogen /kgm./day	Calories /kgm./day		
BE	Amigen	grams 78.7	grams 27	26	grams 65.3	grams + 13.4
SC	Gastrostomy	58.5	27	33	61.3	- 2.8
PO	Gastrostomy	64.5	8	3	7.7	- 5.8
DO	Amigen + soup diet	60.5	30	30	66.5	+ 13.3
BR	Amigen + soup diet	82.	30	33	77	+
CL	Amlyre	73	30	23	60.6	+ 12.4
GA	Amigen	60	30	34	8.4	+ 5.6
CH	Lactalbumin hydrolysate	70.5	30	36	34.	+ 6.4
BA	Lactalbumin hydrolysate	68	30	37	9	+ 6.0
TD	Gastrostomy	73.6	34	34	68.8	+ 4.8
BRU	Gastrostomy	160	61	35	14.8	+ 5.

\*From T. H. I. Ref. 6

this standpoint the substitution of large molecular material such as gelatin for part of the small molecular material which constitutes the protein hydrolysates used for intravenous feedings is a step in the right direction.

# SUMMARY AND CONCLUSIONS

Nitrogen balance studies were completed in 26 patients for 5 day periods during which food was provided parenterally by means of continuous intravenous infusions of solutions of glucose and various preparations of hydrolyzed protein. Gelatin produced for intravenous use was added in some instances to replace one half of the hydrolysate and in 3 instances it was used as the sole source of nitrogen.

Protein hydrolysates parenterally were no more efficient in producing nitrogen balance than were the enteral methods previously studied. In fact the results were a little less satisfactory.

When gelatin was infused as the sole source of protein in 3 patients positive nitrogen balance was not obtained. However when approximately one half of the protein hydrolysate was replaced by gelatin the results were slightly better than when all of the nitrogen was provided in the form of the hydrolysate.

Nitrogen intakes as high as 0.69 gram of nitrogen per kilogram per day were success-



Fig 7 Extent of thrombophlebitis seen 3 days after infusion



Fig 8 Organizing thrombus present 9 days after infusion

were seen following infusions of shorter duration. The individual tendency to thrombophlebitis seemed to be a more important factor than the degree of hypertonicity of the solution in determining how soon thrombophlebitis would occur. To cite extreme cases thrombosis occurred with 5 per cent glucose solutions in a few hours in a susceptible individual whereas another individual tolerated a 14 per cent solution of glucose hydrolyzed protein and gelatin for over 4 days without changing the infusion site.

#### DISCUSSION

It appears from these data as from the data of others that positive nitrogen balance is obtainable by parenteral means alone even in the early postoperative period after extensive abdominal procedures. Comparison of the figures in Tables I and II does not indicate that hydrolyzed protein and glucose introduced by vein are any more efficient in bringing about nitrogen equilibrium than when they are given by mouth. In fact it seemed to be a little more difficult to achieve equilibrium by the parenteral route with these materials.

It should be noted that not all patients can tolerate the intravenous infusion of 6 per cent gelatin solution in the amounts used here. Gelatin is a macromolecular colloid and increases plasma volume to a marked degree (4). When large amounts are used there is danger of producing pulmonary edema and in patients with poor cardiac reserve even small quantities may be harmful. In patients without circulatory symptoms however no difficulty was encountered in giving 0.15 gram of nitrogen per kilogram per day of gelatin nitrogen (about 1,000 c.c. of 6 per cent solution in 24 hours). The suggestion that gelatin might be utilized in the presence of the constituents of a complete protein was made by Brunschwig (1). The fact that the mixture of gelatin and hydrolyzed protein gave slightly better results than when all of the nitrogen was in the form of the derivatives of the complete protein is more surprising when one considers that about one third of the gelatin was recovered unchanged in the urine. The amino nitrogen appearing in the urine as determined in 5 patients with an intake of approximately 0.3 gram of nitrogen per kilogram per day amounted

# ASPIRATION BIOPSY OF LYMPH NODES

## A Critical Review of the Results of 300 Aspirations

R. E. MEATHERINGHAM M D and LAUREN V ACKERMAN M D Columbia Missouri

**T**HERE is a wide divergence of opinion regarding the diagnostic value of the aspiration biopsy (the withdrawal of tissue through a needle by suction), these attitudes ranging from absolute rejection to evangelistic overenthusiasm and over application

Although the modern use of aspiration technique dates to 1930 at the time when Martin and Ellis (8) reported a simple method used by them at the Memorial Hospital in New York, only a few actual statistical results have been published. It is our purpose to evaluate the aspiration biopsy of lymph node enlargements as a diagnostic aid.

The material presented by these authors has been compiled from 300 consecutive biopsies of lymph nodes (245 patients May 1942 to October 1945) seen at our hospital, an institution limited to the diagnosis and treatment of neoplastic diseases.

The hollow needle puncture for securing tissue for microscopic examination is not a new procedure. Grieg and Gray in 1904 aspirated material from lymph nodes to study the etiology of trypanosomiasis but apparently not until 1915 was this method used to secure the cellular material occurring in lymphoblastomas (14). Goeller (1920) applied the principle to the use of a special trocar for securing prostatic material. Guthrie in 1921 reported observations on material collected by needle puncture and aspiration of lymph nodes in cases of Hodgkin's disease and Forkner (1927) reported in considerable detail the structure of cells that are found in lymph nodes both normal and pathologic, on both fixed and supravital stained material which was obtained by passing a tiny barbed dental broach through a small gauge needle which was inserted into the node.

From the Department of Pathology The Ellis Fischel State Cancer Hospital.

### PROCEDURE

The technique of securing aspirated material is essentially that described by Martin and Ellis (8, 9).

Materials required for the procedure are (1) glass piston syringe (20 to 50 c.c.) (2) long (10 cm. or longer) aspiration needle (No. 17 to No. 15) with obturator (3) Bard Parker bistoury (No. 11 stab) blade (4) novocain 1 per cent and 2 cubic centimeter syringe with No. 25 hypo needle (5) surgical lubricant (6) skin disinfectant (7) filter paper fixative. The area to be aspirated is located and the overlying or adjacent skin infiltrated with novocain solution. The node is held steady by the disengaged hand until the procedure is completed. A skin nick is made with the bistoury blade to facilitate insertion of the needle and to prevent contamination of the specimen by bits of surface epithelium. The aspirating needle with the obturator inserted is then thrust through the skin nick and the node engaged with its tip. The obturator is carefully withdrawn and the syringe (with its piston coated with surgical lubricant) is attached to the shank of the needle. Strong negative pressure is then maintained by partial withdrawal of the piston and the needle advanced slowly into the mass with a rotary back and forth motion. The needle is withdrawn to the edge of the mass and again inserted into it several times in slightly different directions. Negative pressure is then slowly released, the syringe disengaged and the needle withdrawn. (If negative pressure is not released the aspirated material may be spattered over the interior of the syringe and some be lost.)

The obturator is now inserted and the core of material within the needle is pushed out upon a small (2 cm.) square of absorbent paper which is then placed in Zenker's solution with glacial acetic acid. *Negligence in following the details of this procedure results in failure.*

fully given for 5 day periods. When the nitrogen intake was 0.40 and 0.47 gram of nitrogen per kilogram per day positive nitrogen balance was observed in 2 patients who were in negative caloric balance (10 and 12 calories per kilogram per day respectively).

Untoward reactions were studied not only in these patients, but in other patients receiving protein hydrolymates in the surgical wards. Hyperpyrexia, local venous thrombosis and a characteristic symptom complex culminating in nausea and vomiting were observed. The addition of gelatin was of value in preventing the symptom complex culminating in nausea and vomiting. However, most of the more recently prepared material (1945) gave little trouble from this standpoint or from the standpoint of hyperpyrexia unless thrombosis appeared. All of the preparations when used for considerable periods resulted in thrombosis.

This could not be entirely prevented by daily change of the infusion site but was delayed by the use of a plastic tube in place of a needle. The tendency was subject to marked variation between individual patients and in several patients the infusion of hydrolyzed protein had to be stopped for this reason. Venous thrombosis appeared to be the chief limiting factor in parenteral nutrition.

#### REFERENCES

1. BRUNSCHWIG, A. SCOTT V. B. CORBIN N. and MORT R. *Proc. Soc. Exp. Biol.* N. Y. 1943, 58:46.
2. LILMAN, R. CHARNAS, R., and DAVIES H. W. *Arch. Surg.* 1943, 47:216.
3. ELMAN, R. Personal communication: responsible investigator.
4. FLETCHER A. G., JR. HARDY J. D. RIEGEL, C., and KOOP C. E. *J. Clin. Invest.*, 1945, 24:405.
5. PARKINS, W. M. KOOP C. E., RIEGEL, C., VARR, H. M. and LOCKWOOD J. S. *Ann. Surg.*, 1945, 18:93.
6. RIEGEL, C. KOOP C. E., STEVENS, L. W. DEWE J. and RICHARDS J. E. *J. Clin. Invest.*, 1947, 26:111.

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Fig 1. Aspiration biopsy from supraclavicular lymph node involved by epidermoid carcinoma. N 1 large masses of tumor cells

From this point on the specimen is handled exactly as is other tissue in so far as fixing, clearing, embedding and staining are concerned. Special stains can be made if necessary. Three slides should be made from each specimen and 6 to 8 sections from each of 3 levels should be placed on each slide. Smears of aspirated material are not done in this laboratory for the reason that in our opinion they cannot give the sufficient additional information which the paraffin sections supply. These smears distort the architecture and the diagnosis then must depend on the identification of individual cells.

The most satisfactory material aspirated consists of a plug of tissue of varying length but this is usually dependent upon the nature and consistency of the aspirated mass (Fig 1). Pseudocaseous or keratinoid material may be

obtained from nodes containing epidermoid carcinoma. bits of soft gelatinous material may be secured from mucinous carcinomas, and in some cases blood may be removed and the bits of tissue be contained in a blood clot. If a great deal of blood is secured it may be placed in 2.5 per cent sodium citrate solution, shaken vigorously and sections made of the centrifuged sediment. Fat is often secured, and in the region of the salivary glands, characteristic glandular tissue may be obtained. In successful cases the histologic characteristics as well as the cytologic relations are maintained the specimen differing essentially only in size from formal biopsy material.

#### ADVANTAGES AND INDICATIONS

The necessity for biopsy and histologic diagnosis in the study and treatment of neoplastic diseases is unquestioned (6, 7) and it is equally true that under certain circumstances the aspiration biopsy has certain advantages over other methods of securing material (11, 12, 13). The procedure may safely be employed in an out patient clinic, thus reducing or avoiding hospitalization and the diagnosis may be obtained within 24 hours. Risk of infection is minimized. We have seen no case in which fungation from the needle puncture has occurred. Certainly when lymph nodes are aspirated this danger is more theoretic than actual for if tumor is found therapy can be instituted at once. The capsular defect left after needle puncture is inconspicuous compared to the



Fig 2. Aspiration biopsy from cervical lymph node revealing well differentiated epidermoid carcinoma. Not epithelial pearl. Primary tumor arose in the larynx.

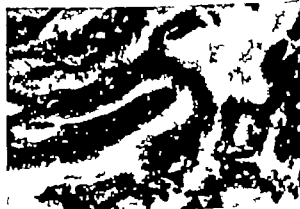


Fig 3. Aspiration biopsy from axillary lymph node showing metastatic adenocarcinoma. Primary tumor arose in the breast.

large defect resulting from the usual incisional biopsy. No special training is required for securing or preparing specimens. (However, the experience and skill of the operator is reflected in the percentage success of his biopsies.) Evaluation of cure rates may also be facilitated in follow up of treated patients. Operability or inoperability of a lesion may be determined by the presence of distant or regional node metastases. Histologic proof of the presence of a malignant tumor can be established for record purposes in clinically obvious cases. As in any other diagnostic methods, only positive results are conclusive. The aspiration should be repeated without hesitation if it is found to be necessary. Formal biopsy may be required but little time is lost in either case.

The indications for aspiration biopsy of enlarged lymph nodes have been considerably extended lacking valid contraindications and augmented by favorable experience in its accuracy and reliability. In general, any enlarged firm node which does not present an overlying ulcerated surface may be investigated by needle puncture and aspiration especially if it is not easily accessible to surgical excision.

Martin and Morfit (10) felt that any lymph node enlargement (except cervical) in adults exceeding 1 centimeter was presumptive evidence of abnormality. But the location of the node, its consistency and the site and histologic character of possible primary tumor are

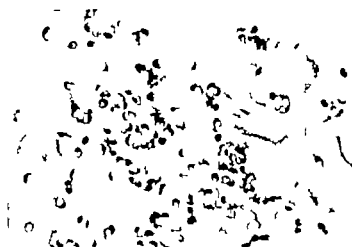


Fig. 4. Aspiration biopsy from supraclavicular lymph node. Metastatic adenocarcinoma. Primary tumor arose in the stomach.

factors which should have a bearing on whether or not a node is investigated. Obviously the method finds greatest usefulness in tumor clinics for investigation of lymphadenopathy coexisting with a primary lesion or for evaluation of nodes after treatment of a primary lesion.

In patients who exhibit peripheral lymph node enlargement as a presenting symptom, the nature of a possible primary lesion may be determined by microscopic examination of material aspirated from the adenopathy. Of the 3,896 cases reported by Martin and Morfit of patients having a cervical adenopathy as the only presenting symptom, 218 (0.06 per cent) indicated the existence of a silent primary neoplasm as shown by aspiration bi-



Fig. 5. Aspiration biopsy, cervical lymph node. Metastatic melanocarcinoma. Primary tumor arose in skin of the ear.



Fig. 6. Aspiration biopsy section from axillary lymph node. Metastatic carcinoma. The primary tumor arose in the breast.





Fig. 7 Aspiration biopsy cervical lymph node. Lymphosarcoma.

opsy of the enlarged nodes. Absolute histologic proof of cancer in large regional nodes draining a foul infected lesion may indicate a radical course of treatment. Conversely proof of a merely inflammatory enlargement of palpable nodes may prevent the performance of a radical procedure.

The one real disadvantage of aspiration biopsy as applied to peripheral lymph node enlargement is that only a small amount of tissue can be secured and consequently it may be impossible to identify the details of capsular invasion and gross structural fine points. In such cases which usually include Hodgkin's disease, lymphosarcoma, etc., an entire node should be taken for study by the usual routine technique.

Primary lymph node disease is best diagnosed by incisional biopsy in which such details as capsular invasion, architectural pattern and reaction of perinodal tissues can be studied carefully. Hyperplastic and neoplastic diseases constitute the bulk of primary diseases of lymphoid tissue if by the term "neoplastic" we include Hodgkin's disease, follicular lymphoblastoma, lymphosarcoma, and lymphatic leukemia. We are of the opinion that in lymph nodes the presence of other than lymphoid tissue is evidence of a secondary or a metastatic disease.

Recognition of metastatic lymph node enlargement is of the utmost importance in the choice of treatment. We believe that here aspiration biopsy offers the greatest degree of usefulness. It is self-evident that a broad

knowledge of the clinical nature of malignant disease and its mode of spread is a primary requirement. The identification of metastatic lymph node involvement is not always possible, but the usual diagnostic cytologic and histologic criteria are just as applicable for metastatic disease as they are for primary neoplasms. The existence and the nature of a hidden primary lesion may be suggested by the pathologic changes within the lymph node and by its location in some particular lymph node area (Figs. 2, 3, 4, 5 and 6).

## RESULTS

Although this is a statistical review the implications are clinical so the results shall be discussed largely from this standpoint. In our study the most common areas of lymph node metastases were in the cervical, submaxillary, axillary, inguinal and supraclavicular areas. The sites of origin for these metastases were for the most part expected but in a few instances a primary carcinoma behaved in a rather unpredictable manner. In the cervical region the most common site of origin was from within the oral cavity. In the submaxillary area, from the lower lip and tongue and in the axilla, from the breast. In the supraclavicular area 14 out of 24 originated in the breast. In the inguinal region neoplasms of rectum, anus, cervix, vulva and penis were responsible. Of these 5 large groups of nodes, the greatest percentage accuracy occurred in the supraclavicular group. The reasons for this are apparent considering the infrequency with which that node group is affected by disease other than metastatic carcinoma. The accessibility of the supraclavicular region also leads to a larger percentage of successful biopsies.

The present study is based upon 300 aspirations performed on 245 patients who presented lymphadenopathy considered to suggest the existence of neoplasm. Diagnoses were originally made from all microscopic slides, the slides were recently reviewed the diagnoses checked by one of us (L.V.A.) and review was also made of the subsequent clinical course of the patients and of further procedures which might affect the accuracy of previous diagnoses. In 7 cases originally reported negative

TABLE I.—300 ASPIRATIONS ON 245 PATIENTS FROM MAY 1942 TO OCTOBER 1945

Location	No. patients	No. aspirations	Group I Successful		Group II, Unsuccessful	
			No. revealing carcinoma	No. revealing lymphoid tissue	No. lymphoid tissue obtained	No. patients later developing carcinoma
Cervical	73	93	45			
Submaxillary	47	6	3		5	
Axillary	30	45		7	5	8
Inguinal	35	4		7		5
Supraclavicular	18	32	3	7		3
Subscapular	1	13	5	5	6	3
Preaxillary	8	6	6			
Parotid		4	3			
Retromaxillary	3	3				
Intraclavicular	3	3				
Totals	245	300	60	37	60	34

re-examination reversed the diagnosis to positive. In no case were a few questionable cells reported as tumor and in no case was a false positive reported. In this limited series clinical judgment of lymph node involvement in malignant disease was approximately 64.7 per cent correct, as verified by positive biopsies. The figure would undoubtedly be higher if it were not for the fact that all suggestive adenopathies were routinely investigated they were not necessarily considered malignant. Five aspirations revealed primary lymphomas later verified by conventional biopsy. Of these the cervical region was the site of involvement in 3 cases, submaxillary in 1 and axillary in 1. Lymphosarcoma was diagnosed 4 times (Fig 7) and Hodgkin's disease once. Tuberculosis was diagnosed in 4 instances and was proved either by means of animal inoculation or acid fast stain.

One hundred and ninety-seven of the 300 aspirations were considered successful in that either tumor or lymphoid tissue was seen. One hundred and three cases represented technical failure to obtain sufficient tissue but subsequent clinical course or further diagnostic procedures proved only 34 of these to be in error (11.1 per cent of total aspirations.)

Forty two cases were diagnosed as 'lymphoid tissue' and only 5 of these were proved subsequently to be incorrect, placing them in the 'wrong' classification (a technical error of 11.9 per cent). It is thus apparent that a node may contain tumor in another portion or more commonly material from an adjacent uninvolved node may be aspirated and thus normal appearing lymphoid tissue be obtained. But if tissue sufficient for diagnosis is secured our series indicates that one may assume (within 11.9 per cent error) that the diagnosis is correct. The 69 cases in which 'no lymphoid tissue' was reported represent technical failure to obtain lymph node material by means of aspiration, but not failure of diagnosis for they represent cases in which subsequent follow up proved no malignant condition to have been present.

# SUMMARY AND CONCLUSIONS

Aspiration biopsy in our experience provides a reliable, safe, rapid and economical method of investigating lymph node enlargements, the accuracy of which within limits of application, very creditably approaches that of other similar diagnostic procedures. The greatest value of the method lies in the evaluation of nodes suspected of being the site of metastatic disease, particularly those regional nodes approximating foul and infected primary lesions. The diagnosis of lymphomas was invariably suggested but exact classification could not consistently be made.

The relative merit and indications of incisional or formal biopsy are adjunctive rather than competitive. The decision as to operability or inoperability or the choice of treatment is facilitated by the establishment of the presence or almost certain absence of metastases in enlarged nodes.

Aspiration biopsy also provides an accurate method of determining the presence of metastasis in patients to be treated by roentgen therapy and the size of the field may be chosen accordingly. Empirical treatment based on clinical judgment alone can be avoided, as well as the delay in treatment occasioned by waiting for an incision to heal.

It should be emphasized that the diagnoses which were made in these aspiration biopsies



# STRENGTH-INTERVAL CURVES AND REPETITIVE STIMULI IN ELECTRODIAGNOSIS

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REPETITIVE stimuli have been used by physiologists and clinicians to study the kinetics of stimulus for many years. The best known repetitive stimulus used by clinicians has been the faradic current. Because however it usually has an uncontrollable waveform is variable in duration, amplitude and repetition frequency it is of limited value for obtaining data.

Another repetitive stimulus often used by physiologists is the alternating sine wave of variable frequency. Since there is no appreciable time interval between stimuli it does not correspond to the conditions studied in this work.

Repetitive stimuli separated by a controllable interval of time have been studied chiefly by physiologists. For example there are the paired stimuli as studied by among others Hill and Solandt the recurrent discharges of condensers studied by Lapicque Chauchard and Albert and unidirectional periodic current or Leduc current studied by May.

The data obtained from such studies have been plotted as strength frequency curves in which the frequency was changed by varying both the duration of the stimulus and the time interval between stimuli. The data were also plotted as strength interval curves in which the duration of the stimuli was held constant and the time intervals between them varied.

Because the duration of stimuli and likewise the time intervals between them varied so much from investigator to investigator the literature contains very few clues which aid one in selecting appropriate values for electrodiagnosis. For example, for the purpose of his

investigation it was necessary for Solandt to use stimuli lasting 2 000 milliseconds. Lapicque Chauchard and Albert used time intervals between stimuli ranging from 833 to 2 000 milliseconds. Only by analysis of these data as well as those of Scott and May could one find some suggestions applicable to our problem.

From such analysis it appeared that characteristics to be studied were (1) *Addition Latente* or recruitment (2) the profile of the strength interval curve, and (3) a search for a possible optimum interval and limiting interval time.

## MATERIAL AND METHOD

The material consisted of 6 cats in which section and immediate suture of the left sciatic nerve was done.

The first strength interval curves were obtained on about the 7th postoperative day and at approximately weekly intervals thereafter until clinical recovery was well advanced.

For this study, a constant current impulse stimulator was designed by one of us (J G G) and Mr J A. Fizzell which entailed the following features: (1) constant predetermined values of stimulating current irrespective of rather great changes in tissue impedance (2) seventeen durations of stimulating current ranging from 1 millisecond to 1500 milliseconds these selected to conform to a logarithmic scale (3) nine values of intervals between stimuli ranging from 1 to 4 000 milliseconds (Fig 1).

In making a systematic approach to the problem mentioned above we elected to hold the duration of the stimulus constant at 5 milliseconds and to vary the durations of the interval employing those of 1 5 10 15 20 25 and 30 milliseconds. When the duration of stimuli was held constant at 1 millisecond, it was found that some time after section the threshold exceeded the amount of available current.

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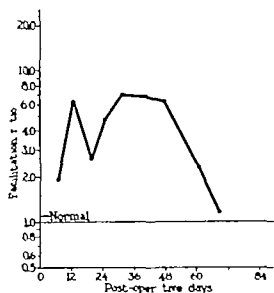


Fig. 2. Facilitation ratio expressing both facilitation and inhibition versus postoperative days. The duration of the stimulus was 5 milliseconds the interval 1 millisecond the end point was a twitch. Facilitation ratio =  $I/I_1$  where  $I_1$  = the threshold current for a single stimulus and  $I$  = the threshold current for repetitive stimuli.

val of 1 millisecond. We shall describe first the change in the facilitation noticed during the periods of degeneration, denervation and regeneration using a twitch as the end point.

In the normal the facilitation ratio ranged from 1.1 to 1.7 with an average value of 1.3. Following section and suture of the sciatic nerve of the cat, the evaluation of changes in facilitation and the facilitation ratio followed closely the changes in rheobase and galvanic tetanus ratio. Thus early in degeneration there was an increase in the facilitation ratio followed by a decrease and secondary increase. During denervation the ratio became the highest but early in regeneration it dropped off and usually was at a low value by the 70th postoperative day. It should be pointed out that in several cases there was a decrease and increase in the ratio early in regeneration which was then followed by a progressive diminution in the ratio to a low value. In several instances the ratio became less than 1.0 during the period of regeneration thus indicating that inhibition was present (Fig. 2).

When on the other hand the duration of the stimulus was 5 milliseconds and the interval between stimuli was 0 milliseconds inhibition was observed in some cases during early degeneration and was present in all cases during late regeneration. It is to be remem-

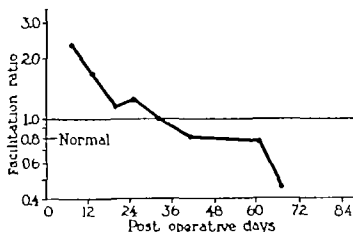


Fig. 3. Facilitation ratio expressing both facilitation and inhibition versus postoperative days. The duration of the stimulus was 5 milliseconds the interval 30 milliseconds the end point a twitch.

bered that a facilitation ratio of less than 1.0 denotes inhibition (Fig. 3).

Because the liminal twitch is difficult to reproduce as in the case of other investigators we have preferred to use sustained tetanus as the end point of stimulation. Under this condition in the case of normal muscle, the threshold current for repetitive stimuli usually diminished as the time interval between stimuli was increased. Following section and suture, there was an initial increase in the facilitation ratio followed by a sharp decrease to below 1.0 indicating inhibition. During denervation the greatest facilitation occurred and during the period of recovery there was a continued decrease in the ratio occasionally followed by a temporary increase but leading to a final inhibition (Fig. 4).

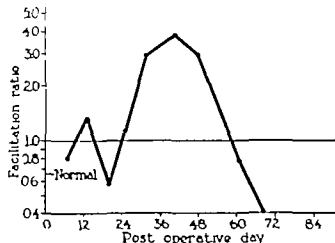


Fig. 4. Facilitation ratio expressing both facilitation and inhibition versus postoperative days. The duration of the stimulus was 5 milliseconds the interval 1 millisecond the end point tetanus.

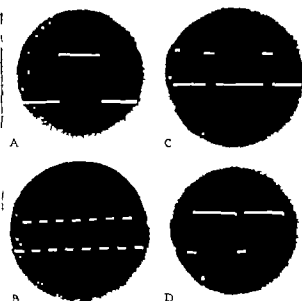


Fig. 1. Oscillograms of constant current stimuli. A, Single stimulus of 5 millisecond's duration. B, repetitive stimuli—5 millisecond's duration, 5 millisecond's interval. C, repetitive stimuli—5 millisecond's duration, 1 millisecond's interval. D, repetitive stimuli—5 millisecond's duration, 1 millisecond's interval.

## RESULTS

*Facilitation and inhibition* Kries and Sewall called attention to what was called *Addition Latente* in 1881.

Facilitation or recruitment has been expressed as follows. A very short subthreshold stimulus leaves behind it a local change of excitability which gradually dies away, so that a second subthreshold stimulus although separated from the first by a finite time interval, may sum with it and become effective.

The change of excitability has been said by Hill and Solandt to depend upon the function of accommodation and from curves obtained by them, they measured the time rate of accommodation.

It was pointed out by Lapicque that *Addition Latente* occurs when the duration of each stimulus is brief as compared to the chronaxie. As will be seen this is usually true when the intervals are of short duration but if the intervals are of longer duration not only does facilitation cease but actual inhibition may occur.

The term facilitation as defined above denotes that a muscle is more excitable to re-

petitive stimuli having a specified duration and time interval than to a single stimulus of the same duration. The term inhibition on the other hand denotes that a muscle is less excitable to repetitive stimuli than to a single stimulus. For the purpose of showing how facilitation and inhibition vary during the periods of degeneration, denervation, and regeneration it is desirable to express these two terms in some mathematical form. One convenient method of doing this is to take the ratio of the threshold current for a single stimulus of a certain duration to the threshold current for repetitive stimuli of the same duration and plot this number as a function of postoperative days on suitable graph paper. The ratio just described may be termed the facilitation ratio and expressed in equation form it becomes

$$\text{Facilitation ratio} = \frac{I_1}{I_r} \text{ where } I_1 = \text{the threshold current for a single stimulus and } I_r = \text{the threshold current for repetitive stimuli}$$

When using this equation a ratio of 1.0 indicates the condition where neither facilitation nor inhibition exists. Facilitation is present when this ratio is a number greater than 1.0 and, conversely inhibition is present when this ratio is a number less than 1.0. The curves in Figures 2, 3, 4, and 5 have been computed by means of the facilitation ratio formula just described and plotted on semilogarithmic coordinate paper.

In our study the durations of the stimuli were 1 and 5 milliseconds. When the duration of the stimulus was only 1 millisecond it was found that as denervation occurred the threshold rose to such a degree that often data could not be obtained. Therefore, in this study we will report the data resulting from stimuli of 5 milliseconds duration with intervals of 1, 5, 10, 15, 20, 25, and 30 milliseconds.

The liminal response of muscle to repetitive stimulation is a twitch. Although this end point is difficult to reproduce, the data obtained in this manner will be reported since they may become valuable in mathematical treatment of the kinetics of stimulus. Since facilitation was observed best when the interval was 1 millisecond the first study was made using a stimulus of 5 milliseconds and an inter-

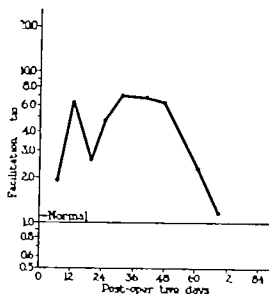


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In the normal the facilitation ratio ranged from 1 to 1.7 with an average value of 1.3. Following section and suture of the sciatic nerve of the cat the evaluation of changes in facilitation and the facilitation ratio followed closely the changes in rheobase and galvanic tetanus ratio. Thus early in degeneration there was an increase in the facilitation ratio followed by a decrease and secondary increase. During denervation the ratio became the highest but early in regeneration it dropped off and usually was at a low value by the 70th postoperative day. It should be pointed out that in several cases there was a decrease and increase in the ratio early in regeneration which was then followed by a progressive diminution in the ratio to a low value. In several instances the ratio became less than 1.0 during the period of regeneration thus indicating that inhibition was present (Fig. 2).

When on the other hand the duration of the stimulus was 5 milliseconds and the interval between stimuli was 30 milliseconds inhibition was observed in some cases during early degeneration and was present in all cases during late regeneration. It is to be remem-

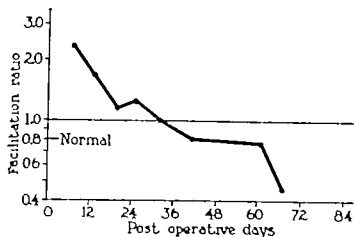


Fig. 3. Facilitation ratio expressing both facilitation and inhibition versus postoperative days. The duration of the stimulus was 5 milliseconds the interval, 30 milliseconds the end point a twitch.

bered that a facilitation ratio of less than 1.0 denotes inhibition (Fig. 3).

Because the liminal twitch is difficult to reproduce as in the case of other investigators we have preferred to use sustained tetanus as the end point of stimulation. Under this condition in the case of normal muscle the threshold current for repetitive stimuli usually diminished as the time interval between stimuli was increased. Following section and suture there was an initial increase in the facilitation ratio followed by a sharp decrease to below 1.0 indicating inhibition. During denervation the greatest facilitation occurred and during the period of recovery there was a continued decrease in the ratio occasionally followed by a temporary increase but leading to a final inhibition (Fig. 4).

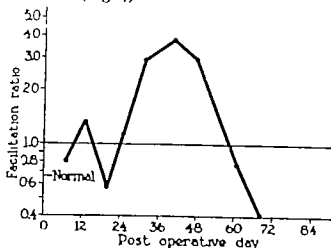


Fig. 4. Facilitation ratio expressing both facilitation and inhibition versus postoperative days. The duration of the stimulus was 5 milliseconds the interval 1 millisecond the end point tetanus.



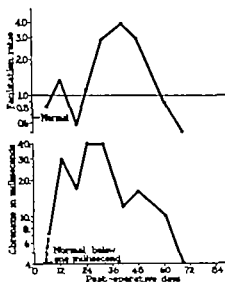


Fig 5. Comparison of the facilitation ratio to chronaxie on various days after operation. The duration of the stimulus was 5 milliseconds, the interval, millisecond the end point, tetanus.

Confirming Lapicque's observation it was found that with intervals of short duration a lengthening of chronaxie was accompanied by an increase in the facilitation ratio and conversely when the chronaxie shortened the facilitation ratio decreased (Fig 5).

#### THE PROFILE OF STRENGTH INTERVAL CURVES

Lapicque said in the case of muscle directly stimulated by means of a given capacity the liminal voltage is constant for very small intervals then as the interval increases, it goes up gradually until it reaches the threshold of an isolated stimulus (infinite interval). This should not be misinterpreted as meaning a stimulus of infinite duration which would be the rheobase value of voltage.

May also reported that with stimuli of 5 milliseconds duration the strength of the contraction increased with increasing frequency to 120 per second and then remained constant. It is permissible for us to assume that for liminal stimulus the threshold would have diminished with shorter intervals. Thus we were unable to confirm in the case of normal muscle. On the contrary we found that as the interval increased up to 30 milliseconds the threshold diminished as was the case in Solandt's work.

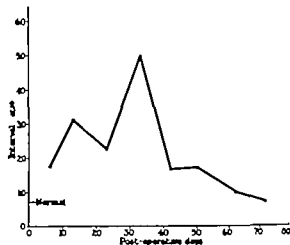


Fig 6 Interval ratio versus postoperative days. The duration of the stimulus was 5 milliseconds in each instance. Interval ratio =  $T_m/T$  where  $T_m$  = the threshold current for an interval of 15 milliseconds and  $T$  = the threshold current for an interval of 1 millisecond.

In a few instances an optimum interval was observed as had been observed by May. However an optimum interval was at times more clearly demonstrated on the 6th or 7th postoperative day.

In a strength interval curve obtained from degenerating denervated and early recovering muscle the magnitude of the threshold current generally rises as the length of the interval is increased according to the state of muscle whether denervated or recovering. This continues up to a point where a plateau is reached and a further lengthening of the interval causes no further rise in the threshold. In fact as recovery occurs the threshold may even decrease. This interval at which the plateau is reached is known as the limiting interval. At about the 7th postoperative day the strength interval curve is so nearly flat that there is no definite limiting interval. During the period from about the 7th to the 40th postoperative day the limiting interval becomes longer and longer until recovery begins.

At the 40th postoperative day in some cases no plateau was noticed even at an interval of 30 milliseconds. Thereafter as neurotization was taking place the limiting interval began to reappear at shorter intervals until at the 70th postoperative day the strength-interval curve became nearly flat and resembled the

normal. Although this phenomenon of limiting interval" was observed in all cases the lack of uniformity with which the limiting interval diminished during the process of neurotization seems to us to render it an inaccurate index of recovery.

On the other hand, the steepness of the rise of the strength interval curve was seen to change appreciably during the periods of denervation, denervation and regeneration. For example the rise of the curve for denervated muscle was usually quite steep. However as recovery began and progressed the rise became less and less steep finally at about the 70th postoperative day the curve was almost flat. These changes in the rise of the curve can be visualized quite readily if one plots the ratio of only two points on the strength interval curve as a function of postoperative days.

The points we elected to use were the threshold current for an interval of 15 milliseconds and the threshold current for an interval of 1 held constant at 5 milliseconds. The ratio obtained by dividing the threshold current for an interval 15 milliseconds by the threshold current for an interval of 1 millisecond is termed the interval ratio and is plotted as a function of postoperative days (Fig 6). It should be remembered that a high interval ratio denotes a steep rise in the strength interval curve whereas a low ratio denotes a more gradual rise or even a flat curve.

In the normal the interval ratio is usually less than 1.0 and occasionally during early degeneration a ratio of less than 1.0 was observed. As denervation progresses however the ratio becomes some multiple of 1.0 and by the 30th to 40th postoperative day has reached its highest value at times as high as 5.0. As regeneration began and progressed the ratio took on smaller and smaller values until about the 70th postoperative day when it again became a number less than 1.0.

#### APPLICATION TO MAN

When we began to study strength interval curves in man we had no guide as to which duration of stimulus and time interval between stimuli would give the most satisfactory data. We elected to use a stimulus of 1 millisecond &

duration and intervals of 1, 5 and 12 milliseconds respectively.

This proved to be an unfortunate choice for two reasons. First when a muscle is denervated it is often impossible to obtain data for a single stimulus of less than 14 to 30 milliseconds duration a fact which prevented us from making a quantitative study of facilitation and inhibition. Second because the threshold values of current for the longer time intervals increased so rapidly especially during denervation we were unable to obtain satisfactory data studying the steepness of rise of the strength interval curve.

Although we are able to say from data obtained in human material that a flat strength interval curve is indicative of advanced recovery we feel that the subject of strength interval curves for electrodiagnosis in man needs restudy.

It is suggested for the benefit of those who may desire to undertake such an investigation that a stimulus of 30 milliseconds duration and time intervals of 1, 5 and 15 milliseconds be tried. This would ensure the obtaining of data for a single stimulus at all times and permit an evaluation of facilitation and inhibition. In addition a stimulus of 5 milliseconds duration should give satisfactory data for studying the steepness of the rise of the strength interval curve after injury to the nerve.

From our investigation it would appear that longer intervals than those mentioned above could offer very little because a limiting interval soon occurs for a stimulus having a duration of 20 or more milliseconds.

#### SUMMARY

We have reported on the experimental data obtained from strength interval curves in the tibialis anticus muscle of the cat during the periods of degeneration, denervation and regeneration following section and immediate suture of the sciatic nerve. While changes in facilitation ratio obtained using a twitch as an end point were described to permit of a study of the kinetics of stimulus it was pointed out that the change in facilitation ratio obtained when using tetanus as the end point gave a more accurate and critical assessment

of the muscle on the various postoperative days. Attention was then called to the fact that the limiting interval was an unsatisfactory index of recovery because of the lack of uniformity with which it diminished during the process of neurotization. It was next shown that the steepness of the rise of the strength-interval curves which was expressed in terms of an interval ratio gave reliable information as to the state of the muscle on the various postoperative days.

The applications of strength-interval curves for electrodiagnosis in man were discussed and at that time we pointed out the reasons for our failure to obtain satisfactory data in a large number of cases. We then suggested several changes in technique which should be useful to future investigators in this field

#### CONCLUSIONS

1 *Addition Latente* or facilitation whereby the threshold for repetitive stimuli of short duration is less than that for a single stimulus of same duration was found in normal muscle

2 Facilitation was found to be greatest in completely denervated muscle.

3 With the beginning of regeneration, facilitation progressively diminished and finally inhibition occurred

4 Although during the period of degeneration and regeneration a limiting interval was found it proved inconclusive in making a diagnosis

5 The steepness of the rise of the strength interval curve becomes greater as degeneration progresses is greatest during denervation, and becomes less and less during recovery

#### REFERENCES

- CHAUCARD M and ALBERT M. *Ann. physiol.* Par 935 6
- HILL, A. V. *Proc. R. Soc. Lond., Series B*, 935 926, 9305.
3. KRIES, J. and SEWALL, H. *Arch. anat. Physiol. Leipzig*, 881, Part 2 5 66.
4. LAPICQUE, L. *Cold Harbor Symposium on Quantitative Biology* 916, 4 98.
5. MAY OTTO. *Brain Lond.*, 19 9 3 34. 272.
6. SCOTT D J J *Physiol.*, 933, 42 3 1
7. SOLANDT D A *Proc. R. Soc. Lond. Series B*, 1936, 20 389.

# CECOSTOMY AND THE MILLER-ABBOTT TUBE

## A Report on their Combined Use in the Preparation of the Obstructed Large Bowel for Surgery

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**D**ECOMPRESSSION and preparation of the colon preliminary to resection of obstructing neoplasms of the left colon are usually accomplished by cecostomy or transverse colostomy. There are several difficulties associated with both methods. A cecostomy accomplishes decompression without complete defunctioning and does not usually permit cleansing of the bowel proximal to the lesion. For these reasons it may be inadequate and a transverse colostomy may be required for proper preparation of the bowel before resection of the growth. A defunctioning transverse colostomy permits irrigation of the isolated bowel proximal to the lesion and is in that respect preferable to cecostomy but it necessitates a further major operative procedure—not without hazard—namely that of closure.

For these reasons the author has sought a more adequate method of large bowel preparation using a cecostomy and therefore not requiring secondary closure. Such a method is the subject of the present communication.

Decompression by cecostomy is performed according to the method of Allen and Welch. Figures 1 and 2 show diagrammatically the type of cecostomy used and the manner in which the Miller Abbott tube is inserted. A large cecostomy tube of 20 millimeter diameter is recommended. Following this procedure a few days of rest are felt advisable so that the colon may regain its tone and resume peristalsis. Three or 4 days have been found quite adequate. A small hole is then cut in the superior aspect of the rubber drainage tube close to its attachment to the cecostomy tube and a Miller Abbott tube (1/4) (preferably size No. 18) is passed into the cecum and the balloon then inflated with 60 to 120 cubic centi-

meters of air. The curved passage through the cecostomy tube offers such resistance to the Miller Abbott tube that it must be manually urged into the cecum. What slack is available in the cecum is readily taken up by the action of peristalsis on the balloon. If the Miller Abbott tube is readjusted and slack placed into the cecum as often as every 10 minutes the tip of the tube may reach the sigmoid flexure within 3 hours. The tube appears to progress equally well on or off suction and it is advisable not to use suction at this time lest the tube become occluded. When the cecum will no longer accept slack tube it is probable that the obstructing lesion has been reached. This fact may be checked by x ray examination. The balloon is then deflated and the tube is made fast externally by strapping it to the cecostomy. Even though a maximum of a yard of tube is necessary we have not shortened the Miller Abbott tube because its length has not interfered with its function in these cases.

Irrigations through the Miller Abbott tube of 1500 cubic centimeters of normal saline solution or tap water twice daily will back flush the colon from the point of obstruction and the drainage will flow from the cecostomy tube. Following each irrigation the Miller Abbott tube is placed on Nelson or Wangensteen suction for 30 minutes to empty the bowel lumen of residual irrigating fluid and to maintain the bowel in a state of decompression. Following this a suspension of sulfathalidine has been instilled into the Miller Abbott tube in some patients. Regardless of this use of sulfathalidine there has been no gross difference in the appearance of the bowel at the time of resection and open anastomosis. We have found it convenient to use the ordinary intravenous saline flasks and tubing as the connections fit the Miller Abbott tube. In a day

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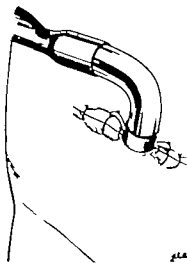


Fig. 2. Diagrammatic sketch of cecostomy incision, cecostomy tube, and insertion of Miller Abbott tube.

or so the obstructing lesion may open sufficiently to permit the irrigations to be given with the patient on the bedpan as both rectal and retrograde colonic irrigation may take place.

Resection can be carried out on a clean bowel when the patient is adequately prepared systematically to withstand the pro-

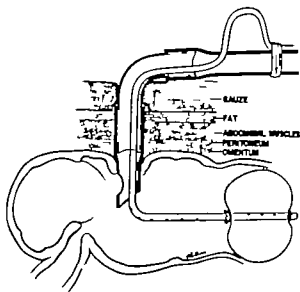


Fig. 3. Diagrammatic sketch in longitudinal section showing manner of insertion of cecostomy tube and of Miller Abbott tube. The cecum is closed about the cecostomy tube by 3 invaginating pursestring sutures, the first being of No. 0 plain catgut which includes a bite into the tube itself for fixation; the remaining 2 being of No. chromic catgut. The omentum is wrapped about the cecostomy tube prior to closure of the abdomen. The right angle glass tube with its attached rubber tubing is used to prevent kinking and has an inside diameter of 30 millimeters. Procedure often about 10 days after cecostomy. The last irrigation is given 2 or 3 hours prior to



Fig. 3. Case 1. X-ray film on entry showing marked dilatation of the colon.



Fig. 4. Case 2. X-ray film showing the passage of the Miller Abbott tube 3 hours after insertion.

operation and is followed by suction. Both sulfathalidine by mouth 6 to 8 grams daily, and a low residue diet are indicated to keep the cecostomy drainage of such a character as to allow the Miller Abbott tube and the cecostomy tube to function at their best.

It is suggested though this procedure has not yet been put to the test, that cleansing of the distal limb of the bowel in transverse colostomies may also be successfully accomplished through the use of the Miller Abbott tube and irrigations.

**CASE 1** M D No 546942 (Figs 3 and 4.) a 73 year old woman entered the Massachusetts General Hospital with a story of complete large bowel obstruction of 48 hours duration. An x ray examination of the abdomen showed a markedly distended large bowel and a barium enema revealed total obstruction in the region of the proximal sigmoid flexure. A cecostomy was performed with satisfactory decompression and by the fourth postoperative day she had regained normal peristalsis. A Miller Abbott tube was passed through the cecostomy and irrigations were instituted. Eleven days following the initial procedure resection and open end to-end anastomosis were carried out at which time the bowel was clean and decompressed with no visible fecal matter. There was also no discrepancy of significance in the diameter of the two limbs of sigmoid at the point of anastomosis.



Fig. 5. Case 1. X ray film on entry showing distention of small and large bowel.

**CASE 2** S DeG No 547698 (Figs 5 and 6) a 60 year old man entered the Massachusetts General Hospital with a story of complete bowel obstruction of 48 hours duration. An x ray examination of the abdomen showed dilated small and large bowel. Barium enema demonstrated an obstructing lesion in the midsigmoid consistent with carcinoma. A Harris tube was passed into the small bowel but as improvement did not occur in the course of 48 hours cecostomy was performed with fair decompression. On the third postoperative day peristalsis had returned to normal and a Miller Abbott tube was passed through the cecostomy and irrigations were instituted. Sixteen days after cecostomy resection and open end to-end anastomosis were carried out. At this time the bowel was clean and well decompressed with no feces present grossly and no significant discrepancy in the diameter of the bowel proximal and distal to the resected area.

**CASE 3** E W No 552309, a 64 year old woman entered the hospital with partial large bowel obstruction and a distended cecum secondary to a carcinoma of the rectum. Cecostomy was carried out with good decompression and 5 days later a Miller Abbott tube was passed through the cecostomy. Irrigations were instituted and 12 days following her initial procedure a combined abdominoperineal resection of her rectum was performed. At this time the bowel was found completely decompressed and in very satisfactory condition for the resection.

**CASE 4** A B No 472577 a 75 year old man entered the Massachusetts General Hospital with 4

Courtesy of Dr. E. Parker Hayden.



Fig. 6. Case 2. X ray film showing the passage of the Miller Abbott tube 2 hours after its insertion.

lay of total large bowel obstruction from an extensive carcinoma of the rectosigmoid. Cecostomy was performed and 4 days later a Miller Abbott tube was inserted into the cecostomy and irrigations instituted. Despite much impacted barium in the ascending colon the Miller Abbott tube progressed slowly and steadily to reach the splenic flexure in 3 days. Fourteen days following cecostomy exploratory laparotomy was carried out and a permanent sigmoid colostomy made because the growth was found to be locally inoperable. At this time the bowel was found to be completely cleansed.

CASE 5 M D No. 548717 a 67 year old woman entered the hospital with a story of progressive recurrent attacks of gaseous distention and abdominal cramps culminating in nearly complete large bowel obstruction for a month prior to entry. Barium enema showed an extensive area of rather marked narrowing in the mid and upper sigmoid flexure. Cecostomy was performed and on the fourth post operative day when peristalsis had resumed normal activity a Miller Abbott tube was passed through the cecostomy. It progressed without difficulty and irrigations were started. On the fifteenth day after cecostomy resection of an area of diverticulitis in the lower sigmoid flexure and open end-to-end anastomosis were done. At the time of resection the bowel was deflated but had a minimal amount of feces present. This patient had no irrigations or suction applied through her Miller Abbott tube during the 24 hour period prior to operation.

CASE 6 M G No. 8284 a 60 year old woman entered the hospital with a story of subacute large bowel obstruction of 14 days duration. Barium enema showed complete obstruction from below at the splenic flexure. Cecostomy was performed with poor decompression and the patient continued to have a moderately dilated colon proximal to the obstruction with associated cramps. On the tenth

postoperative day a Miller Abbott tube was passed without difficulty through the cecostomy and irrigations were instituted—with complete relief to the patient and clinical decompression of the colon proximal to the obstruction. Four days following passage of the Miller Abbott tube resection of the carcinoma of the splenic flexure with open end-to-end anastomosis was carried out at which time the bowel was deflated and clean.

#### SUMMARY

A method of preparing patients with obstructing lesions of the left colon for resection is presented together with several illustrative case reports. This method consists of cecostomy and the passage of a Miller Abbott tube through the cecostomy for the purpose of back flushing the colon by irrigations. It is also useful for postoperative decompression of the anastomosis. It is felt that this method offers advantages over cecostomy alone and it is also believed to be superior to a transverse colostomy because a secondary operative closure is not required.

#### REFERENCES

- ABBOTT W O Arch. I t. Med., 1930, 63 453.
- ALLEN A W and WELCH, C. E. Surg. Gyn. Obst. 44 73 540-552.
- HARRIS, F I Surg. Gyn. Obst., 945 8 67-67A.
- MARRIOTT W B I the discussion of the paper by Da lid and Glüchris, T. South. Surg. Ass 541 54 92.
- MILLER, T G and ABBOTT W O. Am. J. M. S. 934, 87 595.

\*Since this paper was sent in for publication the above reference to prior attempt at intubating the colon through cecostomy has come to our attention (4).

Courtesy of Dr. Arthur W. Allen  
Courtesy of Dr. Joe V. Nege

# SUPRACONDYLAR SHORTENING OF THE FEMUR FOR LEG LENGTH INEQUALITY

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**L**ENGTH inequality of the lower limbs in the growing child may be corrected by elective arrestment of growth of one or more growth cartilages of the longer limb as described by Phemister. After puberty the rate of longitudinal growth from the femoral and tibial growth cartilages declines and marked length discrepancy usually cannot be corrected by this method. In the adolescent or adult with excessive length inequality the deformity can only be corrected by shortening the longer limb or lengthening the shorter extremity.

Individuals with one deformed leg frequently object to the risk of impairment of the sound limb occasioned by surgical shortening. Experience has shown however that leg shortening is associated with few complications when compared with leg lengthening. The formidable procedure of lengthening with its greater incidence of nonunion, postoperative infection or traction damage to nerves, vessels and muscle leaves many surgeons reticent to perform such a procedure. This is particularly so where marked disuse atrophy of bone and soft tissues provides unfavorable conditions in the short limb. Partially paralyzed muscles may be weakened by lengthening and ankylosis of a joint on either side of a lengthened long bone increases the hazard of fracture through the site of the lengthening. The relative safety of femoral shortening permits wider application of this method of leg length equalization than is the case with femoral lengthening.

The usual site of election for shortening the femur in published cases is the diaphysis. It is the purpose of this paper to describe the technique used and end results of 15 cases in which shortening was accomplished by resection of bone from the lower femoral metaphysis.

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## PRINCIPLES INVOLVED IN LEG SHORTENING

The object of shortening is to equalize the length of the limbs or to reduce the discrepancy to an amount compatible with good function. Leg length inequality of less than 1 inch is seldom of functional significance. A discrepancy of 1 inch or more may be sufficient to impair gait appearance and dynamics of the back or unaffected limb. Lengthening the shortened limb is esthetically more desirable from the patient's standpoint but the decision to shorten the longer limb or lengthen the shorter leg can be made only after comprehensive study of the individual case.

Leg shortening usually should be performed near the end of the growth period. The accuracy with which equalization is accomplished by this method is nullified if subsequent unequal growth occurs. The earlier decline in the rate of growth of the lower extremities in girls generally permits operative shortening at the age of 12 or 13 years. In boys in whom puberty occurs later and growth from the lower extremity is relatively greater, equalization by shortening should be delayed until 14 or 15 years of age. Final decision rests in correct evaluation of the maturity of the individual at a given age based on knowledge of his hereditary background, bone age and growth expectancy of the sound limb as well as the affected leg.

Flexion adduction deformity of the hip or any angulation deformity of the limb must be corrected before evaluation of actual leg length inequality is possible. Correction of fixed hip deformity is usually done near the end of the growth period if recurrence of the deformity is to be prevented.

In patients with weak hip abductors or inability to elevate the pelvis on the short limb, a side  $\frac{1}{2}$  to 1 inch of residual shortening of the leg facilitates walking. This also may be true in patients with ankylosis of either a hip or knee.





Fig. 1. Drawing showing the technique of resection of bone from the metaphysis and method of end-to-end fixation over intramedullary peg with screw or threaded pins.

The maximum correction advisable by shortening in the lower  $\frac{2}{3}$  of the femur is about 3 inches. Shortening in excess of this amount may produce permanent quadriceps weakness. If length inequality is more than 4 inches, shortening the longer limb may be preceded by lengthening the shorter leg. Partial equalization of length by resection may be advisable if the patient would be rendered unduly short of stature leaving a difference of 1 or 2 inches to be compensated for by a built up shoe. These factors should be considered in planning any length equalization procedure.

#### CAUSES OF UNEQUAL LEG LENGTH

Congenital anomalies accounted for marked length discrepancy of the legs in 3 cases reported here. Congenital dislocation of the hip of 12 years' duration with chronic disability from pain led to retardation of growth from all growth cartilages of the affected limb in 1 case. In such instances dysplasia of the proximal femoral growth cartilages associated with the disturbed development of acetabulum and capital epiphysis may be a contributing factor to the shortening. Congenital hypoplasia and a short cavus foot resulted in marked shortening of the limb and conspicuous limp in an

other instance. Dyschondroplasia with involvement of one leg was accompanied by retarded growth and premature ossification of growth cartilages in a third case.

Tuberculous arthritis of the hip with extensive destruction of acetabulum and capital epiphysis caused shortening in 6 cases. Similar destruction of the joint from severe pyogenic arthritis accounted for shortening in 3 cases. In 2 patients with tuberculous arthritis and 1 with pyogenic infection of the hip prolonged disability led to severe retardation of growth from all epiphyses of the affected limb. In the latter case premature ossification of the medial part of the upper tibial growth cartilage led to a tibia vara deformity before growth was complete. In such cases eccentric or central ossification of the cartilage leads to localized bone bridging between epiphysis and metaphysis as demonstrated by Gill and Ross. Eccentric bony bridging produces angulation deformity when subsequent weight bearing stimulates growth from remaining cartilage. The resulting angulation deformity further contributes to the shortening.

Osteomyelitis of the shaft of the femur with prolonged disability led to retarded growth from all growth cartilages of the affected limb and premature ossification of the upper tibial growth cartilage in 1 case in this series.

Residual paralysis following poliomyelitis was responsible for retarded growth of the leg in the remaining 2 cases. Reduced functional stimulation or nutritional disturbances associated with altered blood flow through the extremity may account for such inhibition of longitudinal growth in paralyzed limbs.

#### OPERATIVE TECHNIQUE

The history of leg shortening operations has recently been reviewed by White, Howorth and Phalen and Chatterton making repetition unnecessary.

The technique of resection and fixation of the apposed bone ends with an intramedullary peg fashioned from the resected bone has previously been employed by Taylor, Calvé, Royle, Ritter, Groves, Moore, Camera, Harmon and Krigsten and Howorth. The method used here is similar in principle and differs only in location of the sight of resection.

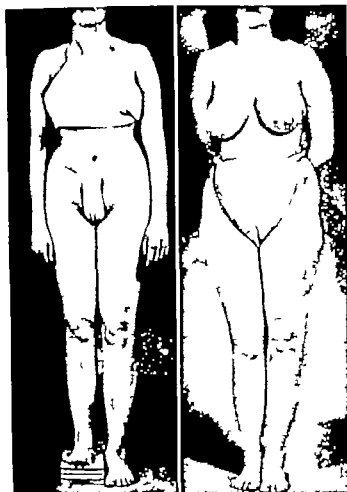


Fig. 2a

Fig. 2. Case 1. a, The patient before operation (left) and 2 years and 5 months after shortening the left femur 2 inches (right). b, Distal end of the left femur 8 weeks after the shortening operation. The osseous grafts have united and ossified callus bridges the bone ends. c, Distal end of the left femur 2 years and 5 months after the shortening operation.

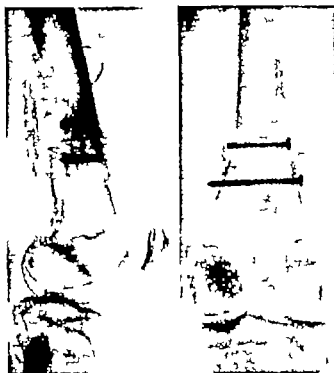


Fig. 2b

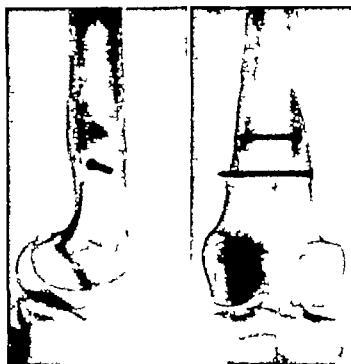


Fig. 2c

A bloodless field is obtained by application of an Esmarch bandage high on the thigh. Through a 7 inch lateral incision over the distal end of the femur the fascia lata is incised and the vastus lateralis muscle identified. The muscle is reflected anteriorly from the intermuscular septum.

The lowermost anterior perforating branches of the profunda femoris artery and vein are identified, ligated and cut. The periosteum is incised longitudinally and elevated from the circumference of the metaphysis over the segment to be excised. The segment of bone to be removed is marked with a chisel and the distal osteotomy is made first with a Gigli saw. The shaft of the femur may then be displaced outward and the proximal osteotomy with the Gigli saw facilitated.

The resected segment is divided longitudinally into several parts with the motor saw and one portion is used for the intramedullary graft. One-half of the graft is inserted into the proximal shaft. A hole is drilled through the outer cortex graft, and inner cortex and a transfixion screw or threaded pin is inserted. The protruding half of the graft is then intro-

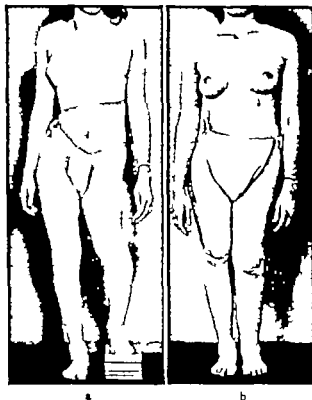


Fig. 3. Case 2. a, The patient at 7 years of age before leg length equalization procedures were done. There is abduction deformity of the left hip, tibia vara, and  $7\frac{3}{4}$  inches shortening of the left leg. Osteotomies of the hip and upper tibia and fibula were followed by lengthening the left tibia and fibula 4 inches. b, The patient at 9 years of age, 9 years after the right femur was shortened 4 inches.

duced into the metaphysis and likewise secured with a transfixion screw.

The remaining pieces of the resected segment are used as onlay grafts as shown in Figure 1 and may be ligated in place with cat gut. The soft parts are approximated in the usual manner.

Postoperative immobilization in a single hip spica plaster dressing for 6 to 8 weeks is followed by weight bearing in a tubular plaster dressing until bony union is complete.

Quadriceps exercises are encouraged during the period of immobilization and active knee exercises are continued after removal of the support.

#### CASE REPORTS

Congenital hypoplasia associated with a short cavus foot was responsible for 2 inches of shortening of the right leg in the following

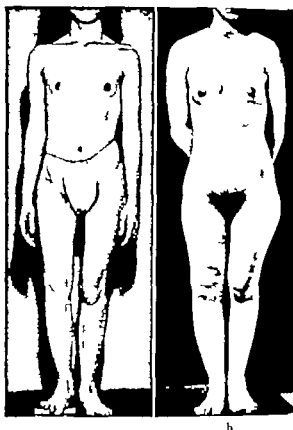


Fig. 4. Case 3. a, The patient, 1 year and 7 months after derotation osteotomy and arthrodesis of the right hip for unreduced congenital dislocation (left). b, The appearance 6 months later after shortening the left femur 4 inches.

case. Exact equalization of limb length was accomplished in this instance.

CASE 1 (Case No. 9, Table I). B. H., aged 14 years, had deformity of the right foot at birth and shortening of the limb was first noted at 2 years of age. Her father had similar deformity of the right foot but no shortening of the limb or disability.

Examination revealed 3 inches of shortening of the right leg. There was cavus deformity of the right foot which was smaller than the left. There was no impairment of sensation or motor power.

The length of the limbs was equalized by shortening the left femur 2 inches. Figure 2a shows the patient before operation and 2 years and 5 months after the femoral shortening operation. Figure 2b shows the roentgenographic appearance of the left femur 8 weeks after operation.

Figure 2c shows the result 2 years and 5 months later at 16 years of age. The length of the legs was equal at that time.

Prolonged disability from infectious arthritis of the hip at 4 years of age was followed by premature ossification of the lower femoral,

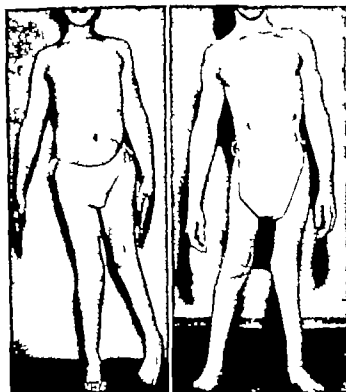


Fig. 5a.

Fig. 5. Case 4. a, The patient at 6 years of age with 2 centimeters shortening of the left leg (left). On the right the same patient at 15 years of age 7 months after shortening the right femur  $1\frac{3}{4}$  inches. b, Distal end of the right femur 7½ weeks after operation. c, Distal end of the right femur 2 years and 6 months after the shortening operation.



Fig. 5b.

upper and lower tibial growth cartilages in the following case. Marked retardation and early arrestment of growth from all growth cartilages including those destroyed by the hip disease produced  $7\frac{1}{4}$  inches relative shortening. Hip deformity and tibia vara accounted for part of the shortening. Complete equalization could not be accomplished in this instance because of marked length discrepancy and short stature of the patient.

CASE 2 (Case No. 4, Table I) J. P. aged 17 years had infectious arthritis of the left hip at 4 years of age. The limb was immobilized in a plaster hip spica dressing for 3 years during which drainage was present. A long leg brace was worn for an additional 7 years. Ankylosis of the joint occurred during the fifth year of the disease. Ten years after onset subtrochanteric osteotomy was done and the brace discarded. She was first seen at the University of Chicago Clinics 3 years later at 17 years of age. Examination showed ankylosis of the left hip in approximately 20 degrees of abduction and 30 degrees of flexion. There was varus deformity of the proximal end of the tibia with marked overgrowth and bowing of the fibula. The left limb was  $7\frac{1}{4}$  inches shorter than the right.

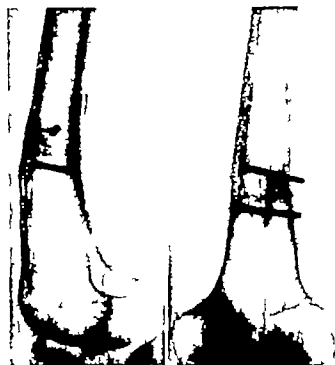


Fig. 5c.

Hip deformity and varus deformity of the tibia were corrected by osteotomies of the upper femur, tibia, and fibula. The left tibia and fibula were then lengthened  $2\frac{3}{4}$  inches. Five months later the right femur was shortened  $2\frac{3}{4}$  inches. Residual shortening of the left limb is approximately  $1\frac{3}{4}$  inches. Figure 5a shows appearance of patient on admission. Figure 5b shows same patient 1 year after operation. Gait is good and she has no back disability from pelvic tilt  $3\frac{1}{2}$  years after last operation.

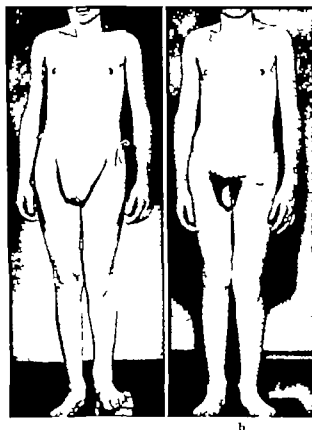


Fig. 6. Case 5. a, Appearance of the patient at 4 years of age before operation. b, The patient 3 months after shortening the right femur  $\frac{1}{4}$  inches.

Unreduced congenital dislocation of the right hip with retarded growth from disuse accounted for marked shortening of the limb in the following case. After operative reduction and arthrodesis of the hip 3 inches of residual shortening of the affected limb was partially corrected by resection of  $2\frac{3}{4}$  inches from the lower femoral metaphysis of the left femur.

CASE 3 (Case No. 5 Table I). H. M. aged 15 years was first examined for untreated congenital dislocation of the right hip at 12 years of age. Shortening limb and pain in the right thigh after exercise had been noted since she first walked. Two older sisters had been treated for bilateral congenital dislocation of the hip.

Examination revealed shortening of approximately  $4\frac{1}{2}$  inches when standing. Approximately 1 inch could be accounted for by upward displacement of the femur. Trendelenburg's sign was positive and there was marked limp.

Two years and 7 months after derotation osteotomy and arthrodesis of the hip, there was 3 inches residual difference in leg length. The discrepancy was reduced to  $\frac{3}{4}$  inch by resection of  $2\frac{3}{4}$  inches from the

TABLE I

Case No.	Age—years Sex	Disease	Leg length discrepancy—Inches	Oper. Att. shortening—Inches	Other operative or palliative procedure
F. A.	18 F	Tuberculosis arthritis hip			Arthrodesis, 1 hip Complete epiphyseal arrest, left knee
E. M.	6 M	Pyogenic arthritis hip		5	Segmentectomy 1 hip Subtrochanteric osteotomy 1 femur
E. K.	14 M	Tuberculosis arthritis 1 hip	14	14	Arthrodesis, 1 hip Subtrochanteric osteotomy 1 femur
J. F.	8 F	Pyogenic arthritis 1 hip	7 $\frac{1}{2}$	14	Osteotomy 1 tibia & fibula Subtrochanteric osteotomy 1 femur Leg lengthening, left
H. M.	5 F	Congenital dislocation 1 hip	3	5	Derotation osteotomy Arthrodesis, hip
N. W.	6 F	Tuberculosis arthritis hip			Arthrodesis, hip Subtrochanteric arthrodesis Subtrochanteric osteotomy 1 femur
C. H.	7 F	Tuberculosis arthritis hip			Arthrodesis, hip Intertracheal osteotomy 1 femur
S. M.	14 M	Residual poliomyelitis trunk & limbs	15	3	Arthrodesis, 1 hip Triple arthrodesis & l
B. H.	1 F	Congenital hypoplasia leg			None
L. M.	7 F	Residual poliomyelitis trunk & leg	14	14	Triple arthrodesis Femoral transecture
R. B.	14 M	Dyschondroplasia	3	14	None
L. L.	14 M	Tuberculosis arthritis hip		14	Arthrodesis hip, tibia Osteotomy
E. K.	7 F	Pyogenic arthritis hip	14	14	Partial osteotomy femur Segmentectomy hip
M. J.	7 F	Tuberculosis arthritis hip	14	14	Arthrodesis, 1 hip
D. J.	7 F	Osteomyelitis femur	3		Partial osteotomy, femur Excision, upper end tibia

left lower femoral metaphysis. Figure 4 shows the patient before the left femur was shortened and the appearance 6 months after resection of  $2\frac{3}{4}$  inches from the left lower femoral metaphysis.

Severe residual paralysis of trunk and lower extremities following poliomyelitis at 21 months of age led to unequal growth of the lower extremities and length inequality of  $1\frac{1}{2}$  inches in the following case.

CASE 4 (Case No. 8 Table I). S. M. aged 14 years, had acute anterior poliomyelitis at 1 year and

9 months of age with severe residual paralysis of the trunk and lower extremities. At 6 years of age caliper braces and a Hoke corset were provided. He was able to walk short distances with crutches but was severely disabled. Two centimeters of shortening of the left leg at 7 years of age increased to 3.5 centimeters in the following 6 years. Correction of this discrepancy by epiphyseal arrest was not believed indicated because of his limited ability to walk. At 13 years of age subluxation and instability of the left hip necessitated arthrodesis of the joint. This was followed by bilateral triple arthrodesis. These procedures were followed by marked improvement in gait. In the presence of weak trunk musculature and inability to elevate the right side of the pelvis it was believed that further improvement would follow equalization of the length of the legs. Accordingly the right femur was shortened  $1\frac{3}{4}$  inches. Figure 5a shows the patient at 6 years of age and at 14 years of age following arthrodesis of the left hip, stabilization of both feet and shortening the right femur.

Figure 5b shows the roentgenographic appearance approximately 2 months after the shortening operation. Figure 5c shows the lower end of the femur 2 years and 6 months later. He walks well with one cane and is able to walk short distances without support.

Chondrodystrophy of the left femur and tibia in the following case resulted in premature ossification of the growth cartilages at the knee with 3 inches of shortening of the leg when growth was complete. Partial equalization of length was accomplished by resection of  $2\frac{3}{4}$  inches from the distal metaphysis of the right femur.

CASE 5 (Case No. 11 Table I). R. B. was first observed at the age of 14 years. At 10 years of age it was first noted that the left leg was  $1\frac{3}{4}$  inches shorter than the right. Roentgenographs revealed exostoses of the upper and lower femur and at both ends of the tibia.

Examination on admission at The University of Chicago Clinics revealed 3 inches of shortening of the left leg with increase in the diameter of the tibia at both ends as seen in Figure 6a. He limped conspicuously. Hard bony masses were felt on the antero-medial aspect of the distal end of the tibia and on the medial aspect of the distal end of the femur. Roentgenographs of the right knee showed narrowing of the shadows of the growth cartilages but the epiphyses were not united. Roentgenographs of the left upper tibia and lower femur showed a cartilaginous exostosis on the medial femoral metaphysis and four exostoses in the upper half of the tibia. The growth cartilages were ossified.

The right femur was shortened  $2\frac{3}{4}$  inches. Figure 6b shows the appearance of the patient 3 months after operation. One year after operation his gait and appearance were normal. There was no increase in the residual length discrepancy of  $\frac{1}{4}$  inch.

## DISCUSSION

Data from the 15 cases are compiled in Table I. Cases 1 to 12 have been observed for periods of  $1\frac{1}{2}$  to 9 years after operation. The remaining 3 patients have been operated on within 6 months and are under observation. The longest period of postoperative immobilization was  $16\frac{1}{2}$  weeks in 1 case. The average period of immobilization was 10 weeks. Weight bearing with support was begun 6 to 8 weeks after operation. Postoperative infection was not encountered. In 1 instance separation of the bone ends occurred due to splitting of the intramedullary graft. In this case drill holes had not been made prior to the introduction of the transfixion screw. Reoperation was necessary.

Permanent quadriceps weakness was not observed in any of these cases. Quadriceps power returned to normal soon after removal of the plaster dressing and the duration and degree of weakness was no greater than that observed following similar periods of immobilization for other operations or injuries.

Circumferential elevation of periosteum from compact cortical bone of long bone diaphyses is a significant factor in producing avascular necrosis of the bone ends in fractures or operations. Healing of such a fracture or osteotomy is accompanied by gradual absorption of necrotic cortex and its subsequent replacement by living bone. Bridging of the ends by ossification of intermediary callus may be delayed for 6 months or longer and unless immobilization is prolonged incomplete ossification and nonunion may result. In the metaphysis where cortex is thinner and the blood supply is relatively greater extensive necrosis is less apt to occur. Metaphyseal fractures generally heal rapidly and experience with metaphyseal shortening of the femur reported here has shown that healing can be expected in approximately the time required for union of a fracture in the same location.

The lateral intermuscular approach to the distal end of the femur is simple and trauma to the quadriceps apparatus is minimal. Organization of hematomas and fibrosis of the vastus intermedius in midfemoral fractures and operations may leave permanent restric-

tion of flexion of the knee. Knee motion returned to normal 6 to 8 weeks after removal of the plaster dressing in all patients with metaphyseal shortening in this report.

Shortening the femur in the distal metaphysis minimizes the antagonistic action of hip and thigh musculature at the site of the osteotomy. The action of hip flexors and adductors may produce angulation in transverse diaphyseal osteotomies in the presence of both internal fixation and external immobilization with plaster. In osteotomies done above the condyles plaster immobilization is more effective and the adductor magnus and longus have relatively little effect on the osteotomy site. Tension of the gastrocnemius is reduced by immobilization of the knee in slight flexion.

Experience with these cases leads to the conclusion that supracondylar metaphyseal shortening of the femur is a relatively simple safe method of equalizing leg length. Operative trauma is minimal and the period of postoperative immobilization is short.

#### SUMMARY

1. The principles involved in leg length equalization procedures are discussed. Hereditary bone age sex stature amount of length

discrepancy condition of the tissues of the shorter limb and associated disability or deformity are the chief factors to be considered.

2. The causes of leg length inequality in 15 cases are enumerated.

3. A method of shortening the femur in the distal metaphysis is described.

4. Five illustrative cases and end results in 15 cases of supracondylar shortening of the femur are presented.

5. Anatomical factors related to the choice of operative site in femoral shortening are discussed.

#### REFERENCES

- CALVE, J. and GALL AND, M. *Am. J. Orthop. Surg.*, 9 8, 6 2.
- CAMBER, U. *Chir. org. movim.* 933, 7 569.
- GILL, G. G. *J. Bone Surg.*, 944, 26 272.
- GROVES, E. W. H. *Brit. M. J.* 91.
- HARMON, P. H. and KRIGSTON, W. M. *Surg. Gyn. Obst.* 940, 7 482.
- HOWORTH, M. B. *Arch. Surg.*, 94 44 543.
- MOORE, J. R. *Pennsylvania M. J.* 1913, 36 75.
- PRALLEN, G. S., and CHAFFERTON, L. C. *Surgery* 942, 12 768.
- PIEMISTAR, D. B. *J. Bone Surg.*, 933, 5.
- RITTER, R. O. *Surg. Gyn. Obst.*, 926, 43 93.
- ROSS, D. J. *press.*
- ROYLE, N. D. *Med. J. Australia*, 9 3, 7 6.
- TAYLOR, R. T. *Am. J. Orthop. Surg.*, 9 6, 4 598.
- WHITE, J. W. *J. Bone Surg.*, 935, 7 597.

# ANAL ILEOSTOMY WITH PRESERVATION OF THE SPHINCTER

## A Proposed Operation in Patients Requiring Total Colectomy for Benign Lesions

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**T**HE operation of total colectomy is most often performed for one of two conditions—multiple polypoid adenomatosis of the colon and chronic nonspecific ulcerative colitis.

Multiple polypoid adenomatosis of the colon or multiple polyposis has been well established to be a familial disease beginning with the report of Cripps. While it can make its appearance symptomatically as early as the age of 2 years (11) it is more often diagnosed in the second and third decades (9).

The therapeutic approach to multiple polypoid adenomatosis limited to the colon must be governed by the known facts concerning the condition—specifically the high incidence of malignancy developing in such polypoid adenomas and the high mortality reported. Various authors report an incidence of proved malignancy in such patients of from 26 per cent (15) to 62.5 per cent (2) with 35 to 40 per cent (6) as the most frequently reported figure. In 127 collected cases (6) 76 treated medically had a mortality of 56.5 per cent and 51 cases treated by any surgical means had a mortality of 35.1 per cent. The youngest patient diagnosed as having cancer was 12 years (7) the youngest dying of cancer was 15 years (11). Lockhart Mummery states that in all such patients cancer will develop if they survive. The usually recommended surgical treatment is resection of the involved bowel which often means a total colectomy and permanent ileostomy. A number of authors recommend fulguration of polyps in the area accessible to a sigmoidoscope and resection of the remainder

of the colon with ileosigmoidostomy. Lilienthal, Soper, Erdmann, Tom Jones (12) and Lockhart Mummery all have reported successful cases by this method. Stone and Rankin have also had such cases. However in a good number of such patients cancer has been reported to develop subsequently in the remaining rectal segment. We have had such an experience in this hospital.

### CASE REPORT

F. K. No. 100268, a white girl of 16 years entered the Johns Hopkins Hospital September 29, 1936.

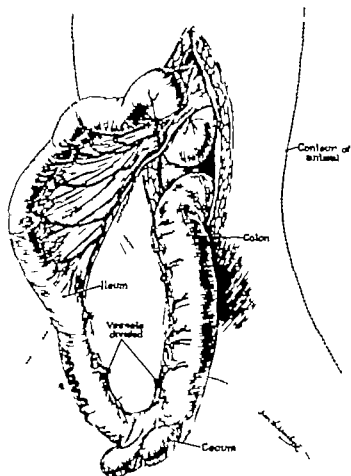


Fig. 1. Mesocolon and vessels ligated and divided. Terminal ileum mobilized by division of two arcuate vessels.

From the Surgical Hunterian Laboratory of the Department of Surgery, The Johns Hopkins University.  
Presented before The Society of Clinical Surgery, Baltimore, Md., November 1936.

Since this report was submitted the procedure described has been applied to a patient with ulcerative colitis. The result, 3 months after operation, is encouraging.



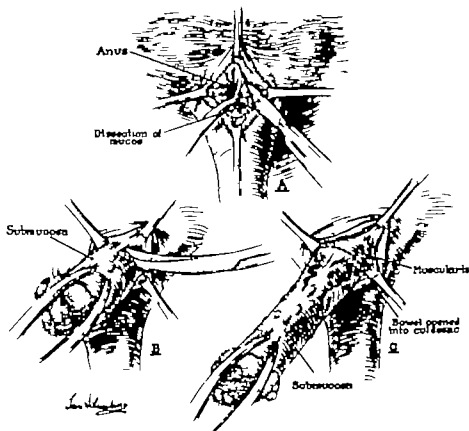


Fig. A, Circumcision of mucocutaneous junction. B, gauze pack in rectum, submucosal dissection. C, dotted line indicates incision to be made through muscularis into peritoneal cavity.

complaining of abdominal cramps and diarrhea. Her father had died of cancer of the rectum at the age of 30. For 7 to 8 years she had bouts of diarrhea with cramps but without gross blood. She was admitted on the ninth day of a severe bout of diarrhea during the last 4 days of which generalized edema had developed.

**Physical examination.** She was extremely pale and generally edematous. There was clubbing of the fingers. Polyps were felt on digital rectal examination. The blood pressure was 80 systolic and 85 diastolic. The red blood cell count was 1,870,000, the hemoglobin 30 per cent. There were nucleated red blood cells in smears. The urine had a specific gravity of 1.00, albumin 70 grams per liter and on microscopic examination there were 1 to 3 red blood cells and 1 to 3 white blood cells per high powered field. The stool was liquid and the guaiac test for blood was positive. *Escherichia coli* was recovered from the urine culture. The phenolsulfonphthalein excretion was 34 per cent in 2 hours, the urea clearance 25 per cent of normal. The nonprotein nitrogen was 76 milligrams per 100 cubic centimeters. Barium enema showed countless polyps in the entire length of the colon. Sigmoidoscopy showed innumerable

small bleeding polyps of the entire rectum and lower sigmoid.

The urinary difficulties resolved on ammonium mandelate therapy. It was concluded that she had multiple polypoid adenomatosis with a coincident pyelonephritis. She was reported from this standpoint by Longcope and Whitehill.

Total colectomy was considered and abandoned in favor of preservation of the rectum and treatment of the distal segment with the cautery. A terminal ileostomy was performed December 1, 1936, and the colon subsequently resected in stages down to the rectosigmoid. All visible polyps were fulgurated proctoscopically on 9 occasions in November and December 1937 until no more were seen. On December 31, 1937, an ileosigmoidostomy was performed after resection of 9 centimeters more of the sigmoid. This specimen contained numerous polyps. She was well thereafter in the main and able to work. Proctoscopy showed "questionable sessile polyps" on September 3, 1938, fourteen months after the last fulguration. Rectal examination on a number of subsequent admissions for pyelonephritis was negative. February 9, 1945, she returned obstructed by a carcinoma of the rectum. February 2, 1945, an abdom-

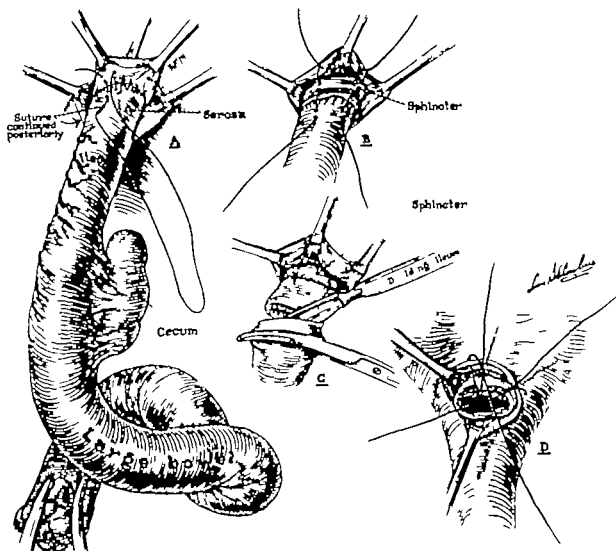


Fig. 3 A Entire colon and several inches of terminal ileum delivered. Ileal serosa sutured to serosa of everted cuff of outer rectal coats remaining. B external sphincter sutured to ileum with interrupted sutures. C, ileum transected. D ileum tacked loosely to anal skin.

Inoperineal resection with permanent ileostomy was performed. There was a large adenocarcinoma in the upper end of the rectum. The remainder of the rectal mucosa was covered by innumerable benign polyps.

She died October 18, 1945, in a convalescent home of progressive cachexia presumably due to metastases—8 years after her rectal fulgurations.

Examination of the gross specimen with myriads of polyps carpeting the rectum indicates the small likelihood that any considerable number of such cases will be cured if a segment of involved bowel is left behind for topical treatment. The disease is preponderantly familial and a genetic predisposition to polyp formation should be expected to persist in this mucosa; however, often it is fulgurated with malignant degeneration constantly threatening as long as the patient lives.

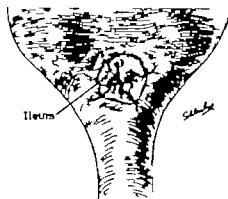


Fig. 4. Final appearance.

In short, multiple polypoid adenomatosis of the colon is a symptomatically troublesome condition with dangerous malignant potentialities. The only safe treatment is permanent eradication of the abnormal epithelium—that



Fig 5. Barium enema of dog N. 22 months after operation.

is bowel resection. When the entire colon is involved this means total colectomy. However, when operating in anticipation of but not in the presence of an established cancer, there is no need to remove the external sphincter.

Chronic nonspecific ulcerative colitis is not fundamentally a surgical disease. Its treatment should be medical, and undoubtedly there will be found a basically sounder treatment than diversion of the fecal stream, and occasional subsequent extirpation operations. At present, however, it can be accepted that ileostomy is often life-saving if undertaken sufficiently early (5, 17). That a certain percentage of patients will continue to have such troublesome symptoms after ileostomy in large bowel diseased beyond any hope of restitution to a functional state that colectomy will be required (1, 13). In these patients likewise, excepting those with multiple perineal and perianal fistulas, there is no need for sacrificing the sphincter ani.

In the experiments to be described the entire colon is resected, the sphincter preserved

and the ileum mobilized and sutured to the anus. The operation is offered for patients requiring total colectomy for nonmalignant conditions. From the standpoint of surgical therapeutic philosophy, this procedure has no relation to those designed to avoid colostomy in patients with cancer of the rectum and sigmoid.

#### OPERATIVE TECHNIQUE

Under intravenous nembutal anesthesia, the vessels and mesentery of the colon are divided and the terminal ileum is mobilized in a manner analogous to that employed for mobilization of the jejunum in esophagoplasty—division of one or more arcuate vessels and the attached mesentery—until the ileum will reach the perineum (Fig 1). The intestine is then replaced and the abdomen closed. In the dog it is impractical to attempt a reconstruction of the pelvic peritoneum. The anus and rectum are then cleaned and the anus packed with dry gauze to support the mucosa in the dissection. The anal margin is held with Allis clips and a circular incision made in the mucocutaneous junction (Fig 2A). Dissection is carried up submucosally, the developing cylinder of mucosa and submucosa being clamped to the gauze sponge (Fig 2B). With traction the bowel almost peels out. When a flap 5 or 6 centimeters long has been developed, incision is carried through the outer rectal coats (Fig 2C) into the peritoneal cavity. This frees the bowel which can be delivered through the intact sphincter. The entire colon and the mobilized ileum are delivered (Fig 3A). The flap of outer coats of rectum is drawn down and everted so that it can be sutured to the ileum serosa to serosa. A continuous suture of No. 0000 catgut is employed to seal off the peritoneal cavity. This is followed (Fig 3B) by interrupted sutures of the same material tacking the sphincter to the bowel. The ileum is then transected (Fig 3C) and loosely sutured to the anal margin (Fig 3D) with interrupted silk.

The final result is surprisingly normal in appearance (Fig 4). An observer accustomed to sigmoidoscopy dogs passed a sigmoidoscope on one of these animals 8 days after operation, reported no lesion and did not suspect the

true state of affairs. The dogs vary in their reaction to the operation. Good sphincter tone is regained. Defecation is apparently voluntary and more or less deliberate. The stools change from liquid to soft as time passes but the softness of the stools remains a problem which the dogs seem to solve by several small soft stools during the day and one copious stool at night. Dogs tolerate ileostomy poorly and some of those surviving have shown considerable perianal excoriation during the weeks immediately following operation gradually healing entirely. The x ray film (Fig 5) taken 5 months after operation in a dog who was operated upon 6 months before the time of this report, shows no dilatation of the ileum.

The dogs were operated upon in two groups. Neither received parenteral fluids before or after operation and no attempt was made in either to replace the fluids lost through the ileostomy. In the first group no antibiotics of any kind were given. Of 22 dogs 11 died of infection usually pelvic abscesses and peritonitis. In the second series the dogs received 0.5 gram of sulfasuxidine per kilogram per day for 4 days preceding operation (twice the usually calculated dose but given in 4 doses per day rather than 6) and 300 000 units of penicillin in oil and beeswax an hour before operation and another 300 000 units 24 hours later. None of the 6 dogs in the second group has shown any infection.

In man it may not be desirable to perform this operation regularly in one stage particularly for ulcerative colitis. However the feasibility of repairing the pelvic peritoneum and the possibility of pulling through a long stump of ileum to be divided later (we feared dogs would gnaw away such a stump) suggest to us that the operation should be safer in man than in the dog. We think that it may prove a feasible method of avoiding a permanent abdominal ileostomy in the patients requiring total colectomy for benign lesions.

#### REFERENCES

1. CATTELL, R. B. *Surg Clin N America* 1944 24 656-660.
2. COFFEY, R. J. and BARGIN, J. A. *Surg Gyn Obst.* 1939, 69 136-145.
3. CRIPPS, W. H. *Tr Path Soc Lond* n 1882 33 165.
4. ERLMANN, J. F. and MORRIS, J. H. *Surg Gyn Obst.* 1925 40 460-468.
5. GARLOCK, JOHN H. *Ann. Surg.* 1941 113 2 14.
6. HULLSIEK, H. E. *Surg Gyn Obst.* 1928 47 346-350.
7. KENNEDY, R. L. *J Am. J Dis Child* 1941 62 481 488.
8. LILIENTHAL, H. *Am. Med.* 1901 1 164 165.
9. LOCKHART MUMFERY, J. P. *Ann Surg.* 1934, 99 178-184.
10. LONGCOPE, W. T. and WHITEHILL, M. R. *Internat Clin* 1937 3 15 19.
11. MCKENNEY, D. C. *Am. J Surg.* 1939 46 204 216.
12. Idem *J Am. M. Assn.*, 1936 107 1871 1876. *Discussed by Tom Jones.*
13. MCKITTRICK, L. S. and MILLER, R. H. *Ann Surg.* 1935 102 656-673.
14. RANKIN, Fred W. *Personal communication.*
15. SOPER, H. W. *Am J M Sc.* 1916 151 405 409.
16. STONE, H. B. *Personal communication.*
17. STRAUSS, A. A. and STRAUSS, S. F. *Surg Clin N America*, 1944 24 211 224.

# TENDON TRANSFER OPERATION FOR IRREPARABLE PARALYSIS OF THE RADIAL NERVE

## Long Term Follow-up of Patients

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**A**MONG the reconstructive operations brought to the foreground by World War II are the various types of tendon transfers for paralysis of the radial nerve. Most surgical reports on this procedure date back to World War I and shortly thereafter moreover there are few recorded follow-ups of more than a few months. The primary objective of this paper is to evaluate the results of tendon transfer operations for paralysis of the radial nerve as late as 26 years after operation.

Murphy in 1914 reported 2 cases of transfer of the flexor carpi radialis tendon to the extensor pollicis longus and extensors of the fingers for radial paralysis with excellent results. Murphy also indicated that he had done several operations of the same type previously. Byrne in June 1916 reported attaching the flexor carpi radialis to the extensors of the thumb and fingers. The tendon transfer in this case was performed 2 years after destruction of the radial nerve and the result was good.

Credit for the operation was given to Murphy. Sir Robert Jones in May 1916 wrote two excellent papers on tendon transplantation in which he discussed in detail operations for paralysis of the radial and median nerves. He indicated good results in 3 cases in which operation was performed by his associate McMurray. In the same year Henry described 1 case in which the flexor carpi radialis was pulled through the interosseous membrane and attached to the four finger extensors and the palmaris longus was inserted into the distal stump of the flexor carpi radialis. Weitz described methods and reported 2 cases. Schreiegg discussed technique in detail.

Between 1919 and 1922 tendon transfer operations for irreparable paralysis of the radial nerve were described and cases reported by many investigators. McMurray and Jones were the chief advocates of the following type of operation: (1) pronator teres into the two extensors carpi radiales, (2) flexor carpi ulnaris into either all four extensors of the fingers or in McMurray's method to the ulnar three, and (3) flexor carpi radialis into the abductor pollicis longus, the extensor pollicis brevis and in McMurray's cases also to the extensor of the index finger (Fig. 1). Jones also inserted the palmaris longus into the extensor pollicis longus. In this country Billington introduced an operation essentially the same as that described by Jones. Pennell in 12 cases prevented ventral flexion of the wrist by means of a fascial graft from the third and fourth metacarpals to the radius. The flexor carpi radialis tendon was passed through the pronator quadratus or interosseous membrane to the extensors of the fingers. The palmaris longus was then inserted into the extensor pollicis brevis. Starr had 50 per cent of excellent results and only 1 failure in 52 cases in which the pronator teres was inserted into the extensor carpi radialis longus and extensor carpi radialis brevis, the flexor carpi radialis into the four finger extensors and the palmaris longus into the extensors and abductor longus of the thumb. Stevenson in 50 cases reported good results at 12 weeks in an operation similar to that of Jones.

Intervening years have yielded few articles on this subject except discussions of methods found in textbooks dealing with the hand (4, 10) however in 4 cases with a maximal follow-up of 6 years good results were reported by Abbott in 1944 in an operation similar to that of McMurray along with arthrodesis of the wrist. Sudeck in 1943 described principles

From the Section on Orthopedic Surgery, Mayo Clinic, and the Section on Surgery, Mayo Foundation.  
Read before the Clinical Orthopedic Society, October 12, 1946, Rochester, Minnesota.

to be observed. Recently Altman and Trott emphasized the value of numerous short incisions including a 2 inch (5 cm) transverse one on the dorsum of the wrist. In contrast to the right angle or U incision on the dorsum of the wrist there was never slough. In 16 cases good results were obtained with usable grip in all. Dorsiflexion of the wrist was limited to approximately 25 degrees and extension of the fingers was incomplete by 15 degrees. The tendon transfer was similar to the Jones operation. The follow up was brief since most of the patients had been wounded in World War II.

Zachary in April 1946 went into great detail concerning methods of quantitative measurement of results of tendon transfer operations for paralysis of the radial nerve. In the 57 cases of dorsal interosseous or radial nerve destruction exacting preoperative and postoperative studies of function were made. The paper should be studied by all future students in this field since quantitative methods will aid greatly in arriving at a conclusion as to the best types of tendon transfers. In 24 cases the flexor carpi ulnaris and flexor carpi radialis were transferred to the thumb and fingers (Jones's type of operation). Very poor extension of the fingers resulted in 6 of these cases in which there was no palmaris to help maintain some flexion at the wrist. Results in the other 18 cases with a palmaris longus present were somewhat better. In this series of 24 cases 50 per cent of ideal function based on degrees of motion and strength was calculated. In 29 instances the flexor carpi radialis was left intact and the flexor carpi ulnaris was passed to the finger extensors and in a few cases to the thumb extensors. In other instances the thumb extensors were activated by the brachioradialis by the palmaris longus or by an active wrist extensor. Zachary expressed the opinion that transfer of the pronator teres to the radial wrist extensors is of value and has little effect on ability to pronate the forearm. His conclusions would indicate that function is incomplete unless the wrist retains one flexor muscle, finger extension being only 21 per cent in the one instance and 97 per cent in the other. Ability to flex the wrist to neutral position was 40 per cent versus 100 per cent

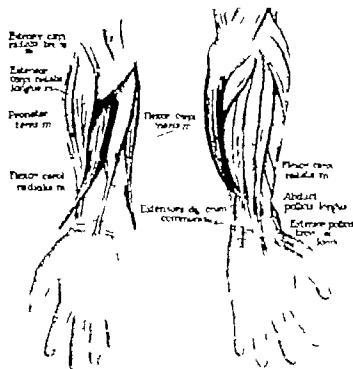


Fig. 1. Anatomy of tendon transfer operation of the Jones type with the exception that the palmaris longus is left intact rather than inserted into the extensor pollicis longus.

and range of thumb extension was 16.5 per cent versus 69 per cent. The over all result was  $50 \pm 5$  per cent versus  $91 \pm 0.4$  per cent of ideal function. Each case is covered in detail in a chart.

#### METHODS

Twenty three patients who had destruction of the radial nerve and 5 who had loss of the dorsal interosseous nerve high in the forearm were studied. In all instances the site of injury of the nerve was explored and the nerve was found destroyed over a considerable distance or an anastomosis of the nerve ends was attempted with no sign of improvement for at least 1 year. All persons on whom the operation was performed through 1945 are included in the series despite complicating factors such as contractures and other nerve injury in some cases.

The follow up consisted of a form letter in which the patient was asked to compare various functions of the injured extremity with the corresponding functions of the normal side in terms of excellent, good, fair or poor. The general over all impression of the patient was asked along with the specific degree of func-



Fig. 2. Complete radial paralysis. Result 1 month after Jones type of operation. Note extent of wrist motion and extension of thumb but slightly incomplete extension of fingers.

tion as related to the extent of wrist motion, finger extension, thumb extension, fist and strength of grasp. In addition, nearly all patients were seen and examined at least 2 months or longer after the original operation. Photographs and, in recent years, motion pictures were studied to aid in evaluating the results. In most instances in which all three methods of evaluation were used on one patient, results agreed closely. Of necessity, we are unable to evaluate our results in terms of degrees of motion or percentages because the personal examinations were done over a period of many years by many different observers. However, by studying photographs, impressions of the examining physicians and letters from the patients, we have arrived at some valuable conclusions.

The tendons used and methods of transfer varied greatly. The Jones operation (Fig. 1) was performed in 10 cases, the McMurray type in 4, and the Jones type without transfer

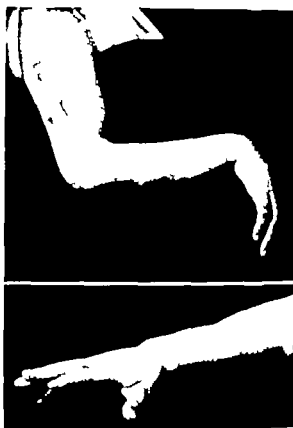


Fig. 3. a, above, Complete paralysis of the radial nerve, 9 weeks after operation. b, 6 weeks after operation. With excellent extension of fingers, thumb, and wrist.

of the pronator teres in 5. The technique in the remaining 9 cases varied greatly. The cutaneous incisions in most cases were of the extensive type, including a J incision on the dorsum of the wrist. At the present time, however, small incisions at the sites of insertion of the flexor carpi ulnaris and the flexor carpi radialis, midway up the forearm over the body of each of these muscles and approximately in the midarm over the insertion of the pronator teres, along with a somewhat longer incision just proximal to the dorsal carpal ligament, are favored because of less tendency to scar and absence of necrosis of the skin.

#### RESULTS

The over-all result (Figs. 2, 3, 4, and 5) for 28 cases was excellent in 10 cases, good in 13, fair in 5, and poor in none. When broken down into various operations, the results were similar for each operation.

Six patients on whom operation had been performed between 11 and 26 years prior to their latest observation showed 3 excellent and 3 good results. This corresponded closely to the findings in those having transfers less than 1 year old; however patients on whom operation had been performed relatively recently were of course much less dexterous with their hands and fingers. In general it would appear that the ultimate outcome can be predicted by the findings a few months after operation.

The duration of complete muscular paralysis prior to operation varied from 2 months up to 23 years; in the latter case the result at 6 weeks was good. Strangely enough the results were not related to the duration of paralysis.

Only 1 patient showed what appeared to be an incomplete ability to flex the fingers because of the transferred tendons being inserted too near the dorsal carpal ligament. Several others had incomplete flexion of the fingers when the wrist was flexed; however from a practical standpoint fingers are rarely flexed with the wrist in ventral flexion.

Extension of the fingers was in all instances sufficient to permit normal function of the hand although in many cases the little finger did not extend as completely as the other three. In most of the cases there was inability to extend the fingers completely with the wrist in neutral position along with a tendency to extend the wrist somewhat on attempted complete extension of the fingers. This seemed to have little effect on the value of the hand and

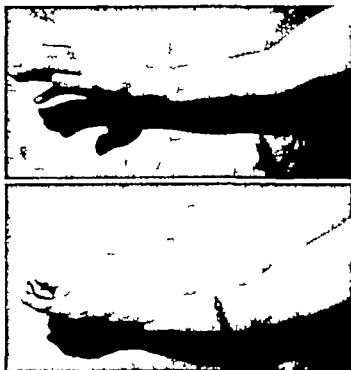


Fig. 4. Same case as Figure 3. Twenty six years after operation. The patient reported essentially normal function of her hand.

was less frequent in patients years after operation.

Although many types of tendon transfers were done to bring about extension of the thumb the degree of motion was universally sufficient to provide excellent function.

Wrist motion and grasp were satisfactory in most cases. Some of the patients are now doing manual labor and using their hands with no favoritism. Among the patients mention was made of ability to use the hand with ease when typewriting, playing the piano, golfing

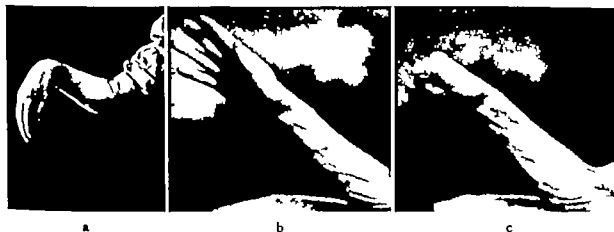


Fig. 5. a, Complete paralysis of the radial nerve, 1920. b, 16 months after operation extension is excellent. c, 16 months after operation patient is able to make a satisfactory fist. In 1946, 26 years after operation, he reported a satisfactory result.



welding and so forth. One patient was on full duty in the armed services. In no instance did a patient regret having had the operation.

#### CONCLUSIONS

Our series of 28 cases of irreparable destruction of the radial or dorsal interosseous nerve with a maximal period of follow up of 26 years reveals that tendon transfer operations for radial paralysis are very successful as a rule. The exact type of operation in our cases seemed to make little difference, however, by using the quantitative measurements of results as recommended by Zachary the value of the individual types of operation can be more carefully ascertained in the future. We are inclined to feel that it is better to have the wrist extensors somewhat stronger than the flexors since slight extension of the wrist is necessary to produce a strong grasp although there is no question but that the fingers will extend more completely in the presence of fairly strong wrist flexors. We recommend leaving the flexor carpi radialis intact provided the palmaris longus or some other active muscle is available for extension of the thumb. Arthodesis of the wrist was not done in any case and we feel that it is usually not necessary. Numerous short cutaneous incisions are

preferred to extensive incisions with much undermining of cutaneous edges. As in all surgical procedures on the hand good hemostasis and a minimum of trauma to tissue are essential. The flexor carpi ulnaris must be attached to the finger extensors sufficiently far from the dorsal carpal ligament to prevent impingement and fixation when flexing the fingers.

#### REFERENCES

1. ABBOTT L. C. *J Nerv Ment Dis.*, 94, 99 466-474.
2. ALTMAN HAROLD, and TROTT R. H. *J Bone Surg* 94b, n. s. 8 440-446.
3. BILLIMOTON R. W. *J Bone Surg* 9 2, n. s. 4 535-547.
4. B. KNEEL, STERLING. *Surgery of the Hand*. Pp. 295-296 Philadelphia J B Lippincott Co 1944.
5. BYRNIE, P. *J Practitioner* 1916, 96 642-644.
6. HENRY A. K. *Lancet*, Lond 9 6 18.
7. JONIA, ROBERT. *Brit. M J* 9 6 1 64-643 670-682.
8. Idem. *Am J Surg.*, 921 35 333-335.
9. McMURRAY T. P. *J Orthop. Surg* 19 9, 1 35.
10. MURPHY, WALTER. *Orthopaedic Surgery* 3d ed., pp. 548-550. Baltimore Williams & Wilkins Co 943.
11. MURPHY J. B. *Surg Clin J hn B Murphy* 9 4, 3 467-5.
12. PIERCE, VERNON. *Brit. M J* 9 9, 704-705.
13. SCHREIBER, HANS. *Munch. med. Wochr* 9 2, 370-37.
14. STARR, C. L. *J Bone Surg* 912, n. s. 4 3-3.
15. STEVENSON G. H. *Glasgow M J* 19 3, 99 2 5-230.
16. SUMICK, PAUL. *Chirurg.* 943 15 665-669.
17. WITZ, H. *Deut. med. Wochr* 19 6, 2 35.
18. ZACHARY R. B. *Brit J Surg* 916, 33 353-364.

# RADICAL AMPUTATIONS OF THE EXTREMITIES IN THE TREATMENT OF CANCER

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AS our knowledge regarding the anatomic and clinical behavior of tumors of the soft somatic tissues increases and as our therapeutic experiences radiologic as well as surgical in the treatment of cancer of the limbs accumulate, certain definite concepts emerge. Throughout a period of twenty years there were over fifteen hundred cases of malignant tumors of the soft somatic tissues of the upper and lower extremities and the trunk, including over nine hundred cases of melanoma encountered on the Mixed Tumor Service of the Memorial Hospital. Perhaps the most significant realization garnered from this experience is that highly malignant connective tissue growths, melanomas, and selected cases of metastasizing epitheliomas must be dealt with radically at the onset if there is to be any hope for the patient's survival. It has been definitely proved that the prognosis becomes progressively poorer with an increasing number of recurrences following repeated local surgical excisions and conservative amputations, due to an obviously higher incidence of visceral metastasis.

Nowhere are these particular groups of cancers more favorably located for the application of radical surgical methods than on the limbs, especially when the regional lymph nodes have already been involved by the disease. Wide local excision of the primary tumor subsequently followed by a regional node dissection has proved to be an unsatisfactory surgical program in such a situation, for with this method the intervening lymphatic pathways are left intact. Only by excision and dissection in continuity can the primary lesion, intervening lymphatic pathways, and the involved regional nodes be entirely removed.

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*Excision and dissection in continuity* (4) is a term which we have employed to designate radical excision of the primary tumor intervening lymphatics and all regional lymph nodes by the same encompassing incisions. A wide removal of contiguous skin and even wider bloc of underlying fascia are included in the dissection. The surgical principle of excision and dissection in continuity is the same one on which the well established operations for breast and rectal cancer are based, namely, radical removal in continuity of the primary growth, intervening lymphatics, and the regional lymph nodes in one stage. If however the primary tumor is located too far from the first relay of lymph node metastasis (melanoma of the toe with metastasis to the inguinal lymph nodes), treatment by excision and dissection in continuity is not feasible. In such a case, only by exarticulation of the limb combined with excision of the regional lymph nodes can all gross limitations of the disease be widely removed—*interscapulothoracic amputation* (with or without supraclavicular neck dissection) for the upper extremity and *hip joint disarticulation* (with or without deep iliac dissection) or *sacroiliac disarticulation (hemi-pelvectomy)* for the lower extremity, depending on the clinical and anatomic factors present in the given case. The indications, surgical technique, and end results for all 3 of these radical amputations have previously been published by us (2, 5, 6).

The purpose of the present report is to analyze all of our cases of radical girdle amputations for malignant tumors in an effort to evaluate the usefulness of these operations for situations which have hitherto been considered practically hopeless. In addition, the value of radical amputation of the limbs in the palliative treatment of cancer will be discussed. This study is based upon 65 patients who were

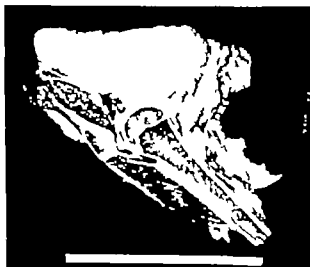


Fig. 1. Surgical specimen from an interscapulothoracic amputation. Bilky fibrosarcoma presenting as axillary tumor. 7-year-old boy. Growth as densely adherent to postrior aspect of the scapula as head of humerus. This neoplasm could be removed only by radical girdle amputation. Such low grade spindle cell sarcomas of the fascial tendon aponeurotic type are non-metastasizing and the prognosis following *ad quod* surgical removal is excellent.

subjected to one of the three major amputations with or without a combined regional node dissection. All except 3 of these operations were performed on the Mixed Tumor Service of the Memorial Hospital from 1926 to 1946 without a single operative death.

#### INTERSCAPULOTHORACIC AMPUTATION

Interscapulothoracic amputation is an operation devised to remove the entire upper extremity, scapula, clavicle and their muscular attachments in one stage. The surgeon who performs such an extensive and mutilating procedure should have a clear conception of its indications and end results together with a comprehensive knowledge of the natural history of tumors.

**Indications.** The indications for this operation are malignant tumors of the upper limb which extend to or through the capsule of the shoulder joint or in its vicinity, extensive infiltrating cancers involving the deltoid, subscapular and pectoral muscles, particularly the unencapsulated myosarcomas, neurogenic sarcomas, liposarcomas, synoviomias, fibrosarcomas and spindle cell sarcomas of undetermined histogenesis, massive axillary neo-



Fig. 2. Melanoma of the skin of the shoulder. Large, keratinized, infiltrating melanoma (with demonstrably involved lymph nodes (proved by aspiration biopsy) in the lower neck and axilla. Excision and dissection in continuity would not be feasible in this case. Nothing less than an interscapulothoracic amputation combined with a lower (supraclavicular) neck dissection should be elected. The presence of this anatomic distribution in order to remove completely the gross limitations of the disease as local. The prognosis following even such a radical surgical program is guarded in view of multiple node metastases to more than one regional lymphatic basin.

plasms, especially where they have become adherent to major blood vessels, the brachial plexus, shoulder joint, scapula or clavicle, sarcomas of the scapula and clavicle where there is invasion of the axilla or shoulder joint (Fig. 1).

In the treatment of melanoma of the skin of the upper limb with demonstrable involvement of the axillary lymph nodes (proved by aspiration biopsy) and in anatomically similar tumors, interscapulothoracic amputation is indicated whenever the practice of excision and dissection in continuity cannot be technically carried out (Fig. 2). Thus the principle of exarticulation of the limb combined with excision of the regional lymph nodes is applied in this way the axilla is encompassed

and excised rather than entered and dissected resulting in an *en masse* removal of the nodes an obviously desirable method of eradicating a regional lymphatic basin which contains melanoma. In the event that the supraclavicular lymph nodes are also involved by tumor a lower neck (supraclavicular) dissection can be included in the operation (Fig 3).

This radical amputation occasionally has a definite place in palliative therapy. When an extensive cancer involving the upper limb and shoulder girdle has become ulcerated and infected with the production of uncontrollable intractable pain it might be prudent in selected cases, to subject the patient to interscapulothoracic amputation even when distant metastasis has occurred. Elimination of sepsis and pain conversion to ambulation and partial activity can be accomplished in certain hopelessly advanced cases only by radical amputation.

In our series of 25 cases, interscapulothoracic amputation was performed for melanoma in 6 cases spindle cell sarcoma of undetermined histogenesis in 5 cases neurogenic sarcoma in 3 cases 2 cases each for rhabdomyosarcoma fibrosarcoma, synovioma and lymphangiosarcoma 1 case each for paraganglioma myosarcoma and epidermoid carcinoma. Five of the operations, or 20 per cent were performed for palliative purposes only. In 6 cases the procedure was combined with a lower (supraclavicular) neck dissection.

The oldest patient was 72 years and the youngest 10 years of age the average age was 34 years.

**Operative considerations** As previously mentioned graphic illustrations of the operation and a description of our standardized technique were published in 1942 (2) at which time we stated that the anterior or pectoral approach of Kocher was preferable to the classical Berger operation.

After the middle third of the clavicle has been resected the ligation of the subclavian vessels is postponed until the anterior incision is carried through the pectoral muscles into the axilla this part of the dissection is similar to the same phase of a radical mastectomy as the axillary artery and vein come immediately

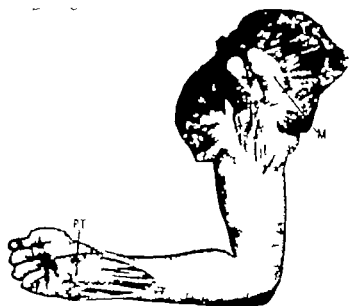


Fig 3. Surgical specimen from an interscapulothoracic amputation combined with a lower (supraclavicular) neck dissection. Synovioma involving the flexor tendons of the wrist with metastasis to the lymph nodes of the axillary and supraclavicular spaces. The surgical principle of excision of an extremity combined with excision of the regional lymph nodes is clearly indicated in this case. This type of tumor rivals that of melanoma in its malignant propensities. Operation performed under epidural anesthesia administered by one of us (FCG). PT primary tumor M metastasis.

into view. With adequate exposure of the axilla and its contents the subclavian vessels are more readily located and the underlying artery mobilized and ligated without the hazard of injury to the overlying vein. Ligation of the subclavian vein is delayed as long as is feasible to allow the limb to drain itself of as much blood as possible. Division of the pectoral muscles gives an excellent exposure of the brachial plexus whose trunks are individually divided and ligated.

The linear incision over the clavicle is extended out to the acromion. The posterior flap is outlined by incising the skin along the vertebral border of the scapula uniting it with the anterior axillary incision along the lateral axillary border. The muscles along the vertebral border of the scapula are transected care being taken at this time to ligate the transverse cervical artery. The amputation is completed after the muscular attachments of the scapula have been severed. Most of the wounds are closed without drains.

**Complications** Healing is unusually good in

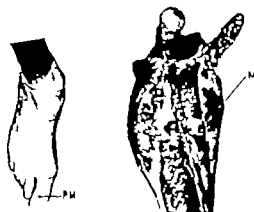


Fig. 4. Surgical specimen illustrating principle of excision and amputation of an extremity combined with excision of involved regional lymph nodes. This patient, 6 year old diabetic, developed subungual melanoma (melanotic whitlow) the size of match head on the right great toe with bulky metastasis to the femoral triangle. The surgical principle of "excision and dissection in continuity" could not be utilized in this case because the first relay of lymph node metastasis as too far removed from the primary lesion. Thus, the only method whereby the primary tumor, intervening lymphatics, and involved regional lymph nodes could be removed in their entirety was by amputation through the hip joint combined with deep iliac dissection. *P M* primary melanoma. *M M* metastasis.

these cases. Skin grafting is resorted to in instances in which the size and the location of the tumor and the degree of skin involvement require a greater sacrifice of skin.

Shock is rarely encountered and then is only minimal when proper sustaining measures, such as the use of blood during the operative procedure, are employed.

If a tumor is fixed the pleural cavity might be entered with resultant pneumothorax especially if the supraclavicular neck dissection is also carried out. This occurred in one of our cases; the pleural rent was repaired, the pneumothorax was appropriately aspirated and the patient's convalescence was uneventful. Injury of the thoracic duct by a left interscapulothoracic amputation may conceivably occur especially when combined with a lower neck dissection although this complication was not encountered in the present series. Tributaries of the thoracic duct are ligated with fine wire or nylon and transected.

**Prognosis following interscapulothoracic amputation.** The usefulness and limitations of this or for that matter any surgical procedure can be determined accurately only by

TABLE I.—INTERSCAPULOTHORACIC AMPUTATION FOR MALIGNANT TUMORS. MEMORIAL HOSPITAL SERIES—MIXED TUMOR SERVICE—END-RESULTS 1926 TO 1946

Total number of cases	35
Indeterminate group	
Total number of indeterminate results	1
Dead as a result of other causes and without recurrence	0
Lost track of without recurrence	1
Determinate group	
Total number minus those of indeterminate group	34
Failures	
Total number of failures in treatment	1
Dead as result of cancer	0
Lost track of with disease (probably dead)	1
Living with recurrence	0
Successful results	
Free from disease at last examination	33
End-results	
Successful results divided by determinate group (33/34)	97 per cent.

careful examination of all patients, if possible, at frequent intervals. Thus, valuable data with regard to the subsequent clinical course are accumulated, the analysis of which is of paramount prognostic import. End-results are reliable only when computed on such a basis. No patient was lost to follow up examination in the present series of 25 interscapulothoracic amputations.

According to the histologic type of lesion for which this operation was employed, the prognosis was best for neurogenic sarcoma, fibrosarcoma and spindle cell sarcoma of undetermined histogenesis, respectively. The least satisfactory results followed amputation for melanoma and synovium. Other histologic types were encountered much too infrequently usually singly so that a discussion on prognosis regarding these would not be in order.

In about 75 per cent of our cases, the primary lesion on the limb was also associated with metastasis to the axilla (proved by aspiration biopsy) and of the remaining cases, the primary tumor was located either in the axilla, or in the supraclavicular or infraclavicular spaces. The anatomic site of the tumor in those

patients operated on for curative purposes rather than for palliation, decidedly affected the eventual outcome for whenever the primary growth was situated in or about the axilla or shoulder the prognosis was much more favorable. The tendency for nonmetastasizing sarcomas of the fascial tendon type and of other low-grade (unclassified) spindle cell sarcomas to select the axillary and scapula regions so frequently explains the more favorable results which follow interscapulothoracic amputation for malignant tumors primarily located in the proximal end of the upper limb.

In radical amputation of the shoulder girdle whenever a supraclavicular or lower neck dissection was carried out during the same operative seance, the prognosis was not nearly as favorable as in the other clinical subgroups. Of 6 such cases 4 were performed for melanoma and 1 each for synovioma and squamous carcinoma. Three of these patients died of visceral metastasis. It must be remembered however that 2 of these amputations were performed for palliative purposes only which would ostensibly lower the net survival rate particularly for the combined operation (plus neck dissection) on the upper limb under discussion at the moment.

Interscapulothoracic amputation has a definite although limited use in the palliative therapy of cancer. In the present series of 25 cases, 5 were knowingly performed for palliative purposes only and of these 2 patients survived one year or more. Elimination of sepsis and pain and conversion of a bedridden frequently malodorous patient to comfort and ambulation may occasionally be accomplished by such radical surgical methods.

In addition to the histologic type of lesion the anatomic site, the performance of a superimposed partial neck dissection and the indication for operation the last but perhaps the most important factor affecting the prognosis following interscapulothoracic amputation is the number of previous surgical procedures (local excision, conservative amputation, axillary dissection, scapulectomy) performed before radical operation is carried out. In 63 per cent of our cases, the patient had been subjected to at least one such surgical procedure in an attempt to eradicate the



Fig. 5. Surgical specimen from hip joint disarticulation. Endothelioma of the femur in a 9 year old girl treated with several courses of heavy irradiation elsewhere, with no regression of the tumor. On admission the patient was bedridden and suffering from intractable pain because of the ulcerated septic condition of the limb. Hip joint disarticulation was elected in spite of pulmonary metastasis, purely as a palliative measure. This patient lived for 5 years following radical amputation, enjoying comfort and ambulation.

growth and 7 patients had undergone two or more operations before interscapulothoracic amputation was finally done. As can be seen in Table I the prognosis following this operation grows progressively worse with an increasing number of local recurrences due to a proportionately greater incidence of multiple regional node involvement and visceral metastases. This was particularly striking for melanoma, synovioma and highly malignant unclassified spindle cell sarcoma. Only when interscapulothoracic amputation will be utilized as the initial treatment provided that the indication is clear will the net survival rate following this operation be appreciably improved.

**End results.** In this reported series of 25 interscapulothoracic amputations for cancer, 13 patients were operated on during the past 4 years and in 5 cases the operation was performed as a palliative measure. Of the 20 curative operations 60 per cent of the patients

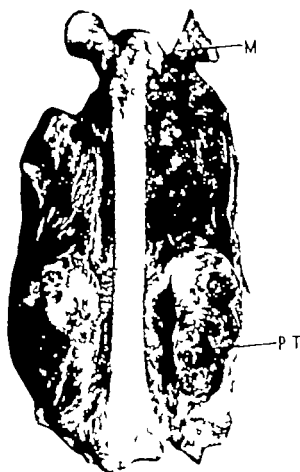


Fig 6. Spindle cell sarcoma of the thigh with metastases to the inguinal lymph nodes. Bisected surgical specimen from hip joint disarticulation combined with deep iliac dissection to illustrate the surgical principle of exarticulation of an extremity and excision of involved regional lymph nodes in one stage for the treatment of tumors other than melanoma. P T primary tumor M metastasis

were alive at the time of the analysis without evidence of recurrence or metastasis. The overall survival rate for the entire series is 54.2 per cent (Table I). The 5 year survival rate based on 11 cases in which patients were operated upon prior to June 1941 is 45.5 per cent.

#### HIP JOINT DISARTICULATION

As with cancers of the upper limb the management of malignant tumors of the lower extremity often entails amputation and of the various surgical techniques employed hip joint disarticulation in selected cases, combined with deep iliac dissection if necessary

gives promise of becoming most effective. The present discussion is based on a personal experience with 32 cases of amputations through the hip joint in 12 of which an *en bloc* excision of the iliac lymph nodes was carried out during the same operative seance. The oldest patient was 72 years and the youngest 3 years of age the average age was 39 years.

**Indications.** Large malignant tumors of the soft parts of the middle and upper thigh which cannot be completely removed by wide excision and for which a high thigh amputation cannot assure an adequate margin are best treated by hip joint disarticulation. For malignant melanoma of the skin of the lower limb where involved inguinal and femoral lymph nodes are far removed from the primary tumor the principle of excision and dissection in continuity cannot be applied under such circumstances hip joint disarticulation combined with deep iliac dissection will accomplish effective removal of the primary tumor intervening lymphatics, and all surgically accessible lymph nodes (Figs. 4 and 6).

Malignant tumors of bone and periosteum which occur in the middle and upper femur and for which a high thigh amputation cannot assure an adequate margin should be treated by hip joint disarticulation. Endothelial myeloma in such a location should be similarly treated if exhaustive studies have demonstrated absence of disease elsewhere.

This operation has a definite place in the palliative treatment of selected cases of cancer of the lower extremity. When the lower limb is the seat of a bulky ulcerated infected foul-smelling growth which involves the upper thigh (malignant lymphoma, Kaposi's multiple hemorrhagic sarcoma, primary malignant tumor with distant metastases, metastatic carcinoma) and the patient's general condition has not deteriorated too much amputation through the hip joint for palliation and comfort is occasionally justified (Fig. 5). If exarticulation of the hip joint is performed for either a primary operable malignant tumor or for palliative purposes only it is requisite that the neoplastic process should not extend to or through, the hip joint otherwise nothing less than amputation through the sacro-iliac joint (hemipelvectomy) will suffice.

In this series of 32 hip joint disarticulations 8 were performed for spindle cell sarcoma of undetermined histogenesis 7 for melanoma 5 for neurogenic sarcoma 4 for synoviuma 2 each for rhabdomyosarcoma chondrosarcoma and endothelioma 1 each for reticulum-cell sarcoma and osteogenic sarcoma Two of the amputations were performed as a palliative measure

**Preoperative considerations** Precautions should be taken to prevent shock The use of an Esmarch or elastic bandage wrapped around the limb to be amputated is invaluable in conserving circulating blood volume It should be carefully applied several hours before the operation is done An elastic bandage is definitely contraindicated however in cases of melanoma where it might possibly aid in the dissemination of tumor cells into the blood stream Constant administration of whole blood during the operative procedure is of course an essential feature in the prevention of shock which may occur following massive or uncontrollable hemorrhage although this was not once encountered in any of our cases

In the event that the tumor is ulcerated and infected daily local treatment, consisting of gentle débridement cleansing and anti septic sprays and frequently applied wet dressings and chemotherapy is of distinct value in reducing the septic condition of the limb

A Foley urethral catheter is inserted into the urinary bladder before the patient is taken to the operating room

**Operative considerations** Our standardized technique has recently been graphically illustrated (5) and will not be repeated in detail

An anterior racquet incision is used The neuromuscular bundle in Scarpa's triangle is cleared and the femoral artery is ligated and divided (*above the profunda femoris*) as is the femoral nerve Thick skin flaps are developed after which all anterior muscle groups are transected as near to their insertion as possible It is advisable to cut the sartorius and rectus femoris rather low so that they may be later used to cover the acetabulum The femoral vein is then ligated and divided thus completing the anterior dissection

Adduction and internal rotation of the limb bring the greater trochanter into view so that

the muscles which insert into it may be severed after which the muscles of the gluteal group are cut The capsule of the hip joint is incised and by further vigorous adduction of the limb the head of the femur is actually forced out of its acetabulum (surgical dislocation) After cutting the round ligament the specimen is left attached to the patient only by a posterior pedicle consisting of the hamstring muscles and sciatic nerves which are severed thus completing the disarticulation

#### HIP JOINT DISARTICULATION WITH DEEP ILIAC DISSECTION

Whenever there is an indication to combine deep iliac dissection for the purpose of removing iliac and retroperitoneal lymph nodes with disarticulation of the hip joint, the technique must necessarily be modified The method of radical groin dissection as performed on the Mixed Tumor Service of the Memorial Hospital (3) is employed but is altered by omitting the dissection of the upper thigh and Hunter's canal The apex of the incision is placed somewhat higher and more medially on the anterior abdominal wall and thin anterior and medial skin flaps are developed Dissection is carried from above downward denuding the lower anterior abdominal wall inguinal region and femoral vessels of fascia, fat and lymphatic tissue *en bloc* By splitting the inguinal ligament and retracting the peritoneum and urinary bladder the retroperitoneal space is exposed widely The chain of lymph nodes and areolar tissue along the iliac vessels are removed *en masse* including those overlying the obturator foramen If necessary the anterior abdominal wall may be incised vertically upward, exposing the retroperitoneal space and its contents well beyond the aortic bifurcation On completion of this deep iliac dissection the common femoral artery is ligated and divided *above the profunda femoris* and the operation of hip joint disarticulation is carried out in the usual manner

The wound should be appropriately drained Because of the extensive skin flaps which are developed when a regional node dissection accompanies the amputation it is essential that a bulky pressure dressing be applied firm enough to prevent pocketing of serum but not



TABLE II—HIP JOINT DISARTICULATION FOR MALIGNANT TUMORS MEMORIAL HOSPITAL SERIES—MIXED TUMOR SERVICE—END-RESULTS 1926 TO 1946

Total number of cases	32
Indeterminate group	
Total number of indeterminate results	
Dead as a result of other causes and without recurrence	
Lost track of without recurrence	
Determinate group	
Total number of minus those of indeterminate group	3
Failures	
Total number of failures treatment	1
Dead as a result of cancer	5
Lost track of (1st disease probably dead)	
Living (1st recurrence)	
Successful results	
Free from disease at last examination	2
End-results	
Successful results divided by determinate group ( 3 )	38.7 per cent

too firm otherwise necrosis of the flaps will occur.

**Complications.** In general the course following hip joint disarticulation is relatively smooth and uneventful. When not combined with deep iliac dissection the wound heals *per primam*. The utilization of extensive skin flaps when the amputation is combined with deep iliac dissection invariably produces skin necrosis along the wound margins, frequently resulting in infections. Lymphorrhea and pocketing of serum beneath the flaps also encourage infections and contribute to poor wound healing.

Aspiration of accumulated serum judiciously applied pressure dressings adequate postoperative penicillin therapy and wide excision of irradiated skin are essential features in the prevention of infection and promotion of satisfactory wound healing following the combined operation.

**Prosthesis.** Because of the absence of a stump the fitting of a prosthesis is a difficult matter following amputation through the hip joint although additional iliac dissection does not add materially to this problem. We have employed a prosthesis for these cases consist-

ing of a leather pelvic support to which the artificial limb is attached. This prosthesis has a double joint action and weighs 10 pounds. (5) It is worn no more than 1 or 2 hours daily for the first few months as the patients find it quite tiring.

**Prognosis following amputation through the hip joint.** As pointed out in discussing the radical operation on the upper extremity the prognosis following amputation through the hip joint will depend upon the anatomic type of tumor and its extent, the presence of visceral metastasis, and the number and variety of previous surgical procedures (local excision, local excision followed by groin dissection, conservative amputation). In general, the prognosis following hip joint disarticulation is about the same as that following inter-scapulothoracic amputation. In retrospect, however, in view of our past experience with radical amputations 5 of the patients subjected to amputation through the hip joint (2 for palliation) would at present be treated by hemipelvectomy. A clearer definition of the indications for *disarticulation levels* will eventually improve the cure rate for both operations.

The most favorable results followed operation for neurogenic sarcoma and low grade (unclassified) spindle cell sarcoma. The least favorable outcome was encountered in melanoma and synovialoma. Again the majority of our patients were not ideally operable cases because of bulky metastasis to the inguinal lymph nodes with prior attempts at groin dissection. A more important factor to influence unfavorably the prognosis following radical amputation of the lower extremity is a high incidence of repeated usually inadequate, surgical interventions followed by recurrences, before disarticulation was finally done. Over four fifths of the patients in the present series were subjected to some type of surgical procedure prior to radical amputation. In 21 cases local surgical excision was performed at least once and in 10 cases 2 or more limited excisions had been performed. Three patients had undergone previous conservative amputation and in 4 cases groin dissection had been carried out. Only when radical amputation (disarticulation) will be employed

as the initial mode of therapy in previously untreated cases provided the indication is clear will we be able accurately and finally to evaluate the usefulness and limitations of such surgical practice in the management of selected cases of cancer of the extremities

**End results** In the Memorial Hospital Series (Mixed Tumor Service) of 32 cases of hip joint disarticulation 4 were performed for palliative purposes only Of the 28 curative operations 42.9 per cent of these patients are alive, as of June, 1946 with no evidence of recurrence or metastasis Only 1 patient in this series of 32 cases was lost to periodic observation after a follow up interval of 2 years

Almost three-fourths of the patients in this group were operated on during the past 4 years. The over all net survival rate is 38.7 per cent (Table II) The 5 year survival rate is 33.3 per cent

#### SACROILIAC DISARTICULATION (HEMIPELVECTOMY)

Since 1944 we have performed the operation of sacroiliac disarticulation<sup>1</sup> in which the entire lower extremity corresponding buttock and innominate bone are removed in one stage, on 8 occasions. One of these operations was performed by the senior author at another hospital The standardized technique as employed by us has been illustrated elsewhere<sup>(6)</sup> and is based on our modification of the surgical procedure first performed by Hogarth Lingle in 1916 The fact that the first operation of this kind was undertaken so late in the history of the Mixed Tumor Service may be explained by the many years which have been required to exploit more conservative therapeutic procedures radiologic as well as surgical for the treatment of malignant tumors of the soft somatic tissues before resorting to an extensive deforming operation in addition to our present more comprehensive knowledge concerning the clinical behavior of tumors of the soft parts.

**Indications** Sacroiliac disarticulation is indicated for primary malignant osseous and periosteal tumors of the upper femur where the



Fig 7 Surgical specimen from amputation through the sacroiliac joint (hemipelvectomy) Massive myxoliposarcoma (specimen bisected) involving the upper thigh and groin and extending over the anterior superior iliac spine Dissection of the blindquarter revealed the tumor to be centered in the iliopsoas muscle Bulky malignant infiltrating tumors of the pelvic parietes are occasionally amenable to surgical extirpation by disarticulation of the innominate bone.

growth has extended to or through the hip joint and for similar neoplasms of the innominate bone. Primary bulky malignant tumors of the soft somatic tissues of the upper thigh (involving the hip joint or extending through the obturator foramen) groin, buttock, pelvic parietes and iliac region are best treated by amputation through the sacroiliac joint (Fig 7)

Massive osteochondromas of the innominate bone and massive plexiform neurofibromas involving the upper thigh groin and hip joint or the buttock and pelvic parietes are best treated by exarticulation of the lower limb through the sacroiliac joint if the tumors contain atypical areas histologically and if they cannot be adequately removed by wide local excision or some other type of conservative operation

This radical operation occasionally has a definite place in the palliative therapy of cancer Even in the presence of hopeless extension or distant metastasis fungating ulcerated tumors of the upper thigh groin and buttock may be removed in selected cases by sacroiliac disarticulation with gratifying results provided the patient's general condition has not deteriorated too much

The operations which are here reported

<sup>1</sup>Other terms which have been employed for this operation are hemipelvectomy, disarticulation of the innominate bone, blindquarter operation, interpel labiodorsal amputation, interiliacropubic amputation, transiliac operation, and interinnominate labiodorsal amputation.

TABLE III—SACROILIAC DISARTICULATION (HIPEL ECTOMY) FOR MALIGNANT TUMORS  
MEMORIAL HOSPITAL SERIES—MIXED TUMOR SERVICE—END-RESULTS 1944 TO 1946

Total number of cases	5
Indeterminate group	
Total number of indeterminate result	
Dead as a result of their causes and without recurrence	
Lost track of without recurrence	
Determinate group	
Total number minus those of indeterminate group	7
Failures	
Total number of failures treatment	
Dead as result of cancer	
Lost track of 1st disease (probably dead)	0
Living with recurrence	
Successful results	
Free from disease at last examination	5
Lost results	
Successful results divided by determinate group (4/7)	74 per cent.

were performed for chondrosarcoma (2 cases) myxoliposarcoma (2 cases) neurogenic sarcoma Kaposi's multiple hemorrhagic sarcoma perosteal fibrosarcoma, and extraosseous osteogenic sarcoma. Two operations were performed for palliation. It is, of course mandatory that a histologic diagnosis be established by aspiration or incisional biopsy before radical amputation or any other surgical or non surgical program for that matter is planned.

**Operative considerations.** The preoperative considerations and precautions which were discussed for hip joint disarticulation are also applicable for cases of sacroiliac disarticulation. Inhalation anesthesia was employed for all cases. In any surgical procedure where a marked drop in blood pressure might occur spinal anesthesia should not be elected. Rotation of the patient which is necessary for the posterior dissection definitely interferes with the technique of continuous spinal anesthesia. In addition the psychic trauma necessarily induced by a mutilating operation is obviously lessened with the patient asleep.

As already mentioned a detailed description of all steps of this operation as performed by us has been published elsewhere (6) and

will not be repeated in the present report. Certain salient features of the technique, however, will be reviewed.

1. An anterior racquet incision is employed.
2. In the first few cases, we divided and ligated the external iliac artery as early in the operation as possible but ligation of the vein was delayed to allow the extremity to drain itself of as much blood as possible. We soon found that ligation of the common iliac artery permitted a relatively bloodless operation. In one instance however necrosis of the posterior flap followed ligation of the common iliac artery but this complication can be prevented by using a T incision with the straight crossbar along the inguinal region and the vertical incision resulting from a wide V excision of the center segment of the longer posterior flap.
3. By severing the pubic insertion of the rectus abdominis and dividing the inguinal ligament the anterior abdominal wall is actually detached from the bony pelvis.

4. By retracting the peritoneum its contents, and the urinary bladder the iliac fossa is widely exposed. The ureter, peritoneum, intestines and urinary bladder must not be injured. The spermatic cord is preserved.

5. The symphysis pubis is easily divided with a Gigli saw but it should be clearly skeletonized otherwise the pubic arch will instead be cut through.

6. The external iliac vein is ligated and divided just prior to exposure of the sacroiliac joint. Disarticulation of the joint is performed during the anterior phase of the dissection, using a chisel.

7. The posterior dissection is left for last, at which time the amputation is completed by severing the gluteal muscles, major ligaments of the sacrum and the great nerve trunks of the lumbar and sacral plexus.

With this technique all the major maneuvers of the operation are performed through an anterior approach providing for ample exposure and easy access to vital structures in the pelvis.

**Postoperative complications.** Abdominal distention is a frequent postoperative complication. If a Levine tube is placed in the stomach as soon as the patient has reacted from the anesthetic and constant suction is applied for

48 to 72 hours, serious abdominal distention can be avoided. Obviously large amounts of plasma should be given during this time to combat an inevitable electrolyte imbalance and hypoproteinemia.

*Paralysis of the urinary bladder* occurs often but is only temporary lasting 4 to 7 days. Continuous tidal bladder drainage is not only beneficial for an atonic bladder but prevents soiling of the dressing during the first post operative week.

*Anemia* is a constant postoperative manifestation and does not respond to iron liver extract or blood transfusions. We have found evidence in our cases, of compensatory marrow hyperplasia. It is not unlikely therefore that removal of an entire lower extremity and innominate bone deprives the hemopoietic system of sufficient bone marrow so as to produce this normocytic normochromic anemia which is only temporary lasting about 3 weeks.

Fecal incontinence and abdominal herniation do not occur following this operation although loss of libido is experienced rather frequently.

A prosthesis has never been devised for these cases. The patients learn to sit on the opposite ischial tuberosity and manage to use crutches satisfactorily after about 3 weeks of practice.

One of our patients, a 26 year old white female who was subjected to hemipelvectomy in March 1945 for a neurogenic sarcoma of the thigh and pelvic parietes married and became pregnant 1 year after operation and expects to give birth within a few months. No obstetrical difficulties should be anticipated in hemipelvectomy women. Judin's patient conceived and gave birth spontaneously to a healthy infant following sacroiliac disarticulation.

*Prognosis and end results following hemipelvectomy.* The neoplasms of the soft parts which carry the best prognosis following this operation are neurogenic sarcoma and non metastasizing low grade spindle cell sarcoma of the fascial tendon type. Of the bone tumors chondrosarcoma offers the most favorable prognosis.

In the present series of 8 sacroiliac disarticulations 2 were performed for palliation

TABLE IV — EXARTICULATION OF THE EXTREMITIES FOR MALIGNANT TUMORS MEMORIAL HOSPITAL SERIES—MIXED TUMOR SERVICE SUMMARY OF END-RESULTS 1926 TO 1946

Type of operation	Number of cases	Over-all net survival per cent	Five year survival rate per cent
Interscapulothoracic amputation	25	54.2	45.5
Hip joint disarticulation	32	38.7	33.3
Sacroiliac disarticulation (Hemipelvectomy)	8	71.4	
Total number of cases			65
Over-all net survival rate			54.1 per cent.

both of these patients died—one 12 months and the other 15 months after the operation. Of the 6 curative cases 1 patient died suddenly 7 months after the operation at which time there was no clinical evidence of recurrence or metastasis. The remaining 5 patients are alive and free from disease at the time of this analysis.

The net survival rate for the entire series of hemipelvectomy patients in all stages of disease was 71.4 per cent (Table III). Obviously the 5 year cure rate cannot as yet be computed for this group as the operation was not employed by us until the year 1944.

#### SUMMARY AND CONCLUSIONS

Sixty five patients were subjected to one of three major amputations (interscapulothoracic amputation hip joint disarticulation sacroiliac disarticulation) for neoplastic disease on or about the extremities. These operations need not be hazardous. There were no operative deaths in this series.

The indications operative technique and postoperative complications for these three surgical procedures are discussed with special emphasis on the prevention and treatment of complications specific for cases of amputation through the sacroiliac joint.

The surgical principle of exarticulation of an extremity with excision of the involved regional lymph nodes in one stage for selected cases of melanoma and clinically similar tumors is presented and illustrated by 6 cases of interscapulothoracic amputation combined with a lower (supraclavicular) neck dissection and 12 cases of hip joint disarticulation combined with a deep iliac dissection.

The value of these surgical procedures in the palliative therapy of cancer is shown. Nine of the amputations in the present series were performed for palliative purposes only.

*Interscapulothoracic amputation and hip joint disarticulation* serve a definite and distinctly useful rôle in the treatment of selected cases of cancer of the extremities. With regard to amputation through the sacroiliac joint (hemipelvectomy) our cases are too few and too recent as yet on which to base an accurate and final evaluation of the operation. The accumulated evidence indicates that sacroiliac disarticulation will prove to be a valuable surgical procedure in the treatment of extensive cancers of the lower limbs groin buttock in nominate bone and pelvic parietes.

In this series of 65 cases only 1 was lost to follow up examination 2 years after operation. The 5 year survival rate following interscapulothoracic amputation is 45.5 per cent, and for hip joint disarticulation 33.3 per cent. The net survival rate for cases of sacroiliac disarticulation is 71.4 per cent (Table IV).

#### REFERENCES

- JUDIN, SARGENT S. *Surg. Gyn. Obst.*, 926, 43 668-676.
1. PACK, GEORGE T. McNEER, GORDON, and COCKEY BRADLEY L. *Surg. Gyn. Obst.*, 942, 74 6 75.
2. PACK, GEORGE T. and REEKERS, PAUL. *Am. J. Surg.* 942, 56 545-565.
3. PACK, GEORGE T. SCHWARTZ, ISABEL, and MORITZ, MASON. *Surgery* 945, 7 849-866.
4. PACK, GEORGE T. and EHRLICH, HARRY E. *Am. Surg.* 946, 123 965-985. (Parts I and II.)
5. *Ibid.* 1946, 24 -27 (Part III.)
6. PRINGLE, J. HOGARTH. *Brit. J. Surg.* 9 6, 4. 283-296.

# EXTENSIVE COMBINED THORACOLUMBAR SYMPATHECTOMY IN HYPERTENSION

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**I**N many instances prolonged lowering of the blood pressure occurs in well selected cases following extensive thoracolumbar sympathectomy. It has been my experience that the fall in blood pressure with the patient in the horizontal position does not depend entirely on the extensiveness of the sympathectomy. The postural effect on the blood pressure however depends on the completeness of denervation of the splanchnic area. Therefore to obtain effects immediately or for a period of 3 or 4 months it is not necessary to deviate from the technique of either the supradiaphragmatic approach used by Peet or the subdiaphragmatic approach employed by Adson. Smithwick demonstrated to his satisfaction that extensive removal of the sympathetic nervous system was necessary to maintain a prolonged lowering of blood pressure. In 1938 he devised an operation permitting him to combine the supradiaphragmatic approach of Peet with the subdiaphragmatic operation of Adson by the removal of the twelfth rib and incising the diaphragm thus allowing exposure for a more complete splanchnic denervation. Grimson in 1941 described a technique for complete thoracic and partial to total lumbar sympathectomy.

In my experiences since 1934 with the surgical treatment of hypertension the technique advised and so adequately demonstrated by Peet was first employed. Later the subdiaphragmatic approach was used as advocated and devised by Craig and Adson. In 1938 the latter technique was combined with a unilateral nephro-omentopexy. Since 1940 by a gradual evolvement the thoracolumbar sympathectomy has become more and more extensive (5).

It has been shown by many investigators<sup>1</sup> that regeneration of the sympathetic nervous

system is most difficult to retard. That this is true is illustrated by special tests on 2 patients whose drop in blood pressure was considered good for a period of 2 years following operation. The preoperative blood pressure levels and the complaints of severe headaches returned however after the 2 years had elapsed. These patients were subjected to further removal of the sympathetic nervous system with good results. It has been my experience that if an immediate drop in blood pressure does not occur within a reasonable length of time following operation more extensive removal of the sympathetic nervous system will not be beneficial. Therefore subjecting hypertensive patients to more extensive sympathetic denervation is justified only in patients who have had relief of symptoms for 6 months or more whose previous complaints then returned and the blood pressure became elevated.<sup>2</sup>

Since neither the mortality nor the morbidity is increased by the technique that is employed at the present time the added assurance that a more complete denervation has been accomplished makes the procedure a justifiable one.

The operation is performed in two stages at approximately 10 day intervals. The position of the patient during operation is of the utmost importance in facilitating the procedure. A lateral semiprone position is used (Fig. 1) with the thoracic spine flexed forward to as great a degree as possible. Flexion aids in making the upper dorsal ganglia more accessible. Either a combination of high spinal anesthesia reaching up to the fourth thoracic level and a light intravenous pentothal anesthesia, or the combination of pentothal curare and nitrous oxide is used. It is absolutely necessary to have adequate oxygenation throughout the operation.

Poppen, J. L. The surgical treatment of essential hypertension (In press.)

From the Department of Neurosurgery, The Lahey Clinic.  
Dr. Kurt Richter of Johns Hopkins Hospital has studied many of our patients at varying intervals after operation from the standpoint of skin resistance.



Fig. Photograph showing the lateral semiprone position of the patient and the site of previous incision

The incision is made paravertebrally over the thickest portion of the long muscles of the back at the line of cleavage of the longissimus dorsi and iliocostalis dorsi muscles. It extends from the level of the seventh rib curving very slightly anteriorly to the distal portion of the twelfth rib (Fig. 2). The longissimus dorsi and iliocostalis dorsi muscles are separated over the medial portion of the eleventh rib as well as over the seventh or eighth rib. The seventh rib is removed if the dorsal spine cannot be flexed, as is the case in a few straight backed individuals. If the dorsal spine can be flexed readily experience has demonstrated that the fourth dorsal ganglion can be removed more easily through the eighth than through the seventh rib. The medial portions of the eleventh and the seventh or eighth ribs are then removed for a distance of approximately 4 centimeters from the transverse process care being taken that the rib is not removed farther laterally than the width of the iliocostalis and longissimus dorsi muscles so as to prevent deformity. Removal of as much of the rib vertebrally as possible allows more adequate exposure.

Considerable care should be taken to enter the proper line of cleavage between the parietal pleura and endothoracic fascia. When the line of cleavage has been established it can be followed medially with a semisharp Hedblom periosteal elevator to the anterolateral border

of the bodies of the vertebrae where the greater splanchnic nerve lies. The index finger may then be inserted into the space and the line of cleavage followed cephalad and caudad through the openings of the seventh or eighth and the eleventh ribs. Caution must be exercised at this point that the palmar surface of the index finger is kept firmly against the endothoracic fascia rather than against the parietal pleura as the line of cleavage is being followed to prevent rupture of the parietal pleura. It is needless to emphasize that opening of the pleura should be avoided if at all possible since a relatively quiet anatomical dissection is immediately transformed into a more difficult and somewhat noisy procedure if the pleura is opened. Even though considerable care has been used the pleura has been opened in 5 per cent of operations. The mere opening of the pleura may not be disastrous or cause more than relatively minor difficulties at the time the operation is performed. If by chance a post operative infection should take place however one must necessarily deal with an empyema. This certainly is adequate reason to avoid studiously opening the pleura. Anesthesia can be of great assistance in preventing injury to the pleura by the control of the depth and rate of the respirations.

After the pleura has been separated paravertebrally cephalad to the level of the fourth thoracic ganglion and caudad to the attach-

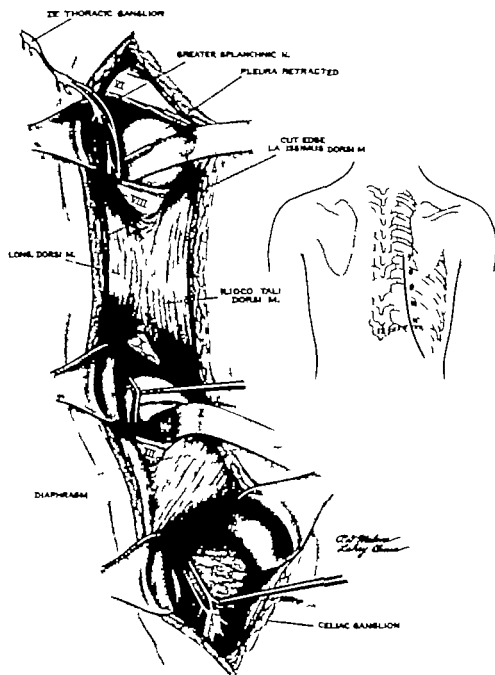


Fig. 2. The incision is outlined in the insert. The approach to the thoracic chain with its branches is made by removal of segments of the seventh or eighth and eleventh ribs by separating the iliocostalis and longissimus dorsi muscles. The long deep muscles of the back are retracted toward the spinous processes below the twelfth rib, thus allowing the retroperitoneal space to be entered by incising the transversalis fascia.

ment of the diaphragm the greater splanchnic nerve is mobilized along its entire length. The greater splanchnic nerve is mobilized first because it is in a relatively avascular bed. With the patient in the semiprone position, if slight oozing should take place at the time the gan-

glia are mobilized and their respective rami divided, blood gravitates toward the medastinum. If the greater splanchnic nerve were separated after the ganglia had been mobilized, possibly it would be obscured by blood-stained tissue.



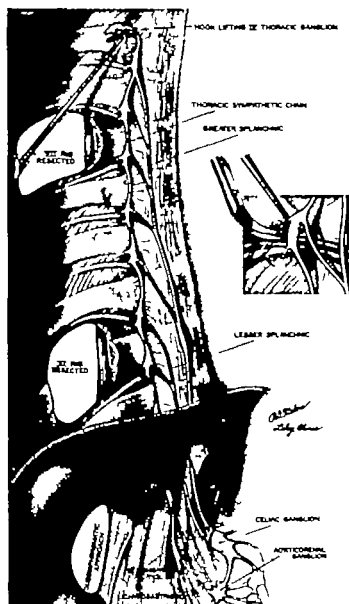


Fig. 3 The insert demonstrates the separation of the ganglion from the intercostal vessels before the rami communicantes are divided. The drawing allows visualization of the entire splanchnic distribution from the inside and its relationship to the apertures through which the removal is accomplished.

Great care is taken in mobilizing the delicate nerve fibers that make up the greater splanchnic nerve from the individual ganglia (Fig. 3). It is surprising to note the difference in the size of the individual ganglia as well as the fact that some of the ganglia do not have individual fibers leading from them to the greater splanchnic nerve (Fig. 4). In a few instances connecting fibers lead directly from

the thoracic trunk to greater splanchnic nerve (Fig. 5a). The main trunk of the splanchnic nerve usually arises from fifth or sixth ganglion (Fig. 6) but in several patients it has arisen as a separate trunk from as high as the fourth ganglion (Fig. 7). The nerve itself may have one to several ganglia or may have none.

After the fourth thoracic ganglion has been mobilized the trunk is divided above it. The

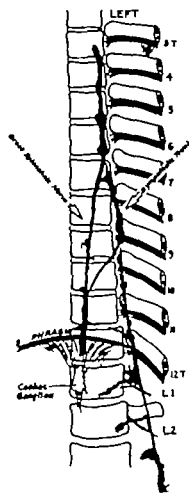


Fig. 4.



Fig. 5.



Fig. 6.

Fig. 4. Photograph of an actual specimen placed on a schematic drawing of the corresponding thoracic and lumbar vertebrae. Demonstrates the variation in the size of the ganglia as well as the fact that each ganglion may not have an individual connection with the greater splanchnic.

Fig. 5. Photographs of the actual surgical specimens showing the greater splanchnic arising from the thoracic

ganglia by individual fibers. *a*, Demonstrates how two ganglia in this instance the ninth and tenth, send joint fibers to the greater splanchnic as well as a separate branch from the thoracic trunk between them.

Fig. 6. Demonstrates the splanchnic arising from the fifth thoracic ganglion, *a* and from the sixth thoracic ganglion *b*.

entire mobilized upper sympathetic trunk and its branches are then pulled down through the aperture made by the removal of the eleventh rib care being taken that the entire system is kept in continuity so that there can be no question or possibility of leaving any ganglia or any fibers that lead to the thoracic aorta. Care must be taken that the thoracic ganglia are separated from the intercostal nerve and artery before dividing the ramus to avoid unnecessary bleeding (Fig. 3 insert). All bleeding even from a larger intercostal artery can readily be controlled by the electrosurgical unit.

It has been my experience that the dissection is less difficult if the thoracic trunk is not divided until the desired number of ganglia that are to be removed have been mobilized

After the thoracic ganglia and trunk as well as the splanchnic nerve have been completely mobilized in continuity to the diaphragm the iliocostalis and longissimus dorsi muscles which are called the sacrospinalis muscle at the level of the twelfth rib are retracted medially toward the spine. This permits the lumbodorsal fascia as well as the transversalis fascia to be incised care being taken during the dissection that the iliohypogastric nerve is not injured. The retroperitoneal space is then entered and the soft tissues retracted anteriorly. The greater splanchnic nerve can be readily identified as it emerges through the diaphragm usually through a hiatus of its own (Fig. 3) although it may emerge through the aortic hiatus. The greater and lesser

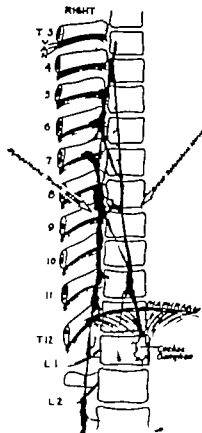


Fig. 7 Demonstrates separate ganglia in the greater splanchnic also the greater splanchnic arising from the fourth thoracic ganglion

splanchnic nerves emerge through the same aperture in many patients however in others they emerge through a separate aperture in the diaphragm. The greater and lesser splanchnic nerves are then detached from the celiac ganglion. The lesser splanchnic nerve usually has fibers entering the celiac ganglion and smaller fibers entering the aorticorenal ganglion (Fig. 3). In the female the third lumbar ganglion is mobilized and the trunk immediately beneath it divided. In many instances fibers may be seen extending from the third lumbar to the aorticorenal ganglion or directly to the abdominal aorta. In other patients none may be found. The second lumbar ganglion always has a few fibers leading to the aorticorenal ganglion the first usually having a fairly sizable trunk or at times several small strands of nerve leading to the aorticorenal ganglion (Fig. 8b). The rami of the second lumbar ganglion are then divided the crux of



Fig. 8 The more common appearance of the thoracic and lumbar ganglia with their splanchnic branches also the aorticorenal from the first and second lumbar

the diaphragm usually covers a part of the first lumbar ganglion. With the distal end of the lumbar trunk kept under slight tension, the crux of the diaphragm is incised and the first lumbar ganglion readily exposed and its rami divided. The incision through the crux of the diaphragm is then increased for a distance of several millimeters so that the aperture in the diaphragm is of sufficient size to permit the ganglia to be pulled through it from above. The mobilized cephalad end of the thoracic trunk and the splanchnic nerve are then grasped with forceps and by gentle traction the subdiaphragmatic portion of the greater and lesser splanchnic nerves as well as the lumbar trunk can readily be brought through the diaphragmatic aperture. In this manner the entire system is kept in continuity and there can be no question as to the completeness of the procedure.

Photographs are taken of the specimen so that they may be used for future reference. If for instance unusual areas of excessive perspiration develop in a supposedly denervated

area, one can refer to the photograph and determine whether or not the ganglia involved were actually removed. In this manner one can determine, also, at a later date how much regeneration actually takes place in these individuals.

That the operation in competent hands is not associated with great danger is indicated by the fact that one postoperative death has occurred in 250 patients with essential hypertension. This patient died from a coronary thrombosis on the second day following the second stage operation. Superficial wound infections were encountered in 4 cases which were readily controlled by immediate drainage and removal of the black silk sutures. In none of these cases of infection has the thoracic cavity been involved. In several cases slight pleural effusion has developed and in only 3 instances was aspiration thought necessary in the remaining cases the effusion subsided within a few days without aspiration. Unfortu-

nately severe postoperative discomfort which was directly due to mechanical intercostal neuralgia occurred in a considerable number of these patients and lasted from several days to several weeks.

# SUMMARY

A technique for extensive thoracolumbar sympathectomy is described which allows adequate exposure for removal of the sympathetic system from the fourth thoracic to the third lumbar ganglia, inclusive.

# REFERENCES

1. ADSON A W, CRAIG W M and BROWN G E. Surg. Gyn. Obst., 1936, 62, 314-331.
2. CRAIG W M and ADSON A W. Surg. Clin. N. America, 1930, 19, 969-980.
3. GRIMSON K. S. Ann. Surg., 1941, 114, 753-775.
4. PEET M M, WOODS W W and BRADEN S. J. Am. M. Ass., 1940, 115, 1875-1878.
5. PEET M M and ISBERG, E. M. J. Am. M. Ass. 1946, 130, 467-473.
6. POPPEN J L. Lahey Clin. Bull. 1943, 3, 151-158.
6. SMITHWICK, R. H. Surgery 1940, 7, 1-8.

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### THE IMPORTANCE OF BLOOD IN PREOPERATIVE AND POSTOPERATIVE TREATMENT

**I**N order to carry on the important functions of the blood and to meet emergencies, such as sudden loss of blood, trauma and major operations, an adequate volume of circulating blood must be maintained and enough hemoglobin must be maintained in the erythrocytes to supply oxygen to the tissues. The effects of sudden hemorrhages such as occur in peptic ulcers, placenta previa, ruptured ectopic pregnancies, ruptured uteri and pulmonary tuberculosis may be offset by transfusions of blood. The use of transfusions of blood before operation to minimize or to prevent shock in such cases and to prepare patients who have jaundice or hemorrhagic diseases is generally accepted. In the obstetrical emergencies Rh negative blood should be given when the Rh type has not been determined previously.

It has been found that transfusions of blood will decrease coagulation time. Since transfusion of 100 cubic centimeters of fresh blood usually is enough to produce a hemostatic effect, a preoperative transfusion may make surgical procedures possible in conditions such as jaundice or certain blood dyscrasias in which they would otherwise have been impossible.

Usually a patient with acute or chronic anemia has a marked decrease in blood volume in which case fewer erythrocytes are present to carry oxygen and carbon dioxide and because of the necessity for increased cardiac output the heart may be strained. A patient who has either acute or chronic anemia may reach the stage of air hunger as a result of the anemia. Anemia may result from slow loss of blood in conditions such as menorrhagia, slowly bleeding ulcer and rectal disorders (hemorrhoids or neoplasms). If the patient with this type of anemia undergoes operation, trauma or further loss of blood, irrespective of the type of anesthesia, shock or permanent cerebral damage may ensue because the oxygen supply to the brain is insufficient.

When a patient is anemic, the choice of the anesthetic agent for an operative procedure may be difficult. For example, some operative procedures are best done with the patient under spinal anesthesia. However, if the concentration of hemoglobin is less than 50 per cent, use of this anesthetic procedure is definitely contraindicated.

In the postoperative period certain additional conditions may be present in which blood transfusions may prove of value. Favorable results of transfusions in treatment of certain infectious diseases have been reported.

The purpose is to add such antibacterial agents as natural antibodies leucocytes and complement to the blood of the recipient. Immunotransfusions may have even more value.

A patient who is doing well in many respects but does not eat, seems tired and listless and has little strength frequently responds well to one or more transfusions. The exact reason for this is unknown. The hemopoietic power may have become depleted and not enough blood cells are produced for the patient to carry on a normal convalescence. It is surprising how much the boost offered by a transfusion of blood will help some patients.

In ordering a blood transfusion the physician should not forget that intravenous administration always carries a certain risk. On the other hand if a blood transfusion is indicated it should be given. Each 500 cubic centimeters of blood administered raises the concentration of hemoglobin approximately ten per cent and increases the erythrocyte count about 500,000 cells per cubic millimeter. Hence no set amount should be agreed on for all patients. The patient should be given that amount of blood which fulfills the purpose of the transfusion. That amount is not necessarily administered in one transfusion but may be given in a series of transfusions.

THOMAS H SELDON

## BLOOD PLASMA

WAR experience has helped to define the usefulness and limitations of blood plasma. The great abundance of plasma available to the armed forces of the United States led to an extensive clinical trial unhampered by supply or economic considerations. The purity and excellence of the plasma and the disposable sterile pyrogen free dispensing set provided allowed administration of large quantities of plasma

to individual patients without fear of reaction. An occasional allergic reaction manifested by urticaria was about the only reaction which could be definitely ascribed to plasma. However physiological disturbances some of extreme gravity, did result from its improper use.

Of greatest importance is the knowledge gained with the use of plasma and whole blood in wound shock. Early experience demonstrated that those who were resuscitated from shock by the administration of plasma presented a severe secondary anemia in convalescence. Further, those in extreme shock could be resuscitated only with the administration of whole blood. Later laboratory investigations of blood volumes and hematocrit readings demonstrated definitely that lowered blood volume was the important factor in wound shock and that the lowered blood volume was due to loss of whole blood rather than plasma, with certain few exceptions. Plasma therefore is not the ideal agent in most cases of wound shock and when so used is frequently a poor substitute for whole blood. When used to restore blood volume it dilutes the remaining red cells. If blood loss has been large the resulting diluted blood may be so deficient in red cells as to be ineffective as an oxygen carrier in the seriously wounded individual who must have surgical care.

Appreciation of these facts led to the adoption of certain principles of management. The wounded admitted to hospitals in severe shock with no brachial blood pressure were immediately and rapidly given low titer group O blood<sup>1</sup> without waiting for grouping and cross matching of the first liter. Those in less severe shock were administered plasma only while grouping and cross matching were rapidly completed. Forward of hospital units where whole blood was not available plasma was

<sup>1</sup>Group O blood with anti-A and anti-B agglutins in titer less than 1-64.

given to those in shock in a quantity only sufficient to render them transportable to the nearest hospital unit where whole blood and facilities for surgery were available.

The necessity for whole blood in restoring blood volume was most apparent in those casualties with severe or multiple wounds. If large quantities of plasma were used in resuscitating such individuals they did not tolerate prolonged anesthesia and surgery necessary to the care of their wounds. When whole blood was used in adequate quantities surgical procedures were well tolerated and frequently extended over a period of many hours. The amount of blood required before and during surgery frequently totalled 3500 to 5000 cubic centimeters and occasionally more was required. In those with minor degrees of shock accompanying wounds which were not extensive and severe resuscitation and surgical care were occasionally accomplished with or following plasma therapy and no blood. However the margin of safety is certainly greater if every individual in shock from war wounds, or similar injuries receives some whole blood before or during surgery.

While whole blood loss alone accounts for the reduced blood volume in wound shock in the vast majority of cases there are a few exceptions. In certain abdominal and thoraco-abdominal wounds where there is gross contamination or sepsis in the peritoneum or pleura, plasma loss from exudation does occur. These cases most often have whole blood loss from their wounds in addition to the plasma loss. In some cases the whole blood loss is minimal and the plasma loss from exudation is maximal. When the latter situation was discovered at surgery plasma alone was used in the continued effort to combat shock.

Plasma loss and hemoconcentration were also found to occur in fulminating cases of clostridial myositis or gas gangrene of the wet

type. This loss of plasma through the wound or into the involved muscles was best combated with the infusion of large quantities of plasma. These same cases also tended to present a severe anemia and whole blood was necessary as well as plasma.

In cases of burn shock, unless complicated by wounds, the reduced blood volume is due almost entirely to plasma loss. The most common error in the management of burn shock is the failure to administer plasma rapidly enough and in sufficient amount. Best results were secured when the plasma was given as an emergency measure administering it into two veins or with positive pressure, if necessary to rapidly restore the hematocrit reading to normal. Once a normal reading was obtained the administration was continued at a sufficient rate to maintain this normal reading. As much as 4000 to 6000 cubic centimeters of plasma were used in the first twenty-four to thirty-six hours in extensive burns. With adequate and energetic therapy burn shock could almost always be controlled. Whole blood was not found necessary in the first thirty-six hours in the management of uncomplicated burns. Secondary anemia developed rapidly thereafter however and whole blood then replaced plasma in burn management.

Hemoconcentration and the need for the infusion of large quantities of plasma were found also in crush injuries. The tremendous swelling which developed in the limbs of these unfortunate victims after they were moved from beneath stones and masonry often led to very high hematocrit readings. Their management was often complicated by the development of pigment nephropathy and anuria.

In wartime plasma was used extensively to correct and prevent hypoproteinemia. Amino acid solutions for intravenous use were never generally available and were not available at

all until late in the war. Patients with severe wounds invariably showed some degree of hypoproteinemia and in those with abdominal wounds in whom nasogastric suction was continued over a period of days, hypoproteinemia became severe unless plasma was given in proper amounts. It became routine practice to give these patients 500 to 1000 cubic centimeters of plasma daily beside the whole blood needed. Plasma protein determinations by the copper sulfate specific gravity method indicated that 500 to 750 cubic centimeters of plasma daily was sufficient to maintain a satisfactory level in most patients of this sort.

Plasma has a definite and important place in peacetime surgery. It should be available everywhere for emergency management of the shock of severe burns. It should likewise be available for the management of traumatic shock to sustain life until whole blood is available. Its limitations in the management of shock should be well known so that it is not given in large quantities when whole blood is needed. A program to provide properly prepared and packaged plasma at low cost for emergency use throughout the nation would appear to be desirable.

HOWARD E. SNYDER



# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE recent book by I. S. Smillie<sup>1</sup> encompasses the intricate and difficult task of describing the injuries to the knee joint in a comprehensive monograph. The author presents the subject in a manner which is outstanding in more than one sense. As would be expected a large portion of the book is given over to the discussion of what is commonly called internal derangement of the knee—that is the lesions of the menisci and the intrinsic ligaments. Another deals with the injuries of the collaterals, a third with those of the extensor apparatus, a fourth with the joint fractures, bones and injuries to the surrounding soft tissues. The most gratifying feature is that the author so happily combines precision and clearness in the clinical presentation with conciseness and lucidity in developing for his readers the basic background of mechanogenesis and pathology.

The discussion of the semilunar cartilage injuries is an example. The diagnosis is based on observational points inclusive enough to protect the clinician against disappointment.

With all the weight that is laid upon the comprehensive description of all diagnostic features and their evaluation, one finds there is no tendency to introduce unusual or occasional observations nor to confuse the issue by elevating these to the dignity of diagnostic landmarks, as is so often done in monographs of this kind. Consequently one will find much which is hardly worth mentioning has been left unsaid.

In each particular section the pertinent facts of mechanogenesis and pathology are stated simply and clearly and their clinical implications are stipulated with a great deal of plausibility for instance the manner of occurrence, the nature and the signs of the different types of meniscal tears. The same can be said of the chapters that deal with the injuries of the collaterals and with the loose intra-articular bodies. There is another redeeming feature about this book, namely that there is throughout a wholesome tendency of conservatism. While the operative side is discussed comprehensively and one cannot say that any of the current operative methods are omitted, yet it is not given undue prominence. An instance is the emphasis laid upon the development of the quadriceps extensor apparatus as a conservative therapeutic measure.

In fact the introductory chapter is devoted to the importance of the quadriceps. This is followed in logical sequence by one on secondary traumatic

synovitis and hemarthrosis. The surgical anatomy and the specific pathology are dealt with separately along with the individual topics and one will find this presentation clear, concise, and thoroughly adequate. One chapter devoted to fractures of the tibia and fibula which involve the knee joint is quite attractive, as is the one dealing with the wounds of the knee. Nevertheless, the outstanding chapters, we believe are those dealing with the internal derangement, those on the collaterals and the free joint bodies, the injuries of the extensor apparatus and, above all, those sections which present prevention and treatment of posttraumatic functional deficiencies by conservative measures.

The wide experience of the author is amply demonstrated by imposing statistics. There is an abundance of roentgenograms covering all illustrative cases, each one bringing out a specific clinical situation they are numerous and yet do not tire the reader by duplication. Illustrations are excellent, both those in color and those which appear as diagrammatic drawings. In its particular field the book certainly can claim to be a classic.

ARTHUR SZODOLNY.

IN a profusely illustrated volume of 350 pages the author of *Demonstration of Physical Signs in Clinical Surgery*<sup>2</sup> describes the more common physical signs in surgical diagnosis. There are 573 illustrations, most of which are photographs, many in color. Although many of the photographs are old they are quite satisfactory. The colored photographs are excellent and admirably illustrate the lesion in question. The text is brief and used chiefly to describe the illustrations and the various signs and tests they illustrate. Credit is given by means of footnotes to those men originally describing a sign or test. The book will be found useful by the student meeting these findings for the first time.

THOMAS C. DOUGLASS.

THE book *The Essentials of Obstetrics and Gynecology*<sup>3</sup> by Scott and Van Wyck is based on the lectures in obstetrics and gynecology given at the University of Toronto. It is divided into two parts, the first covering obstetrics and the second gynecology.

<sup>1</sup>DEMONSTRATION OF PHYSICAL SIGNS IN CLINICAL SURGERY. BY HARRISON KELLEY, F.R.C.S. (Eng.), F.I.C.S. 2nd ed. Baltimore: The Williams & Wilkins Co. 1945.

<sup>2</sup>THE ESSENTIALS OF OBSTETRICS AND GYNECOLOGY. BY WILLIAM ALBERT SCOTT, B.A., M.B., F.R.C.S. (Can.), F.R.C.O.G. (Eng.), and H. BROOKFIELD VAN WYCK, B.A., M.D., F.R.C.S. (Can.), F.R.C.O.G. (Eng.). Philadelphia: Lea & Febiger. 1944.

INJURIES OF THE KNEE JOINT. BY I. S. SMILLIE, O.B.E., M.B., F.R.C.S. (Ed.), F.R.F.P.S. Baltimore, Md. The Williams & Wilkins Co. 1945.

Part one obstetrics is divided into three sections. Section one covers normal obstetrics. The initial chapter is concerned with a well written and brief discussion of the embryology of the genital system. It also includes a short description of pelvic anatomy which is adequate for the medical student to orient himself. Physiology is divided into a discussion of the changes in the various periods of a woman's life, and is briefly covered in a style that should be easily understood by the student. The physiology of conception is carried along in a sequence that follows logically and reads easily. The discussion of the puerperium is excellent. It is presented concisely with fundamentals and commonly met problems outlined in a practical manner.

Section two deals with abnormal obstetrics. Toxemia, abortion, premature labor and bleeding are outlined. The diseases complicating pregnancy are briefly discussed. Syphilis could probably have been given more discussion, especially an outline of therapy. Diabetes also deserves more mention, even in an outline type of text. The Rh factor is mentioned and discussed in relation to erythroblastosis fetalis and even though our knowledge of the relationship and management is meager, a more complete discussion might have been warranted.

Section three deals with operative obstetrics. The views expressed are conservative and sound. One illustration shows three types of obstetrical forceps, all of which are designed for the more difficult types of operations. One wonders why the more commonly used instruments are not shown. Two illustrations of instruments used in destructive operations are also shown, but in the short résumé of this operation no mention is made of their specific application.

Part two covers gynecology and is presented in a well planned outline manner. The various gynecological disorders are discussed according to location, starting with the vulva and progressing upward. The discussion of Leucoplakia fails to mention the more than casual relationship to carcinoma, however, later under the latter heading this relationship is brought out. Carcinoma of the cervix and corpus is briefly but well covered. The use of illustrations in describing these conditions would have been helpful. The authors favor radiation therapy for cervical malignancy and radiation followed by surgery for that in the body of the uterus.

Ovarian tumors are classified in a simple outline form. The treatment of pelvic infections has been given conservative handling. Sulfa drugs are stressed in the treatment of gonorrhea and penicillin is only mentioned as a hospital treatment for speedy cure. More detail about its use might have been given.

The chapter on endometriosis covers the cardinal points in the disease. Sterility and acquired dys-

menorrhea and the more than casual relationship between fibroids, retrodisplacement, and endometriosis might have been stressed more.

A good outline of the causes of vaginal bleeding is presented and diagnostic points in differentiation have been emphasized.

Gynecologic operative procedures are covered in twenty-one pages. Stress is placed on good surgical technique, careful handling of tissues and hemostasis. A short outline of sensible postoperative care is given. The details of various special operations have been limited throughout, except for a series of illustrations showing the steps in performing a Manchester operation for prolapse. The authors apparently favor this procedure.

This short volume outlining both obstetrics and gynecology should be helpful to students. The authors have adhered to the essentials with the elimination of theory and controversial discussion.

GEORGE B. BRADBURN

THE book entitled *Uterine Contractility in Pregnancy* is based on some 3,200 individual records of the contractions of 1,200 pregnant women, taken during both pregnancy and labor by means of the Lorand tocograph. The observations have a practical value because they demonstrate the close relationship which exists between the quality of the contractions of pregnancy and that of the same woman during her labor. It was found that each individual possesses her own contraction pattern which persists with relatively little modification throughout all of gestation.

The studies also indicate how a knowledge of the quality of the contractions which appear early in labor can assist the obstetrician in predicting the future quality of the contractions as labor advances and in distinguishing between inertia and disproportion as causes of prolonged labor. Furthermore the studies made with the utilization of oxytocic drugs emphasize the necessity of using very small and accurately measured doses of such drugs in the treatment of uterine inertia.

The book is the result of diligent studies made over a period of several years. In the list of references are nineteen publications of Murphy on this subject. The text is well written and easy to read, the type is clear, the charts and tables are instructive, and the paper is of good quality. Anyone interested in obstetrics will find a good deal of information about uterine contractions in both normal and abnormal labor which can be applied in daily practice.

J. P. GREENHILL.

<sup>1</sup>UTERINE CONTRACTILITY IN PREGNANCY. By Douglas P. Murphy, M.D. F.A.C.S. Philadelphia, London, Montreal: J.B. Lippincott Co. 947

## CORRESPONDENCE

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A NEW TECHNIQUE FOR PULMONARY SEGMENTAL RESECTION ITS APPLICATION IN THE TREATMENT OF BRONCHIECTASIS—  
A Correction

*To the Editor* In the article entitled A New Technique for Pulmonary Segmental Resection Its

Application in the Treatment of Bronchiectasis which appears on pp. 257-268 of the March, 1947 issue of SURGERY GYNECOLOGY AND OBSTETRICS an error has been made in the arrangement of Figures 8, 9, 10 and 11. Figures 10 and 11 should appear on p. 262 as Figures 8 and 9, and Figures 8 and 9 should appear on p. 263 as Figures 10 and 11.

RICHARD H. OVERBOLT

CLINICAL CONGRESS OF AMERICAN  
COLLEGE OF SURGEONS

JAMES ARTHUR L. ...  
 ...

H. WARD & LATHROP, Civil Engineers, LEANS, CLEVELAND, S. C. 1223

[illegible]

PRELIMINARY PROGRAM FOR 1947 CLINICAL CONGRESS  
THE WILDORF ASTORIA NEW YORK  
SEPTEMBER 8 TO 12, 1947

[illegible]

An idea of the scope of the clinical program may be obtained from consulting the August 1941 issue of SURGERY, GYNECOLOGY AND OBSTETRICS, pages 2551 to 2588 in which was published the preliminary program prepared 1 1/2 years before the Clinical Congress was transferred from New York to Cleveland.

## THE FARM IS USUAL

The usual varied and comprehensive program for starting at the headquarters hotel is that of The International Lecture will be held on the evening of September 5 in the Grand Ball room with the inaugural ceremony for the incoming officers and the International Address by Dr. Ivan Mehl and the delivery of the second Martin Memorial Lecture. The Convention includes the presentation of candidates for Fellowship and the presentation of the delivery of the International Address will be held on the evening of September 7. Other official meetings include the Annual Meeting of Fellows on September 11, the Assembly of Initiates on September 12, meetings of the Board of Regents and of the Governors, and meetings of various committees.

Evening sessions will be held on Tuesday, Wednesday and Thursday devoted to subjects in the field of general surgery and also in ophthalmology and otolaryngology which will be featured in separate meetings.

Afternoon sessions will consist of panel discussions led by recognized authorities in their respective field who will be aided by well qualified collaborators. Preliminary plans include the following on one afternoon of a symposium on fractures and other traumas and on another afternoon of a symposium on cancer. A number

of panels on the surgical specialties are planned for the final afternoon.

Morning meetings will include separate panel discussions at 11:00 o'clock on Tuesday Wednesday and Thursday for ophthalmologists and otolaryngologists.

#### FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

The Forum on Fundamental Surgical Problems will be conducted on Tuesday Wednesday, Thursday and Friday mornings. Included will be brief reports of original clinical and experimental observations relating to the broad aspects of surgery and the surgical specialties. No prepared discussions of the reports are planned but questions and comments will be invited. Dr. Owen H. Wangensteen of Minneapolis, chairman of the committee which is planning the program, is working toward representation of as many as possible of the various university departments of surgery in this presentation of clinical and experimental research work.

The enlistment of the interest of young men who are doing original work, through the Forum, is one of the most beneficial results of these sessions which are now considered to be an indispensable feature of every Clinical Congress.

#### HOSPITAL STANDARDIZATION CONFERENCE

The first formal session of the Clinical Congress will be the opening meeting of the twenty-sixth Hospital Standardization Conference. Dr. Irvin Abell of Louisville, President of the College, will preside. The hospital conferences will continue on Monday afternoon, with sessions following on Tuesday Wednesday and Thursday mornings, afternoons, and evenings.

Hospital administrators, members of governing boards, heads of the various hospital departments and their personnel nursing groups, and many other persons directly or indirectly concerned about hospital progress will be interested in the discussion of current hospital problems. National organizations representing various groups of hospital personnel will co-operate and participate in the meetings, which will include formal sessions, panel discussions, round table conferences, and open forums.

#### ADVANCE REGISTRATION

The hospitals and medical schools of New York afford accommodations for a large number of visiting surgeons. However in order to insure against overcrowding, attendance at the Congress will be limited to the number that can be comfortably accommodated at the meetings and also by ac-

commodations in the hotels. It is therefore expected that surgeons who wish to attend the Congress will register in advance.

The members of the Board of Regents regret that conditions beyond their control will not permit unpaid registration at the 1947 Clinical Congress. They voted to restore the registration fee of \$5.00 for Fellows and for endorsed Junior Candidates. Non-Fellows attending as invited guests of the College will pay a fee of \$10.00. No fee will be required of initiates of the class of 1947.

To each surgeon who registers in advance a formal receipt will be issued. This is to be exchanged for a general admission card upon his registration at headquarters during the Congress. This card is not transferable and must be presented in order to obtain clinic tickets and admission to scientific sessions.

#### MEDICAL MOTION PICTURES

The latest available films showing surgical procedures and related subjects will be shown in the medical motion picture exhibits which will be held daily. These are a much appreciated feature of the Clinical Congress.

Both sound and silent, standard and color films will be shown all of which have been approved by the Committee on Medical Motion Pictures.

#### TECHNICAL AND SCIENTIFIC EXHIBITION

The technical exhibit, together with the registration and clinic ticket bureaus, will be located in the Basilidon Room, Jade Room, and Astor Gallery all on the third floor of the hotel. Leading manufacturers of surgical instruments, x-ray apparatus, sterilizers, operating room lights, ligatures, dressings, hospital apparatus and supplies of all kinds, and pharmaceuticals, and publishers of medical books will be represented in the exhibition. The technical exhibits will demonstrate many of the newer features learned from our experience in the war.

#### HOTEL RESERVATIONS

Although the prospect is that the hotel situation in New York will be more favorable than it would have been last year nevertheless there is still a critical shortage of hotel rooms and early reservations are most desirable. In making these, communications should be addressed to the New York Convention Bureau through which all reservations for the Clinical Congress are to be clear. No correspondence should be sent directly to the hotels. A letter has been sent to Fellows in which the procedure is outlined with this letter was enclosed a form to be used in making

reservations. First, second, third, fourth, and fifth choices of hotels may be designated. The following hotels are recommended by the Committee

	Minimum rates with Bath		
	Single	Double	
Alberton House, 143 East 30th Street	\$2 75	\$	
Alberton House for Women, 130 East 57th Street	3 00		
Ambassador, Park Avenue and 51st Street	6 00		
Astor Broadway and 44th Street.	3 50	4 00	
Barbizon (Women) Lexington Avenue and 63rd Street	3 50		
Barclay 111 East 48th Street	6 00	8 00	
Belmont Plaza, Lexington Avenue and 49th Street	4 00	6 00	
Beverly Lexington Avenue and 50th Street	5 00		
Biltmore, Madison Avenue and 43rd Street	5 50	7 50	
Bristol, 129 West 48th Street	2 50	3 50	
Capitol, 51st Street and 8th Avenue	3 00	4 50	
Carlisle, Madison Avenue at 76th Street	6 00		
Chesterfield, 130 West 49th Street	2 50	4 00	
Commodore, Lexington Avenue and 42nd Street	3 50	5 50	
Concourse Plaza, Grand Concourse and 161st Street.	3 50	5 50	
Cornish Arms, 311 West 23rd Street	2 25	4 00	
Delmonico, 502 Park Avenue	6 00	8 00	
Emex House, 160 Central Park South	6 00	8 00	
Fifth Avenue Hotel, 24 Fifth Avenue (9th Street)	4 00	6 00	
Governor Clinton 31st Street and 7th Avenue	\$3 30	\$4 40	
Henry Hudson, 353 West 57th Street	2 50	3 50	
Kenmore Hall, 145 East 23rd Street	2 00	3 50	
Lexington, 48th Street and Lexington Avenue	4 00	6 00	
Luxor Baths Hotel, 121 West 46th Street.	2 25		
McAlpin, Broadway and 34th Street.	3 30	4 95	
Martinique, Broadway at 32nd Street.	2 75	3 85	
Midston House, 22 East 38th Street	3 50	4 00	
New Weston, Madison Avenue and 50th Street	4 00	7 00	
New Yorker 34th Street and 8th Avenue.	3 85	5 50	
Paramount, 46th Street, West of Broadway	3 00	5 00	
Park Central, 7th Avenue and 55th Street	4 00	6 00	
Parkside, 18 Gramercy Park South	2 75		
Pennsylvania, 7th Avenue and 33rd Street	3 85	5 50	
Piccadilly 227 West 45th Street	3 00	5 00	
Plymouth, 143 West 49th Street	2 50	3 50	
President, 234 West 48th Street	2 50	4 00	
Prince George, 14 East 28th Street	2 50	4 00	
Roosevelt, Madison Avenue and 45th Street	4 50	6 50	
Shelton, 49th Street and Lexington Avenue	3 50	5 00	
Taft, 7th Avenue and 50th Street	3 00	5 00	
Times Square, 43rd Street and 8th Avenue	2 25	4 00	
Tudor, 304 East 42nd Street	2 50		
Victoria, 7th Avenue and 51st Street	3 00	4 50	
Waldorf Astoria, 50th Street and Park Avenue	7 00		
Warwick, 54th Street at Sixth Avenue	5 00		
Wellington, 7th Avenue and 55th Street	3 00	4 50	
Woodstock, 127 West 43rd Street.	3 00	5 00	

## CLINICAL CONGRESS PROGRAM IN BRIEF

### *Monday*

- 9:30 General Assembly for Surgeons and Hospital Representatives, Grand Ballroom
- 30-3:00 Panel Discussion, Wedgwood Room
- 12:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 1:00 Hospital Conference, Sert Room
- 1:00 Surgical Film Exhibition (General), Grand Ballroom
- 3:30-5:00 Panel Discussion, Wedgwood Room
- 8:15 Presidential Meeting, Grand Ballroom

### *Tuesday*

- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Hospital Conference, Sert Room
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat), Jensen Suite
- 1:00 Surgical Film Exhibition (General) Wedgwood Room
- 1:00 Panel Discussions
  - Ophthalmology—Otorhinolaryngology
- 1:30-3:00 Panel Discussion, Grand Ballroom
- 1:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 1:00 Hospital Conference, Sert Room
- 1:00 Symposium on Fractures and Other Traumas
- 1:00 Surgical Film Exhibition (General) Wedgwood Room
- 3:30-5:00 Panel Discussion, Grand Ballroom
- 7:00 Surgical Film Exhibition (Eye, Ear Nose and Throat), Wedgwood Room
- 7:30 Hospital Conference—Trustees, Sert Room
- 8:00 Scientific Session, General Surgery Grand Ballroom
- 8:00 Scientific Session, Ophthalmology Jensen Suite
- 8:00 Scientific Session, Otorhinolaryngology Le Perroquet Suite

### *Wednesday*

- 8:00 Meeting of Cancer Committee, Carpenter Foyer and Dining Room
- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Hospital Conference, Sert Room
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat)
- 1:00 Surgical Film Exhibition (General)

#### *State and Provincial Committees*

- 9:30 Executive Committees
- 9:15 Credentials Committee and Committees on Applicants
- 1:00 Judiciary Committees
- 1:00 Panel Discussions
  - Ophthalmology
  - Otorhinolaryngology
- 1:00 Meeting of Board of Governors, Jensen Suite
- 30-3:00 Panel Discussion, Grand Ballroom
- 1:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 1:00 Symposium on Cancer Wedgwood Room
- 1:00 Surgical Film Exhibition (General)
- 1:00 Hospital Conference, Sert Room

- 3:30-5:00 Panel Discussion, Grand Ballroom
- 6:00 Vandyck Remond Dinner Le Perroquet Suite
- 7:00 Surgical Film Exhibition (Eye, Ear Nose and Throat) Wedgwood Room
- 7:30 Hospital Conference, Sert Room
- 8:00 Scientific Session, General Surgery Grand Ballroom
- 8:00 Scientific Session (Eye, Ear Nose and Throat), Empire Room

### *Thursday*

- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Hospital Conference, Sert Room
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat)
- 10:00 Surgical Film Exhibition (General) Wedgwood Room
- 1:00 Panel Discussions
  - Ophthalmology
  - Otorhinolaryngology
- 30 Adjourned Meeting, Governors, Grand Ballroom
- 1:45 Annual Meeting, Fellows, Grand Ballroom
- 1:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 1:00 Hospital Conference, Sert Room
- 3:00 Panel Discussion—Graduate Training in Surgery Jensen Suite
- 3:30-5:00 Panel Discussion, Grand Ballroom
- 3:30 Surgical Film Exhibition (General), Wedgwood Room
- 3:30 National and Regional Fracture Committee, Le Perroquet Suite
- 4:00 Committee on the Library Room 4-J
- 7:00 Surgical Film Exhibition (Eye, Ear Nose and Throat), Wedgwood Room
- 8:00 Scientific Session, General Surgery, Grand Ballroom
- 8:00 Scientific Session, Ophthalmology Wedgwood Room
- 8:00 Scientific Session, Otorhinolaryngology Sert Room

### *Friday*

- 8:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 9:00-12:30 Forum on Fundamental Surgical Problems, Grand Ballroom
- 9:30 Surgical Film Exhibition (Eye, Ear Nose and Throat)
- 10:00 Surgical Film Exhibition (General) Wedgwood Room
- 30 Assembly of Initiates, Grand Ballroom
- 30 Panel Discussion, General Surgery
- 1:00 Clinics, Demonstrations and Clinical Group Conferences, selected local hospitals
- 2:00-4:00 Panel Discussions
  - Obstetrics, Sert Room
  - Plastic Surgery 4 U Blue Room
  - Neurological Surgery Assembly Room M N
  - Thoracic Surgery Jensen Suite
  - Urology Le Perroquet Suite
  - Orthopedic Surgery Carpenter Foyer and Dining Room
- 1:00 Surgical Film Exhibition (General) Wedgwood Room
- 3:30 Panel Discussion, General Surgery
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## COLLECTIVE REVIEW

### GAS GANGRENE

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MANY of the great men of medicine have been interested in gas gangrene as a complication of wounds because of its spectacular nature, fulminating course, profound toxemia, mutilating effects, and high mortality. Hippocrates described very vividly a fulminating infection of the leg which appears to have been gas gangrene and Celsus also seemed to have recognized its occurrence. Thereafter the disease apparently was not recognized for a long time and Avicenna, Guy de Chauliac, J. de Vigo, and Ambrose Paré (12) did not refer to it although they observed many wounds. In 1745 Quesnay attributed the first exact observations on gas gangrene to Peyronnie, who described the subcutaneous emphysema, the erysipelatous color of the skin, and the rapidity of death. In 1746 Fabricius de Hilden also published one of the earliest clinical descriptions and expressed his belief that the principal cause of this terrible ill is some venomous humor which Nature has driven into these people. Later Dupuytren described a condition of spontaneous emphysema occurring in trauma and resulting in rapid decomposition of the injured part. In 1786 Thomas Kirkland recognized the disease and called it gangrene of the emphysematous type. Early in the nineteenth century Larrey, the leading surgeon of the Napoleonic wars, described the rapid progress of gangrene which spread from the injured limb in a few hours and often caused death in less than 10 hours. To prevent this complication of wounds which he called 'traumatic gangrene' he advocated early amputation of mangled extremities. Boyer (1814)

Velpeau (1829), Martin de Bazas (1836) and Malgaigne all stressed its occurrence as a complication of fractured limbs. Chassaignac (1849-50) believed that certain gangrenes with emphysema had a poison far in excess of the mechanical injury and called it *empoisonnement traumatique*. Billroth thought that the decomposition of mortified elements, possibly by the action of some ferment, was the cause of this condition which he referred to as primary mephitic gangrene. Maisonneuve in 1853 named it *gangrene foudroyante* and at this time some believed the disease had its inception as a clinical entity. During the Crimean War, Pirogoff and Salleron wrote of this condition and in the Franco-Prussian War it was reported by Wyatt, Frery, and Passow. However for some unexplained reason not a single case was recorded by Keen during the American Civil War.

Shortly thereafter during the bacteriological era, the bacterial cause of this disease was established and the more important causal bacteria were identified by various workers, Louis Pasteur discovering the *Vibrio septique*, Novy the *Clostridium oedematis*, and Welch the *Clostridium welchii*.

There is evidence that the incidence of gas gangrene has been significantly increased during more recent times, presumably because a high percentage of the wounds in modern wars has been produced by high explosive shells, bombs, and land mines. According to Zeissler, 100,000 German soldiers died of this complication during the first World War. In the more recent Ethiopian and Spanish Wars, gas gangrene was relatively infrequent, but with the advent of active fighting in

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for neoplasm, hernioplasty (124), biliary tract operations (1) abortions (44) instrumental deliveries, hypodermic injections (81 119) and seemingly clean surgery, particularly amputations for arteriosclerotic or diabetic gangrene

Although it may occasionally follow quite trivial injuries it is most likely to develop in wounds with the following features

- 1 Extensive devitalization of muscles particularly in the extremities.
- 2 Interference of the main blood supply to a limb or muscle group produced by injury prolonged application of a tourniquet tight packing or application of constricting bandages, splints, or casts.
- 3 The presence of foreign bodies clothing or dirt deep in the tissues.
- 4 Delay in surgical treatment
- 5 Puncture wounds with considerable hemorrhage or retained foreign bodies (182)

Certain muscles derive their blood supply from one or two main sources and this is true particularly for the gluteus maximus, hamstring rectus femoris vastus intermedius and gastrocnemius muscles. Massive devitalization of tissue produced by any crushing lacerating or penetrating wound which impairs or destroys these sources of blood supply enhances the occurrence of gas gangrene. Power has pointed out that the re-establishment of the collateral circulation of ischemic muscle appears to be extremely slow and that muscle deprived of its blood supply for 6 8 or more hours frequently dies. MacLennan (108) found that in 28 of 44 cases of gas gangrene in the Tripolitania and Tunisia campaigns a major artery had suffered severe trauma

*Type of projectile.* Trueta, Lenner and Mullally observed that the nature and form of the projectile producing a wound played an important etiological role. Rifle, pistol and machine gun bullets, particularly those that retain their proper shape seldom produced this complication while bullets misshapened either deliberately or by ricochet were more prone to produce clostridial infections. Injuries caused by bombs shells, or trench mortar grenades were prone to precipitate gas gangrene because of the irregular shape of the wounds, the extensive damage to the soft tissues, and the impairment of both the local and general circulation

*Improper surgical care* Improper surgical care of wounds may be a very potent factor in the development of gas gangrene because of the resultant formation of devitalized tissue in a wound. The prolonged application of a tourniquet may produce ischemia and necrosis of muscle thereby

giving any bacteria that are present an excellent opportunity to proliferate (151) A delay in initial surgical care for the men wounded in skirmishes between patrols in Tripolitania and Tunisia resulted in an incidence approximately 4 times greater than that for those injured in pitched battle (106) Delayed definitive treatment may actually permit the inception of gas gangrene while inadequate débridement primary closure of incompletely débrided wounds, tight packing of wounds closure under tension and application of improperly fitting casts or splints may favor the development of devitalized tissue and gangrenous clostridial infections (68) Plaster-of paris casts may be particularly dangerous when applied under conditions which do not permit close observation of the patient afterward and when the cast has not been bivalved or split to allow for subsequent swelling of the tissues (74)

#### BACTERIAL ETIOLOGY

Gas gangrene is a clinical entity of multiple bacterial etiology produced by a great variety of gas-producing anaerobic bacteria chiefly the *Clostridium welchii*, *Clostridium oedematiens*, *Clostridium septicum*, *Clostridium histolyticum* and *Clostridium sporogenes*. Other clostridia described include the *clostridia fallax tertium*, *putrificum aerofetidum bifermentans capitovale* and *sphenoides* (8 26 54, 76 107 123 167) The individual case usually presents a mixed bacterial flora and aerobic pathogenic cocci and bacilli have been found to coexist with the anaerobes in more than half of the cases. The different strains have varied symbiotic and synergistic relationships which are but little understood. The bacteria producing the initial infection in gas gangrene are but slightly proteolytic and much of the tissue destruction and digestion that follow the gaseous infiltration and edema is thought to be due to proteolytic commensals, the most frequent and active of these being the *Clostridium sporogenes* (40)

Trueta reported the relative incidence of anaerobic bacteria in cases of gas gangrene studied by various men as follows

	Welch and Sergiev Per cent	McIntosh per cent	Henry per cent
<i>Clostridium welchii</i>	77	67.3	80
<i>Clostridium oedematiens</i>	34	4.0	10
<i>Clostridium sporogenes</i>	27	38.7	—
<i>Clostridium fallax</i>	16.5	—	6
<i>Clostridium septicum</i>	13	16.3	13

According to Bates the *Clostridium welchii* occurs in approximately 80 per cent of the cases of gas gangrene the *Clostridium septicum* in 10 per cent, and *Clostridium oedematiens* in 3 per cent.

Europe in 1939 and 1940, its incidence increased, varying between 0.7 and 1.8 per cent.

#### PREDISPOSING FACTORS

**Location of the wound.** There are many factors which have been found to predispose to the development of clostridial infections. The location of the wound is of considerable importance since the various tissues of the body are known to have different powers of local resistance and the resistance of these tissues also varies with their location. The muscular areas of the thigh, calf and buttock are especially susceptible while the face, scalp, back, and thorax are affected infrequently (2, 99, 107, 124, 168). In a series of 607 cases collected by Millar from civilian life between the beginning of the Post-Lester period and 1930 the known sites of injuries developing gas gangrene were the lower extremities in 47.6 per cent, the upper extremities in 22.6 per cent, undesignated extremities in 11.3 per cent, the trunk and genitalia in 16.3 per cent, and the head or neck in 2.4 per cent.

The legs have been most often affected because of their large masses of muscular tissue which are subject to traumatization and growth of the clostridia, their susceptibility to injury of the arterial circulation and the likelihood of contamination by dirt and fecal matter (80). All parts of a given region have not been equally susceptible. Trueta pointed out that gas gangrene developed in the thigh most commonly from wounds in the upper third, less often from wounds in the middle third and least often from wounds in the lower third. Furthermore it occurred more commonly in wounds of the front of the thigh. In the arm there appeared to be less distinction between one part and another.

**Age.** The highest incidence of gas gangrene has been in the age groups between 10 and 39 years, the ages that are commonly exposed to the physical hazards of life (124).

**Sex.** The ratio of males to females in civilian practice (124) was about 5.7 to 1.0 while in military practice the cases were confined almost entirely to males for obvious reasons.

**Season.** Maes found that gas gangrene occurred more frequently in the colder than in the warmer months of the year and he believed that clostridial contamination of wounds by woolen clothing worn more frequently in cooler months was the explanation.

In Millar's series, however this variation according to season was not apparent, the incidence being approximately the same for the four seasons of the year.

**Geographical location.** Areas which have been repeatedly cultivated over several or more centuries have produced a higher incidence of gas gangrene than noncultivated areas. This was supported to a certain extent by MacLennan's observations upon the anaerobic bacterial flora of samples of soil taken from the African desert and from the cultivated environs of some coastal towns (107). MacLennan also pointed out that the incidence of gas gangrene increased from 3.4 per 1,000 wounded to approximately 6 or 7 per 1,000 wounded when the fighting moved from the Western Desert to the more cultivated areas of Tripolitania and Tunisia.

**General physical condition.** Reduction in the patient's general powers of resistance by shock, fatigue, exposure, continued pain, hunger, malnutrition, loss of blood, and certain metabolic diseases such as diabetes and arteriosclerosis has increased his susceptibility to clostridial infection (3, 43).

#### EXCITING FACTORS

**Type of wound.** Certain types of wounds, such as compound fractures, gunshot and high explosive wounds, fracture dislocations, extensive lacerations, or crushing injuries containing torn devitalized muscle and dirt have been particularly prone to develop gas gangrene (26, 145, 183). The presence of foreign bodies, such as dirt, gravel, cinders, bits of clothing or fragments of wood, metal or glass, has seemed to enhance the virulence of contaminating clostridia. This has been clearly demonstrated experimentally in a recent study of gas gangrene in animals by Altmeier and Furste (10) who found that the minimum lethal dose of a standardized strain of *Clostridium welchii* was decreased 1,000 times in the presence of devitalized muscle and 1,000,000 times in the presence of crushed muscle and dirt. In other words, it took only one-millionth as many bacteria to produce a fatal gangrenous infection in the presence of devitalized muscle and dirt as it did when bacteria were injected into healthy muscle.

The association of gas gangrene and fractures is well known. In the American Expeditionary Forces of the first World War there were 1,379 cases of gas gangrene among the 25,272 cases of fracture of bone, an incidence of 5.3 per cent (26). In Millar's series, 60.9 per cent of the cases collected from civilian life occurred in individuals with fractures.

Other forms of trauma that have precipitated this complication are cutaneous thermal burns (53, 114) and various operations including appendectomies, genitourinary operations, resections

ized by cholesterol it is similar to streptolysin O to which it is closely related antigenically

3. Eta toxin is a lethal toxin without necrotizing or hemolytic activity which has been differentiated from alpha toxin by discrepancies in the neutralizing values of sera as determined by necrotizing and lethal testing

4. Beta toxin is a thermolabile lethal and necrotizing toxin which can be recovered from the intestinal tract of lambs suffering from lamb dysentery

5. Gamma toxin is a lethal toxin without hemolytic or necrotizing power the existence of which has been inferred because of discrepancies between the neutralizing values of various specific sera when tested against corresponding filtrates

6. Delta toxin is lethal and hemolytic for the red cells of sheep, pigs, goats, and cows but does not affect human serum or manifest any necrotizing activity

7. Epsilon toxin is a lethal and necrotizing toxin which exists in two forms, thermostable and thermolabile. In its thermolabile form it has occurred in the intestinal contents of sheep suffering from lamb dysentery and infectious enterotoxemia, and the disease is almost certainly due to absorption of toxin from the alimentary canal

Recently MacFarlane and MacLennan (109) have described further activities of *Clostridium welchii* toxin which may be very significant. In observations made on muscle taken from the site of clinical infection or following the intramuscular injection of toxin in rabbits they obtained evidence of a marked increase of extractable fat in such muscles which was due perhaps to the release of intracellular lipoids. By the incubation of rabbit and human muscles with *Clostridium welchii* toxin and toxin neutralized by antitoxin they were also able to demonstrate that the toxin produced a friable mass of loose brittle fibers which they designated as collagenase activity. This activity was not demonstrated for the toxins of *clostridia oedematis* and *septicum*. They believed that there were possibly two toxic factors involved in gas gangrene: one derived from the bacteria, which can be neutralized by antitoxin and another derived from disintegrating tissues which can be prevented from killing the patient only by surgical removal of the tissues concerned. Studies at Cincinnati in experimental gas gangrene have also been indicative of a secondary toxin arising from the disintegration of tissue. This hypothesis received some support from the observations that the anaerobic cellulitis due to *clostridia welchii* and *welchii* infections of the brain and serous lined cavities (140) is not associ-

ated with the profound toxemia observed in cases of *Clostridium welchii* myositis. This naturally leads to the question of a possible relationship between the effects of a toxic destruction of muscle and those associated with its traumatic destruction. In both conditions there is circulatory failure, liability to renal involvement leading to uremia and perhaps fat embolism. In this connection Cooke *et al.* have described 2 fatal cases of gas gangrene which showed extensive fat embolism of the lung and other organs at autopsy. It would seem profitable to focus attention on the collagenase activity of the toxin of the *Clostridium welchii*

The knowledge that the *Clostridium welchii* occurs frequently in wounds in which no symptom of gas gangrene is observed has led to the assumption by some that many of the *Clostridium welchii* strains are atoxic. Robertson and Keppie investigated 26 strains of the *Clostridium welchii* obtained from wounds with gas gangrene, wounds with clostridial infection but without symptoms of gas gangrene and wounds without evidence of clostridial infection. Their studies indicated that all of the strains tested seemed to be of a basic toxicity sufficient to produce gas gangrene if the state of the wound was such as to permit their rapid proliferation and the evolution of toxins.

In a recent study at Cincinnati (10) the virulence of 15 strains of the *Clostridium welchii* isolated from dirt was determined quantitatively and compared with that of 25 strains isolated from wounds manifesting gas gangrene, localized clostridial infections, or nonspecific low grade infections. The results of this study were as follows:

1. The virulence of strains isolated from infected wounds for as long as 35 years was from 1,000 to 1,000,000 times greater than that of strains isolated from dirt, clothing, and soil.

2. The virulence of the types isolated from localized infections and low grade infections in some instances was as high as that of strains obtained from the fulminating cases.

3. There was no measurable correlation between the virulence of these strains for experimental animals in closed wounds containing crushed muscle and dirt and their relative ability to produce alpha toxin, theta toxin and hyaluronidase in vitro.

4. The virulence as determined by the crushed muscle and dirt technique did not correspond with that determined by the simple injection of bacteria.

After a study of more than 600 strains of the *Clostridium welchii* isolated from cases of abortion Butler (24) concluded that the strains caus-



It has become increasingly apparent that the relative incidence of the various clostridia in gas gangrene varies with the geographic location. In a carefully studied group of 146 cases of gas gangrene developing in war wounds in the Middle East (107) the incidence of the *Clostridium welchii* was much lower (56 per cent) than that given by other workers in Europe while that of the *Clostridium oedematiens* was much higher (37 per cent). The occurrence of other bacteria in this series of MacLennan is well illustrated in Tables I and II.

However in the more recent fighting in France MacLennan and Macfarlane (109) later found that the *Clostridium welchii* was the most common single anaerobe in infectious gangrene occurring in 24 of 27 cases studied by them and in more than 90 per cent of the German cases reported by captured German medical officers. They also believed that the anaerobic flora of the soil in Italy was very similar to that of Tunisia and Western Europe, and that approximately 60 per cent of the wounds contained clostridia, among which the *Clostridium welchii* and the *Clostridium sporogenes* were predominant.

Although the *Clostridia welchii oedematiens*, septicæ and histolyticum are recognized as the most important agents in the production of gas gangrene (26) the fact remains that the *Clostridium welchii* is the principal cause being present either alone or in association with the other gas-producing anaerobes in from 56 to 100 per cent of the cases in the reported series.

*Characteristics of the Clostridium welchii* This organism, first isolated in 1892 from a cadaver by Welch and Nuttall, has acquired eleven synonyms (140) the most frequently used of which are *Bacillus perfringens*, *Clostridium welchii* and the gas bacillus. It is a short, thick, capsule-bearing bacillus with truncated ends and it is fairly ubiquitous in man's environment being commonly present in soil dust, sewage milk, water the intestinal and genital canals of man and animals, woolen clothing and fur of domestic animals.

TABLE I.—INCIDENCE IN PER CENT OF PATHOGENIC ANAEROBIC BACTERIA FOUND IN 146 CASES OF GAS GANGRENE.

Species	Incidence in per cent
<i>Clostridium welchii</i>	56
<i>Clostridium oedematiens</i>	37
<i>Clostridium septicum</i>	9
<i>Clostridium histolyticum</i>	6
<i>Clostridium bifermentans</i>	4
<i>Clostridium fallax</i>	3
<i>Clostridium tetani</i>	3
<i>Streptococci</i>	9

TABLE II.—INCIDENCE IN PER CENT OF NON PATHOGENIC ANAEROBIC BACTERIA FOUND IN 146 CASES OF GAS GANGRENE.

<i>Clostridium sporogenes</i>	37
<i>Clostridium tertium</i>	30
<i>Clostridium putrificum</i>	10
Unidentified	6
<i>Clostridium butyricum</i>	3
<i>Clostridium cochlearium</i>	9
<i>Clostridium capitivum</i>	5
<i>Clostridium spheeroides</i>	3
<i>Clostridium histiforme</i>	3
<i>Clostridium tetanomorphum</i>	3

Being one of the most hardy of all anaerobes, its most important characteristics include the production of a large amount of gas and powerful toxins during growth. Hemolysins for the blood corpuscles of man, rabbits, dogs, pigeons, white mice, hogs, cattle, sheep, horses, guinea pigs, white rats, and hens are formed (26). In the guinea pig, rabbit, hen, and pigeon, the hemolysins dissolve out the hemoglobins, while in the other animals, the red cells are destroyed. The seven toxins which have been described are listed below but for practical purposes only the alpha, theta, and beta toxins need be considered since the existence of the others is based mainly upon inference (133, 167, 179).

1. Alpha toxin is a thermostable lecithinase which splits lecithin and the lecithin group of lecithoproteins into phosphocholine and a diglyceride (106). Because of this property it is hemolytic to the red cells of most experimental animals except the horse and goat, and its intravenous, intramuscular or intraperitoneal injection is lethal to mice, guinea pigs, rabbits, pigeons, and sheep. Animals surviving more than a few hours after the intravenous inoculation of this toxin may develop a hemolytic anemia with hemoglobinuria. Subcutaneous injections produce a characteristic necrotic lesion.

2. Theta toxin is a lethal toxin which is vigorously hemolytic for the red cells of most laboratory animals except those of the mouse. Being oxygen-labile, thermolabile, and readily neutral-

TABLE III.—THE INCIDENCE OF THE CLOSTRIDIUM WELCHII IN CASES OF GAS GANGRENE

Observer	Percentage Incidence of <i>Cl. Welchii</i> in Gas Gangrene
Babcock	73
Bates	About 80
Boyd	70-80
Cruckshank R.	70-80
Gins and Koepfen	96
MacLennan (107)	56
Weinberg, M. and Seguin, P. (80)	83
Kukin	90

from various parts of a battleship by Endo was contaminated by pathogenic strains of the *Clostridium welchii* in 48.4 per cent of 31 samples in the first collection and 59.5 per cent in the second. The soil of countries that have been cultivated for centuries has always been heavily contaminated with clostridia. Recently Altemeier and Furste collected 15 samples of dirt from the major street intersections of Cincinnati and found that all samples contained viable spores of the *Clostridium welchii* as well as of other clostridia. MacLennan (107) found that *Clostridium welchii* was present in 22 of 26 samples obtained from cultivated areas of the African desert, in 6 of 24 samples from soiled areas, but in only 1 of 41 samples collected from unsoiled areas. Similar but less striking results were obtained with the other clostridia.

Wool clothing is an important source of clostridial contamination and the observations that the uniforms of wounded soldiers harbored the *Clostridium welchii* and other clostridia in a high percentage of instances (51, 107, 165) led to the assumption that this was principally the result of soil contamination. However reports by Gage Macs, and Altemeier (10) indicated that clothing made from wool naturally harbors the *Clostridium welchii* and other anaerobic gas producing bacteria.

Other less common sources of contamination have been unsterile and imperfectly sterilized dressings and instruments (40, 158) the unprepared skin of the abdominal wall (152) and even the ice used for refrigeration anesthesia (92).

**Incidence** In view of its widespread distribution, the contamination of a considerable proportion of open wounds of violence is not surprising. Recent studies of the bacterial flora of various types of wounds are summarized in the following table which shows that the presence of the *Clostridium welchii* varied between 3.8 and 39.4 per cent. The average incidence of contamination in collected series of 3,027 wounds of violence both civilian and military was 14.7 per cent.

#### CLOSTRIDIAL INFECTION

**Incidence** In contrast to the relatively high incidence of contamination, the development of clinical gas gangrene in wounds is relatively infrequent. Its incidence has varied between 0.3 and 5.26 per cent in the following summary of collected series comprising 187,936 major open wounds, the average being 1.76 per cent.

This is especially remarkable since there is often no appreciable difference between the bacterial flora of the wounds developing gas gangrene and

TABLE IV — THE INCIDENCE OF THE CONTAMINATION OF WOUNDS OF VIOLENCE WITH THE *CLOSTRIDIUM WELCHII*

Author	No. of cases	N. of wounds contaminated	Percentage of cases contaminated
Altemeier and Gibbs ( )	90	30	30.4
DeWaal H. L.	708	7	3.8
Dimitz, A. and Gutache H.	424	57	13.4
Meleney ( ) Soft part wounds	226	18	14.9
Compound fractures	674	147	21.8
Levaditi et al.	61		7
Miles ( ) Military wounds	5	24	.8
Spooner	30	3	
	3027	445	14.7

of those that do not (54). This brings up the very challenging question as to why only a small fraction of the wounds contaminated by clostridia develop gas gangrene.

According to Power the answer undoubtedly is that only 0.33 per cent of all the wounds undergo

TABLE V — THE INCIDENCE OF GAS GANGRENE IN WOUNDS OF VIOLENCE

Author	No. of cases	Number of cases which developed gas gangrene	Percentage of cases which developed gas gangrene
Altemeier (7)	7	3	4.3
Callender and Coupal			
Soft part wounds	28, 65	1,350	1.08
Wounds including bone fracture	5,57	1,600	5.26
DeWaal	708	3	.43
Faber, Florey, Grimsom, and Williams	3,47	5	0.15
Jeffrey (77)	About ,000	5	0.5
Langley and Whitestein	6,000	66	.6
Leaner	150	8	.4
MacLennan (108)	About 6,800	44	6 to 7 (British Campaigns in Tripoli and Tunisia)
Neel and Cole Pacific area (Author's) cases	984	7	0.7
Power	6,000	20	4.3
Ross and Ryan	85	8	0.3
Tuchel and Carmichael	,500	20	.8
Wan (75)	2,000	7	.6
	87,936	3,300	76

ing severe infections differed both in regard to growth characteristics and to the amount of capsular material they produced in broth.

Woods and Fein studied the metabolism of amino acids in one strain of the gas bacillus, and, found that it attacked only 5 of 21 commoner amino acids which they investigated these acids included serine, cystine threonine and arginine.

Observations upon animals infected with pure cultures of the *Clostridium welchii* have thrown much light on the pathogenesis of gas gangrene. The injection of large quantities of washed bacilli failed to produce gas gangrene in animals unless relatively large amounts were used. Characteristic lesions, however were produced readily if a slight injury to the muscles preceded the injection of bacteria (10 25 26 147 167). In the presence of devitalized muscle the inoculation of a virulent culture of *Clostridium welchii* is typically followed by local swelling and induration within from 4 to 6 hours, which increases rapidly. Crepitation of ten becomes perceptible within 6 or 8 hours. The swelling is caused chiefly by edema, and to a lesser extent by infiltration of gas. The symptoms of intoxication that develop include extreme rapidity of the pulse and respiration, prostration, slight convulsions, and paralysis of the bowel. Before death, the animal has paralysis of its hind legs and convulsive contractions.

*Characteristics of the Clostridium septicum* This organism, originally described by Pasteur and Joubert in 1877 normally lives in the soil and is a nonproteolytic very saccharolytic bacillus which produces powerful exotoxins including a hemolytic and a hemagglutinin. It produces less gas than the *Clostridium welchii* and an edema which, although highly hemorrhagic is soft compressible, and less extensive and gelatinous than that produced by the *Clostridium oedematiens*. Small vesicles containing serosanguineous fluid appear on the skin. The muscles infected by this organism are rendered soft and intensely red during the first few hours. It hemolyzes the red corpuscles of the guinea pig rabbit sheep goat, and man (26). The pathogenicity of different strains varies considerably. Areas of swelling and induration develop fairly rapidly in rabbits and guinea pigs after the injection of the *Clostridium septicum* but they are never as extensive as those produced by the *Clostridium welchii*.

The studies of Bernheimer suggest that the hemolytic and lethal actions of crude toxin are either functions of a single substance or of two substances having a similar physical chemical and antigenic property.

*Characteristics of the Clostridium oedematiens*. This organism was probably first discovered by Novy in 1894 in a study of "malignant edema in guinea pigs. The bacterium lives in the soil and produces a highly aggressive exotoxin which destroys the red corpuscles of man sheep and guinea pigs (26). The organism is saccharolytic and produces little or no gas. Apparently it does not invade the tissues and hence, like the *Clostridium tetani* and the *Bacillus diphtheriae*, its poisonous effects are due entirely to its toxin (167) which is highly invasive and kills animals within 48 hours after intravenous injection.

The lesions produced by different strains of the *Clostridium oedematiens* vary according to their powers of toxin production. The intramuscular inoculation of a toxin producing strain is followed quickly by marked swelling of the limb which increases by the hour. As the firm elastic edema extends upon the abdomen, the thigh becomes cold and the skin pale and bluish. The muscles at the site of injection become congested and infiltrated with a gelatinous, deep pink fluid and many fine gas bubbles, but no putrid odor develops. Subcutaneous injection produces a similar lesion with a very thick hardlike edema infiltrating the subcutaneous connective tissue for a depth of from 3 to 4 cm.

*Characteristics of the Clostridium histolyticum*. This organism the most proteolytic of all the anaerobes, is pathogenic to varying degrees for all laboratory animals, including guinea pigs, rabbits, white mice, and rats (26). A guinea pig will die several minutes after an intravenous injection of from 1 to 2 c.c. of a 24 hour culture, and an intraperitoneal injection is lethal in the same dose. Intramuscular injection is followed immediately by violent tetany of the muscles about the head and neck and within several hours by local swelling and redness of the skin. A hemorrhagic layer develops in the subcutaneous connective tissue and the subcutaneous and perimuscular connective tissues undergo rapid digestion. As the process continues for several or more hours, the digestion of the perimuscular connective tissue becomes more evident and the muscles and the muscular bundles become dissociated and liquefied.

The *Clostridium histolyticum*, as well as the *Clostridium fallax* and *Clostridium sporogenes*, does not seem to be sufficiently aggressive to produce gas gangrene clinically by itself.

#### CLOSTRIDIAL CONTAMINATION OF WOUNDS

*Sources* It has been established that the *Clostridium welchii* is practically ubiquitous in the human environment. Even the dust collected

it is palpable. The accumulative effect of this vicious circle may cause the infection to be well advanced in 2 hours, and has been known to produce death from massive gas gangrene of an entire limb in less than 30 hours.

The anatomical picture of special gas gangrene infections may be so typical that conclusions as to the causal organisms may be possible. In the usual case of clostridial myositis caused by the *Clostridium welchii*, the lesion occurs most frequently in the thigh particularly in the upper anterior aspect, as an emphysematous gangrene that spreads, in some cases very extensively from the initial local focus. The wound is very dirty and exudes a thin, dark, evil smelling discharge containing bubbles of gas. The edges of the wound are dark and often black and the surrounding skin is tense swollen, and pallid but gradually assumes a yellowish blue or green color and still later presents areas of necrosis. In clostridial myositis caused by the *Clostridium oedematiens* alone or in combination with other bacteria the most characteristic feature is the absence of gas with widespread and rapidly progressive gelatinous edema immediate and severe general intoxication, and a time lag of 48 hours or more before the appearance of gangrene. The cellular spaces and subcutaneous tissues are distended by a clear gelatinous edema and the muscles are dark red or raspberry in color.

#### SYMPTOMS AND SIGNS

The incubation period between the injury and the onset of gas gangrene varies between a few hours and 4 or more days. Lazarus and Cruickshank stated that while the usual incubation period varied from 1 to 6 or 7 days, the average being 3 days, it has been known to be as short as a few hours after operation and as long as 10 years after inoculation. In the experience of Neel and Cole in the Pacific area it varied from 1½ to 5 days the average being 2.35 days. MacLennan (108) reported an average incubation period of 23 hours for the *Clostridium welchii*, 48 hours or more for the *Clostridium oedematiens* (with an average of 5½ days) and 3 days for the *Clostridium septicum*. Although the incubation period may be as short as 6 hours after wounding the chief clinical manifestations usually develop on the second day.

Pain is nearly always the earliest symptom (30, 54, 167, 21, 108). Although it may be due in part to the effects of injury it is caused principally by the rapid infiltration of the tissues by fluid and gas. In some instances it has been described at first as a sensation of heaviness or tension and later as a burning but rarely a throbbing pain.

In virulent cases the initial symptom has usually been spontaneous pain or a sudden increase in the intensity of pre-existing pain which appeared within 18 to 24 hours after the injury and which was followed shortly by a distinct and rapidly developing distention of the traumatized tissues. Later the pain may disappear and in the overwhelming toxic forms complete absence of pain may be characteristic.

**Rapid pulse.** An alarming rapidity and feebleness of the pulse soon follows the onset of pain which is out of all proportion to the temperature (22, 30, 54). This may become increasingly apparent and progress to circulatory collapse which may be abrupt, progressive, and severe. As the pulse rate becomes increasingly rapid, the amplitude becomes steadily smaller. Early the blood pressure has been described as slightly elevated (167) but later it may become significantly low (108).

**Temperature.** The degree of fever varies considerably but frequently it is less than 101° F. It is not a reliable index of the severity and extent of the infectious process, but it may indicate the prognosis, for a low temperature with rapid pulse suggests a grave outlook. In civilian practice this is not always true, since we have seen severe proved cases with a temperature of 105° F or greater. In the mildest type of clostridial infection clostridial cellulitis, there often is considerable rise in the temperature but the pulse rate shows a corresponding increase.

**General appearance.** Early in the course of the disease the patient may develop a peculiar grayish pallor, listlessness, weakness, profuse sweating, prostration, breathlessness, and dilated pupils. The usual malar flush associated with pyogenic infections is replaced by a striking pallor (54) and an extremely worn or strained expression of the face (99). The pallor may be succeeded by a yellowish or icteric tint of the skin and sclerae. MacLennan (107) has emphasized that the profound shock and toxemia developing in gas gangrene are relatively uninfluenced by transfusions of blood.

**Mental state.** This is one of apathy and indifference, the patient being quite conscious but usually unaware of the seriousness of his condition. The more common central nervous system manifestations may be divided into those of hyporritability and hyperirritability. The former are more common with the wet type of gas gangrene while the latter are more frequently seen in the crepitant form (30). Stupor, delirium and coma may occur late.

**Gastrointestinal symptoms.** Anorexia is a fairly constant finding and vomiting is not an uncommon

sufficient arterial damage to produce an adequate amount of ischemic muscle in which the clostridia can multiply. Although this factor is of importance, the answer does not appear to us to be this simple. Fleming pointed out that the infecting agent has often acquired increased virulence in passing from one individual to another in civilian practice, whereas the virulence of the agents infecting war wounds has been more than likely attenuated by the unfavorable surroundings under which they existed.

#### PATHOLOGY

There is still considerable confusion regarding the classification and interpretation of the pathologic changes in clostridial infection. A large number of descriptive terms has been applied to it, such as subcutaneous emphysema, primary mephitic gangrene, traumatic gangrene, bronze erysipelas, spontaneous emphysema, empoisonnement traumatique, and gangrene foudroyante. More recently terms such as clostridial myositis, anaerobic cellulitis, anaerobic toxemia, and toxic edema have appeared.

The term gas gangrene is inadequate and undesirable in many respects and the following classification is more desirable:

##### 1 Clostridial myositis

###### a. Spreading or diffuse (gas gangrene)

- 1 Crepitant
- 2 Noncrepitant or edematous
- 3 Anaerobic toxemia

###### b. Localized myositis

- 1 Crepitant
- 2 Noncrepitant

##### 2 Clostridial cellulitis (crepitant phlegmon or anaerobic cellulitis)

Clostridial myositis of the spreading or diffuse type represents true gas gangrene and it may be manifested clinically as the crepitant type, the noncrepitant or edematous type, the mixed type, or the profound toxic type. Because of its mild and self-limiting nature, localized clostridial myositis should not be considered as gas gangrene. Diffuse clostridial myositis is essentially an affection of the muscles, and the connective tissues may be comparatively little affected at first. The clinical and pathological pictures presented by this infection differ markedly in long and in segmented muscles (167) the spread, rapidity of evolution, and gravity of the process all being greater in the former. Three distinct zones in these lesions have been described by Trueta: these are

1 A central or dead zone which consists of disintegrated muscle destroyed by trauma, organized clot and a vast number of organisms.

2 A second or dying zone which contains devitalized muscle fibers covered by masses of bacteria and the products of infection. Their anatomical arrangement remains undisturbed although the fibers became separated by an exudate which is or is not packed with leucocytes, according to the type of infection. Local leucocytosis usually is associated with mixed infections.

3 A third or normal zone in which the muscle is normal, except for some cellular infiltration.

The causal bacteria are found more often in the lymph surrounding the muscle fibers than in the fibers themselves, and their spread is in a longitudinal direction rather than a transverse one. It is believed by some that the infection extends rapidly through the damaged muscle to the area where the circulation is still intact and the muscle fibers are normal, where it is temporarily checked. Thus, although the tissues of the first and second zones are quickly destroyed by the combined effect of the trauma and infection, the vitality of the third zone may temporarily prevent further spread of the process and permit successful treatment. Others believe that the process spreads primarily in the connective tissue in the intermuscular septa and surrounding veins and nerves (139). The studies of McNee and Dunn on the microscopic appearance of the advancing edge indicated that the bacilli spread up and down the muscle in the interstitial tissues, preceded by the exudation of a toxic fluid which separated the muscle fibers from the interstitial tissue and killed them, permitting their invasion by the bacteria. Krupp and Smith working with Reed and Orr confirmed the tendency of gas gangrene to spread in loose connective tissue and along the fascial planes. They also concluded that the toxins of the *Clostridium welchii* inhibited the accumulation and phagocytic action of leucocytes and other phagocytic cells.

As gas and edema accumulate in spaces confined by aponeurosis and stretched in elastic skin, a great increase of pressure occurs in the tissues which is sufficient to produce further necrosis of muscles and compression of the lymphatics, veins, and arteries even as large as the femoral. This opens the malignant phase of the infection, and the successive stages of muscle disintegration and bacterial invasion follow one another with great rapidity involving not only a single muscle but a whole group and often an entire limb. The muscles, at first hemorrhagic and friable, contract and soon exude a watery blood stained and often brown foul discharge containing bubbles of gas. The infiltration of the muscles and the intermuscular planes extends well above the area in which

welchii obtained from smears cultures or tissue by Altmeier (8) using a modification of the stormy fermentation of milk by the *Clostridium welchii* by Nagler Crook Hayward Weed and Minton using the Nagler reaction for the *Clostridium welchii* and by Gordon and McCleod using heated blood agar plates containing benzidine for the rapid identification of the *Clostridium oedematis*. Reed and Orr (148) also collected a series of diagnostic biochemical reactions which were generally sufficient to differentiate the various species within 24 hours. While these various tests aid considerably in early diagnosis they all have definite limitations. They do not distinguish the virulent and toxigenic strains from the nonpathogenic ones (104) and it must be kept in mind that these anaerobes have been frequently isolated from wounds not affected with gas gangrene.

Serum roentgenograms taken for gas in the soft tissues have been of practical value in the detection of early or incipient gas gangrene permitting a positive diagnosis 24 or more hours earlier than possible by the clinical findings alone (10 13 167). Films taken at intervals of from 2 to 12 hours may aid in the differentiation of gas due to the clostridia from that due to mechanical causes. If the gas increases in amount or presents a linear spread in the muscle planes, a diagnosis of gas gangrene can be made.

It must be kept in mind that valuable time may be lost in awaiting results of various diagnostic tests during which irreversible changes may occur in the tissues. For this reason it has been more practical in our experience to explore surgically and without delay any wound in which the presence of clostridial myositis is suspected. This plan permits earlier radical surgery when necessary and thereby the most effective method of control of the process.

#### DIFFERENTIAL DIAGNOSIS

Anaerobic cellulitis, streptococcal myositis, and hemolytic streptococcal gangrene must be considered in the differential diagnosis of gas gangrene. Of lesser importance are traumatic emphysema magnesiumous pneumogranuloma staphylococcal acute infectious gangrene, and gangrene caused by the accidental injection of some foreign agent.

*Anaerobic or clostridial cellulitis* is a crepitant septic process of the epifascial retroperitoneal, or other connective tissues which usually have been devitalized by trauma. There is usually no extensive invasion of living muscle as in true gas gangrene. It is most commonly seen in extensive lacerations of soft tissues other than muscle, the anaerobes multiplying freely in necrotic debris. The incubation

period of anaerobic cellulitis is usually 3 or 4 days and the onset is more gradual than that of true gas gangrene. Systemic effects may be slight unless the wound is also very septic, and this relative mildness of the general reaction is helpful in distinguishing between it and true gas gangrene. However anaerobic or clostridial cellulitis is not a condition to be regarded lightly. The spread of infection in the tissue spaces may be rapid and extensive and necessitate radical surgical drainage even within a few hours.

*Streptococcal myositis* In this condition there is a massive infection of muscle together with discoloration edema, serous exudate gas formation local pain and generalized toxemia. Neglected cases may progress to a true gangrene of muscle. The chief points of differentiation between it and clostridial myositis are (1) its more pronounced and extensive cutaneous erythema (2) its involvement of muscle which although edematous and discolored is still alive and reactive to stimuli (3) its different odor and (4) the microscopic appearance of a muscle smear stained by Gram's method which reveals no gram positive bacilli but vast numbers of streptococci among masses of pus cells.

*Hemolytic streptococcal gangrene* occasionally follows some relatively minor operative procedure or injury. The lesion is essentially an epifascial spreading subcutaneous gangrene with thrombosis of the nutrient vessels and resultant slough of the overlying skin. It usually develops in the extremities although the perineum face and other parts of the body may be involved. It is characterized by the onset of pain and marked swelling at the site of the wound, chills elevation of the temperature to from 101° to 104° F. rapid pulse toxemia prostration and a rapidly spreading painful cellulitis which undergoes bullous formation and a peculiar patchy and extending necrosis. Hemolytic streptococci are found in the subcutaneous gangrene and bullae often in pure culture.

*Acute infectious staphylococcal gangrene* may occasionally simulate gas gangrene. Morrison reported such a case in a 5½ year old boy who developed a rapidly spreading cellulitis with pain swelling brawny induration patchy discoloration of the skin and elevation of temperature to 105° F. 3 days after injury. No organism other than the *Staphylococcus aureus* was demonstrated on aerobic and anaerobic culture of the pus obtained by multiple incisions in the involved tissues.

*Crepitation of tissues not produced by bacteria* Cases in which air has been sucked into tissues by penetrating or perforating missiles have been confused with true gas gangrene in some instances.

mon symptom. The tongue very quickly becomes dry and coated.

**Appearance of the local lesion.** The skin overlying the lesion is at first white and tense. There is usually an irritating dirty brownish watery discharge from the wound with a peculiar foul odor. As the swelling increases, the overlying skin becomes dusky and bronzed or khaki-colored in appearance (54). If further discoloration occurs, vesicles filled with dark red fluid appear on the cutaneous surface and later coalesce as the lymphatics and venous channels become blocked. The changes in color of the skin appear earlier in the more superficial and confined infections than in the deep highly invasive types. The distal portion of the limb becomes edematous, engorged, discolored, cold and finally gangrenous. If the patient lives long enough, sloughing may occur. The area of wet gangrene of the skin is always much less than that of the underlying muscle. The edema that occurs in gas gangrene is an integral part of the picture. With certain of the bacteria, such as the *Clostridium oedematiens*, the swelling is extreme and causes the skin to become tense and marblelike in appearance. The appearance of the muscles with their grayish or black sloughing surface is a striking feature. They may be so swollen that they herniate out of the wounds (55). The necrotic muscle does not contract or bleed when cut, and usually presents a darkened color with few gas bubbles in the wound and in the intermuscular septa.

In discussing battle casualties in a South Pacific Evacuation Hospital, Potts pointed out that bubbling of small amounts of gas from an infected wound does not necessarily mean gas gangrene in the ordinarily accepted sense of the term, but a less virulent localized area of myositis in the absence of the well recognized clinical picture. In the cases of clostridial myositis seen by Ross and Ryan in the Owen Stanley and Buna-Gona Campaign, wide variation in clinical types was seen, ranging from the classic fulminating infection with the associated general signs to a local abscess around a retained missile. These latter cases were not gas gangrene but localized areas of clostridial myositis.

**Laboratory examinations.** In many instances a marked reduction in the number of red corpuscles occurs with counts ranging between 1 and 2 million cells per cubic millimeter. The low red blood counts and hemoglobin levels as low as from 30 to 40 per cent are due to the hemolytic anemia and are probably the most striking laboratory findings. The leucocyte count usually does not exceed 12,000 or 15,000 cells per cubic millimeter but in

civilian practice it may occasionally be quite high. In the experience of Nikolakaya severe infections produced by the *Clostridium welchii* in association with the *Clostridium oedematiens* were often associated with a leucopenia, a definite lymphopenia, but rarely a leucocytosis.

According to Trueta, there may be an immediate deterioration of the liver function with consequent acidosis, which was first noticed by Sir Almroth Wright during the first World War and confirmed by Marquid, Clogne, and Didier in France. How far the acidosis contributes to a fatal issue is not known, but the prognosis is related to its intensity.

Positive blood cultures are rarely found (56, 57) but may occur in the initial stages of the fulminating *Clostridium welchii* toxemia described by Trueta. In infections produced by the *Clostridium oedematiens*, rises in hemoglobin levels to as much as 130 per cent have been reported if the edema became extensive and much oozing occurred.

#### DIAGNOSIS

It must be emphasized that this disease is a clinical concept which has usually been recognized by the clinical appearance of the patient and his lesion in its obvious, far advanced, and often irreversible stages. Continued pain at the site of a wound containing devitalized muscle, a rapid and easily compressible pulse, varying degrees of fever, toxemia in association with spreading edema, a thin brown water malodorous discharge, crepitation, herniation of discolored muscle which does not bleed or contract, and typical discoloration of the skin in the region of the wound are relatively late symptoms and signs that strongly suggest the nature of the lesion, even to the novice. Repeated questioning and close observation of wounded patients unquestionably are of value, and the old principle of promptly inspecting the wound in the presence of unexplained fever or pain has been particularly valuable in the earlier recognition of the process. Infiltrating gas may be detected early by the experienced observer through auscultatory percussion, but usually the presence of casts, splints, or large dressings obscures the wound and makes diagnosis difficult and the interpretation of local signs indirect.

Considerable investigative work has been carried out to facilitate earlier diagnosis, principally through the development of methods for the rapid identification of the clostridia *welchii* and *oedematiens*, and other anaerobes associated with gangrene. Methods have been developed and adapted to clinical use by Butler (53) using the demonstration of stained capsules for the *Clostridium*





Clinical examination of these patients who do not show the signs of severe toxemia reveals palpable crepitation in the tissues but roentgenological examinations usually show that collections of air lie along the course of the wound rather than in the planes of the tissue.

Rubenstein, Tabernhaw and Daniels reported 3 cases with subcutaneous crepitant tumor masses about lacerations of the hand in patients who had handled an alloy containing 90 per cent of finely powdered magnesium.

An extremely rare condition which may be confused with gas gangrene is that caused by the accidental injection of benzene. Schreus reported on a series of 15 patients who developed crepitant necrosis of muscle a few hours after injection into the pectoralis muscle of material thought to be typhoid vaccine but later proved to be benzene. No bacteria were found in the exudate.

#### TREATMENT

**Prophylaxis.** Early and adequate surgery is still the most effective means of preventing gas gangrene since it not only eliminates the conditions necessary for the propagation of the bacteria but also removes most of the contaminating bacteria. (3, 13, 21, 25, 29, 93, 135, 176). Adequate surgery implies early meticulous excision of all dead and devitalized tissues, removal of dirt, clothing and other foreign material from the wound, preservation of the blood supply, relief of tension, and sufficient drainage when indicated. In this instance as always it must be remembered that débridement has replaced the use of antiseptics in the prevention of wound infections. (2). The use of postoperative immobilization and the avoidance of tension constricting or malfitting casts and dressings which might produce ischemia and further devitalization of tissue are also integral parts of prophylactic surgical treatment. Any "packing" of open wounds must be done loosely as tight packing may result in devitalization of tissues from pressure and inadequate drainage.

Although there is considerable evidence that the prophylactic administration of gas gangrene antitoxin is of little practical value in the prevention of clinical gas gangrene it has been given almost routinely at the time of injury. (3, 41, 48, 51, 62, 63, 83, 93, 110, 121, 171, 176). English surgeons (49) however have strongly advocated the prophylactic administration of antitoxin to injured patients in whom there is any reason to anticipate gas gangrene as a likely complication. In 1944 the preparations recommended by the British contained 22,500 international units of polyvalent antitoxin including 9,000 units of *Clostridium*

*welchii* antitoxin, 4,500 units of *Clostridium septicum* antitoxin and 9,000 units of *Clostridium oedematis* antitoxin in each ampule. The surgeons stated that clinical judgment of the local and general condition should determine whether the minimum prophylactic dose is likely to suffice or if the dose should be repeated or increased. Hall (65, 66) also stated that there was no reason to doubt the prophylactic value of 7 American gas gangrene antitoxins against the anaerobic infections for which they were intended. He believed that when prompt adequate surgery is possible, gas gangrene may be prevented by this method alone and that the prophylactic use of serum may augment the effectiveness of both early and delayed surgery. He reported that 6 of the commercial antitoxins available were bivalent, containing *Clostridium welchii* and *Clostridium septicum* antitoxins only. Those who question the effectiveness of antitoxin as a prophylactic agent state that gas gangrene is not too well defined as a clinical disease which has a multiple etiology. Since a large variety of gas forming anaerobic bacteria has been identified with this infection, either in pure or mixed culture, it seems rational to use the pentavalent antitoxin rather than any of the lower valent antitoxins. It seems well established that the prophylactic use of antitoxin can in no way take the place of adequate surgery.

At first chemotherapy appeared to be effective in the prevention of gas gangrene, but subsequent experience has shown the great limitations of each of the available agents. Penicillin has been by far the most effective (9, 10, 55) and streptomycin the least. Cutler and Sandusky reported 5 cases treated with penicillin immediately following primary débridement in which gas gangrene developed. They concluded that proper surgical débridement is the major factor in both the prophylaxis and therapy of this infection. Similar experiences were reported by Patterson, Keating and Clegg and by Conway.

In a series of investigations on experimental gas gangrene in guinea pigs produced by the *Clostridium welchii* of standardized virulence, Altmeier and Furste (10) were unable to demonstrate any prophylactic effect of penicillin when a dose of 2,000 units per kilogram per 24 hours was given in divided doses every 3 hours and continued for 4 days. This dose corresponded to one of approximately 17,500 units every 3 hours for an adult male. When the dose was increased to 8,000 units per kilogram per 24 hours, corresponding to an adult daily dose of 70,000 units every 3 hours, the survival time was definitely lengthened and 16 per cent of the animals survived. When the dose was

the mainstay of postoperative management. Plasma has usually been reserved for the correction of persistent hemoconcentration in selected cases of the "wet" types of clostridial infection.

From an analysis of available information the effective methods of treatment for established clostridial myositis or true gas gangrene may be summarized as follows:

- 1 Radical surgery as soon after diagnosis as possible consisting of multiple incisions for decompression and drainage of the fascial compartments, excision of the involved muscles, or open amputation when necessary, followed by adequate immobilization of the affected part.

- 2 Administration of polyvalent gas gangrene antitoxin before and after surgery—50,000 units every 4 or 6 hours as indicated to aid in the control of the toxemia.

- 3 The injection of penicillin parenterally in very large doses up to 1,000,000 or more units every 3 hours before and after surgery to aid in the control of the infection. After its obvious control the dose of penicillin may be gradually reduced.

- 4 Complete bacteriological diagnosis.

- 5 Sulfadiazine or streptomycin may be used for the control of secondary infection if indicated.

- 6 Adequate supportive therapy including frequent transfusions of whole blood, relief of pain, maintenance of the fluid and electrolyte balance and control of acidosis.

- 7 The topical use of zinc peroxide ointment on wound surfaces after radical surgery.

- 8 Secondary operative procedures to facilitate healing of the wound or function of the extremity as indicated.

#### SUMMARY

A survey of the literature reveals that gas gangrene is a very old disease of multiple bacterial etiology and variable clinical picture which occurs as a spectacular and destructive complication in an average of 1.76 per cent of all contaminated wounds of violence. Recent studies have increased our knowledge regarding the predisposing and exciting etiological factors of this disease but the precipitating factor that sets off the infection and explains the discrepancy between the low incidence of infection and high incidence of clostridial contamination in similar wounds is still unknown. The steadily increasing reservoir of information which is being accumulated regarding the characteristics, toxins, and virulence of the various clostridia is contributing to a better understanding of the pathogenesis of this disease. Recent evidence suggests that the profound toxemia associated with this condition is complex being caused not only by the specific toxins and enzymes

produced by the bacteria but also by nonspecific toxin products arising from the degenerating tissue in the area of infection. It has been relatively easy to protect animals from the injection of one or more minimum lethal doses of toxin by the administration of antitoxin or by immunization with toxoid. On the other hand the protection afforded by antitoxin or toxoid has been only partial against one or more minimum lethal doses of virulent bacteria.

The various clinical and pathological pictures associated with this condition in its advanced stages have been well established but considerable difficulty is still experienced in the early recognition of the process. The intelligent use of serial roentgenograms has been of value but better methods of early diagnosis are still needed. Numerous diagnostic tests have been devised recently to facilitate an early and positive diagnosis. Although some of these are of value definite limitations and even danger may attend their clinical use.

Early and adequate surgery is still the best method of treatment for either the prevention or control of gas gangrene. Chemotherapy has been shown to be a valuable adjunct to surgery and penicillin in massive doses appears to be the agent of choice. The effectiveness of serotherapy both prophylactically and therapeutically is still disputed but the evidence indicates that the early administration of the polyvalent type aids in the control of the toxemia when used in conjunction with the necessary surgery.

The preliminary results of investigations with toxoid immunization of experimental animals are encouraging and suggest that effective prevention of this condition by the use of toxoid is a definite possibility.

#### BIBLIOGRAPHY

- 1 ADAMS, R. *Surg. Clin. N. America*, 1946, 24, 531.
- 2 ALTEMEIER, W. A. *J. Am. M. Ass.* 1944, 124, 413.
- 3 *Ideem Surg. Gyn. Obst.* 1942, 75, 518.
- 4 *Ideem Bi Monthly Progress Report No. 3 Committee on Medical Research of the Office of Scientific Research and Development*, 1945.
- 5 *Ideem South M. J.*, 1944, 37, 404.
- 6 *Ideem Surg. Clin. North America*, 1945, 25, 1202.
- 7 *Ideem Transactions West. Surg. Ass.*, 1942, 51, 110.
- 8 *Ideem Surg. Gyn. Obst.*, 1944, 78, 411.
- 9 ALTEMEIER, W. A. and CULBERTSON, W. R. Unpublished data.
- 10 ALTEMEIER, W. A. and FURSTE, W. L. Unpublished data.
- 11 ALTEMEIER, W. A., and GIBBS, E. W. *Surg. Gyn. Obst.*, 1944, 78, 164.
- 12 AVICENNA, GUY DE CHAULIAC, J. DE VICO, and AMBROSE PARÉ. Cited by Trifaud. *Rev. de chir.* 1883, p. 778.

(120) per day. In their studies of experimental gas gangrene Altemeier and Furate (10) found that average doses had no measurable effect but that large doses corresponding to 8,000,000 or more units per day in an adult man had a definite therapeutic effect. Without surgery however discontinuation of penicillin was followed by spread of the lesion and ultimate death. These experiments indicated that penicillin when used in large doses, is a valuable adjunct to adequate surgery in the treatment of established gas gangrene because it limited the spread of the lesion prolonged the period during which surgical decompensation and excision of involved muscles could be done successfully and reduced the mortality. A dose of 1 000 000 units or more every 3 hours is suggested for clinical use in the management of severe established infections. Apparently such large doses may be given without toxic effect. Keefer and Anderson pointed out that the maximum dose of penicillin that can be given to man has not been determined as yet and that doses as large as 100 000 000 units a day have been given without ill effect (85).

On the other hand, Odom and Conway concluded that penicillin in much smaller doses was of little or no value and the former believed that its sole value lay in controlling secondary infection.

Early experiences with the sulfonamides led to the recommendation of their use in the treatment of gas gangrene (13 33 39, 64 76 77 107 137 160) but the recent trend has been away from the use of sulfonamides for gas gangrene itself (171). Jeffrey (79) found no evidence that sulfanilamide, alone and without operation, saved any patient from true gas gangrene. Langley and Winkelstein, who studied 96 cases treated at an evacuation hospital in Northern France during 1944, believed that sulfonamides had little or no effect on the course of gas gangrene and Conway concluded that there was no evidence that sulfadiazine given in adequate amounts produced any significant change in the general condition of patients.

A variety of preparations have been used for topical application on surgical wounds resulting from the treatment of gas gangrene. The use of activated zinc peroxide as a watery suspension (120) or ointment (6 32 64 75 101 120 150) seems to be the treatment of choice. Effective use however depends primarily upon correct application at intervals of from 1 to 2 days with intimate contact of the tissues with the zinc peroxide preparation, adequate hydration produced by a layer of wet absorbent cotton, prevention of the escape of liberated oxygen and moisture by a layer of ointment gauze and a mild compression dressing.

The value of roentgen irradiation as a method of therapy in true gas gangrene is still uncertain. Kelly has been its most enthusiastic proponent and in his opinion the results of its use have far surpassed those obtained with serum, débridement, and amputation. He has been inclined to regard roentgen therapy as a specific in gas gangrene recovery following its use in all cases if it was employed during the first 24 hours. McMillan was equally enthusiastic, he reported a mortality of 14.9 per cent among the 416 cases in which roentgen therapy had been used. Cantrell (27,28) recently deplored the lack of appreciation by physicians of the value of treatment of this type of infection with the roentgen ray. He believed that débridement or other surgical procedures in the acute phase of an already established gas bacillus infection was not indicated when roentgen therapy was available. In view of the fact that serum and surgery were employed in some of the cases, it is difficult to say whether the recovery of 4 patients was due to roentgen therapy or to serum therapy and surgery and the same difficulty applies to the reports of Faust and Turner.

Unfortunately these results have not been substantiated by other clinical investigators, and attempts to reproduce them in animal experiments have failed. Cubbins, Callahan and Scuderi were of the opinion that the roentgen irradiation of gas bacillus infection had little if any value and they saw no reason for considering it as a method of treatment. In 8 cases of proved gas infection which were treated by roentgen irradiation and without surgery or antitoxin there were 8 deaths. Cozen (37 38) also thought that it is unwise to place complete reliance on roentgen therapy for gas gangrene. In his 8 cases which were treated without operation or antitoxin but with roentgen irradiation, there were 8 deaths. Coleman and Bennett using roentgen therapy alone in 14 cases had 4 recoveries and 10 deaths. In experimentally produced gas gangrene Caldwell and Sewell, Dowdy and Vincent as well as Kelly and his associates, have been unable to demonstrate any measurable beneficial effect from roentgen therapy.

The general supportive measures of value in the management of gas gangrene include frequent or daily blood transfusions, maintenance of the fluid and electrolyte balance (6, 13 82) adequate immobilization of the infected and injured parts (6, 167) oxygen therapy and the relief of pain. Frequent blood transfusions help to correct the profound anemia with which this condition is frequently associated (6, 13, 32 172). Conway found that the frequent transfusions of whole blood were

102. LOGAN, M. L. *Clostridium Welchii*, *Clostridium Oedematis* (Novyi) and *Clostridium Septicum* Toxoids. Office of Scientific Research and Development, Yearly Report, 1945 Contract OEMcMr 35 July 1945.
103. LYONS, C. Ann. Surg., 1946, 123, 902.
104. LYONS, C., and OWZOR, C. R. J. Bact., Balt., 1942, 43, 685.
105. MACFARLANE, M. G. Brit. M. J., 1943, 2, 636.
106. MACFARLANE, M. G., and KNIGHT, B. C. Biochem. J. Lond., 1941, 35, 884.
107. MACLENNAN, J. D. Lancet, Lond., 1943, 2, 63.
108. Ibid., 1944, 1, 203.
109. MACLENNAN, J. D., and MACFARLANE, M. G. Summary of Reports Received by the Committee on Medical Research of the Office of Scientific Research and Development. Bull. 1945, 23, 270.
110. Idem. Brit. M. J., 1944, 1, 683.
111. MARS, U. Arch. Surg., 1940, 41, 393.
112. MARXOUEVE, Gaz. med. Paris, 1853, 8, 592.
113. MALGAUKE. Cited by Trifaud. Rev. de Chir., 1883, p. 778.
114. MARONEY, J. Brit. M. J., 1941, 1, 670.
115. McCLEAN, D., ROGERS, H. J., and WILLIAMS, B. W. Lancet, Lond., 1943, 1, 355.
116. McKNIGHT, W. B. LOEWENBERG, R. D., and WRIGHT, V. L. J. Am. M. Ass., 1944, 124, 360.
117. McMLAN, K. D. West. J. Surg., 1943, 51, 187.
118. McNET, J. W., and DUNE, J. S. Brit. M. J., 1917, 1, 727.
119. McNESEY, F. L. Surg. Gyn. Obst., 1945, 80, 263.
120. Idem. A Textbook of Surgery by American Authors. Edited by F. Christopher 4th ed. Philadelphia W. B. Saunders Company 1945.
121. MICHAEL, P. R. Generac. Gids, 1940, 18, 92.
122. MILES, A. A., SPOONER, E. T. C., and VAN DEN ENDE, M. Proc. R. Soc. M., 1940, 34, 90.
123. MILES, A. A. Lancet, Lond., 1941, 3, 507.
124. MILLAR, W. M. Surg. Gyn. Obst., 1932, 54, 232.
125. MOOREHEAD, J. J. Am. M. Ass., 1942, 118, 712.
126. MOOREHEAD, M. Bull. Vancouver M. Ass., 1943, 20, 47.
127. MULLALLY, G. T. Lancet Lond., 1941, 1, 259.
128. NAGLER, F. P. O. Nature, 1944, 153, 496.
129. NEEL, and COLE. Am. J. Surg., 1944, 66, 290.
130. NIKOLSKAYA, L. A. Khirurgia, Moscow 1943 Nov 2-3, 19.
131. NORMANOV, M. Zbl. allg. Path., 1942, 79, 241.
132. NOVY, F. G. Zschr. Hyg., 1894, 17, 209.
133. OAKLEY, C. L. Bull. Hyg., Lond., 1943, 18, 781.
134. ODOM, C. D. Surgery 1946, 19, 562.
135. OULIVY, W. H. Lancet, Lond., 1, 935, 975, 1019.
136. PASSOW, Charlotte-Ann P., 205, 1893.
137. PATTERSON, T. C., KRAMING, C., and CLEGG, H. W. Brit. J. Surg., 1945, 33, 74.
138. PIRGOFF, Leipzig P., 867, 1106, 1864.
139. PLATREANO, V. M. Zbl. Chir., 1942, 69, 1320.
140. POPPE, J. K. J. Thorac. Surg., 1944, 13, 340.
141. POTTER, J. E. Surg. Gyn. Obst., 1944, 78, 477.
142. POTTER, W. J. Ann. Surg., 1944, 120, 836.
143. POWER, R. W. Brit. M. J., 1945, 1, 656.
144. QUENYAN. Cited by Trifaud. Rev. Chir., 1883, p. 778.
145. RAMSEY, C. H. South. M. J., 1938, 31, 775.
146. RAYDIN, L. S. Surg. Clin. N. America, 1941, 21, 1525.
147. REED, G. B., and ORR, J. H. J. Bact., Balt., 1943, 45, 399.
148. REED, G. B., and ORR, J. H. War Med., Chic., 1941, 1, 493.
149. REEVE, J. R. J. Am. M. Ass., 1935, 104, 576.
150. REID, M. R., and ALTEMEIER, W. A. Ann. Surg., 1944, 118, 741.
151. REIMERS, C. Chirurg., 1940, 12, 145.
152. ROBERTS, K., JOHNSON, W. W., and BRUCKNER, H. S. Surg. Gyn. Obst., 1933, 57, 751.
153. ROBERTSON, M., and KEEPE, J. J. Path. Bact., Lond., 1941, 53, 95.
154. ROYD, R., and CLAISSE, R. Mem. Acad. chir. Par., 1940, 66, 777.
155. ROSS, K. C., and RYAN, W. P. Med. J. Australia, 1944, 2, 35.
156. RUBENSTEIN, A. D., HARRIS, I. R., and DANI, J. J. Am. M. Ass., 1945, 129, 659.
157. SALLERON, Arch. de Med. Mil., 1858, 21, 300.
158. SALM, R. J. Obst. Gyn. Brit. Empire, 1944, 51, 121.
159. SCHREIBER, H. T. Deut. med. Wochr., 1943, 69, 73.
160. SEWELL, R. L. Texas J. M., 1944, 40, 12.
161. SEWELL, R. L., DOWDY, A. H., and VINCENT, J. C. Surg. Gyn. Obst., 1942, 74, 361.
162. SIEBERMAN, C. O., and PLUMMER, E. J. Pharm. Exp. Ther., 1945, 83, 71.
163. SPOONER, E. T. C. Proc. R. Soc. M., Lond., 1940, 34, 90.
164. SYEC, H. M., and MCCOY, E. J. Bact., Balt., 1944, 48, 31.
165. TAYLOR, K. Lancet, Lond., 1916, 1, 123.
166. TOPLEY, W. W. C., and WILSON, G. S. *Clostridium*. The Principles of Bacteriology and Immunity 2nd ed. 1936 Baltimore Williams and Wilkins Co. 1941.
167. TRUETA, J. The Principles and Practice of War Surgery St. Louis C. V. Mosby Company 1943.
168. TUFFET, T. Arch. méd. pharm. mil., 1918, 69, 4.
169. TURNER, J. Royal Melbourne Hospital Clinical Report, 1942, 13, 31.
170. U. S. Surgeon General's Office. The Medical Department of the U. S. Army in the World War Vol. 12 Washington 1929.
171. U. S. War Department Technical Bulletin Med. 147 Notes on Care of Battle Casualties, March 1945.
172. U. S. War Department Technical Bulletin, Med. 172 Treatment of Infectious Diseases with Sulfonamide Drugs, June, 1945.
173. VELFAU, Lecons Orales de Clin. Chir., 1841 Vol. 2 Cited by Gurit. Handbuch der Lehre von den Knochenbruechen Berlin 1862, 1, 561.
174. VISNENSKY, A. V. Vest. khir., 1940, 59, 179.
175. WAN, S. E. Chin. M. J., 1939, 44, 97.
176. War Primer on Wound Infection Lancet, Ltd. Lond., 1940.
177. WEED, L. A., and MINTON, S. Jr. J. Lab. Clin. M., 1943, 28, 1251.
178. WENBERG, M. Bull. Acad. méd., Par., 1939, 122, 284.
179. WENBERG, M., and COMBESCO, N. Ann. Inst. Pasteur Par., 1939, 45, 547.
180. WENBERG, M., and SEGUIN, P. La Gangrene Gaseuse. Monographies de l'Institut Pasteur Paris Masson et Cie, 1918.
181. WELCH, W. H., and NUTTALL, G. H. F. Bull. Johns Hopkins Hosp., 1892, 3, 81.
182. WHITE, R. J. Texas J. M., 1938, 34, 271.
183. WOODS, D. D., and FEIN, A. R., Biochem. J. Lond., 1942, 36, 501.
184. WYATT, Quoted by Millar W. M. Surg. Gyn. Obst., 1932, 54, 232.
185. ZEISSLER, J. Deut. med. Wochr., 1940, 66, 340.



102. LOGAN M. L. Clostridium Welchii, Clostridium Oedematis (Novyi) and Clostridium Septicum Toroids. Office of Scientific Research and Development, Yearly Report, 1945 Contract OEMCmr 35 July 1945.
103. LYONS, C. Ann. Surg. 1946, 123 902.
104. LYONS, C., and OWENS C. R. J. Bact. Balt., 1942 43 685.
105. MACFARLANE, M. G. Brit. M. J. 1943, 2 616.
106. MACFARLANE, M. G., and KNOTT B. C. Biochem. J. Lond., 1941 35 884.
107. MACLEODAN J. D. Lancet, Lond. 1943 3 63.
108. Ibid., 1944 1 203.
109. MACLEODAN J. D. and MACFARLANE, M. G. Summary of Reports Received by the Committee on Medical Research of the Office of Scientific Research and Development. Bull., 1945 23 270.
110. Idem. Brit. M. J. 1944 1 683.
111. MALES, U. Arch. Surg. 1940, 41 393.
112. MALBONDEUVE. Gas. med. Paris, 1853, 8 592.
113. MALGADZE. Cited by Trifaud. Rev. de Chir. 1883, p. 778.
114. MARONEY J. Brit. M. J., 1941 1 670.
115. MCCLEAM D., ROGERS, H. J., and WILLIAMS, B. W. Lancet, Lond. 1943 1 355.
116. MCKENRUT W. B. LOEWENBERG R. D. and WRIGHT V. L. J. Am. M. Ass., 1944, 124 360.
117. McMILLAN K. D. West. J. Surg., 1943 51 187.
118. MCNER, J. W., and DUFFY J. S. Brit. M. J. 1917 1 727.
119. MCLENRY F. L. Surg. Gyn. Obst. 1945 80 263.
120. Idem. A Textbook of Surgery by American Authors. Edited by F. Christopher 4th ed. Philadelphia W. B. Saunders Company 1945.
121. MICHAEL, P. R. Genesee. 1945, 18 92.
122. MILES, A. A., SPOONER, E. T. C., and VAN DEN ENDE, M. Proc. R. Soc. M. 1940, 34 90.
123. MILES, A. A. Lancet, Lond. 1941 2 507.
124. MILLAR, W. M. Surg. Gyn. Obst. 1932 54 232.
125. MOOREHEAD J. J. J. Am. M. Ass. 1943 118 712.
126. MORRISON M. Bull. Vancouver M. Ass. 1943, 20 47.
127. MULLALLY, G. T. Lancet, Lond. 1941 1 259.
128. NAELER, F. P. O. Nature, 1944, 153 496.
129. NEEL, and COLE. Am. J. Surg. 1944, 66 290.
130. NIKOLSKAYA, L. A. Khirurgia, Moscow 1943 Nov. 2-3, 19.
131. NORDMANN M. Zbl. allg. Path., 1942 79 241.
132. NOY F. G. Zschr. Hyg., 1894 17 209.
133. OAKLEY, C. L. Bull. Hyg. Lond., 1943 18 781.
134. ODOM, C. D. Surgery 1946 19 562.
135. OLIVIER, W. H. Lancet, Lond., 1 935 975 1019.
136. PASSOW Charlotte—Ann. P. 295 1895.
137. PATTERSON T. C. KEATING C. and CLEGG H. W. Brit. J. Surg. 1945 33 74.
138. PIROGOFF Leipzig P. 867, 1106 1864.
139. PLATYERMAN V. M. Zbl. Chir., 1942 69 1380.
140. POFER, J. K. J. Thorac. Surg. 1944 13 340.
141. PORTER, J. E. Surg. Gyn. Obst. 1944, 78 477.
142. POTTS W. J. Ann. Surg. 1944, 120 836.
143. POWER, R. W. Brit. M. J., 1945 1 656.
144. QUERKEY. Cited by Trifaud. Rev. Chir. 1883 p. 778.
145. RAMEY C. H. South. M. J. 1938, 31 775.
146. RAYDEN, L. S. Surg. Clin. N. America, 1941 21 1225.
147. REED G. B., and ORR, J. H. J. Bact., Balt., 1943 45 399.
148. REED, G. B., and ORR, J. H. War Med. Chic. 1941 1 493.
149. REEVES, J. R. J. Am. M. Ass., 1935 104 526.
150. REID M. R. and ALTEMEIER W. A. Ann. Surg. 1944 118 741.
151. REIMER, C. Chirurg. 1940, 12 145.
152. ROBERTS, K. JOHNSON W. W. and BRUCKNER, H. S. Surg., Gyn. Obst. 1933 57 752.
153. ROBERTSON M. and KIEPPE, J. J. Path. Bact. Lond. 1941 53 95.
154. RONON R., and CLAISSE R. Mem. Acad. chir., Par. 1940, 66 777.
155. ROSS K. C. and RYAN W. P. Med. J. Australia 1944, 2 35.
156. RUBENSTEIN A. D., HABERSHAW I. R., and DANTZ, J. J. Am. M. Ass. 1945 129 659.
157. SALLERON Arch. de Med. Mil., 1858 21 300.
158. SALLM, R. J. Obst. Gyn. Brit. Empire 1944, 51 121.
159. SCHREUT, H. T. Deut. med. Wochr., 1943 69 73 101.
160. SEWELL, R. L. Texas J. M. 1944 40 12.
161. SEWELL, R. L. DOWDY A. H., and VINCENT J. C. Surg. Gyn. Obst., 1943, 74 361.
162. SIENKOWSKA C. O. and PLUMMER, E. J. Pharm. Exp. Ther. 1945 83 71.
163. SPOONER, E. T. C. Proc. R. Soc. M. Lond., 1940 34 90.
164. SVEG, H. M. and MCCOY E. J. Bact. Balt. 1944 48 31.
165. TAYLOR, K. Lancet, Lond. 1916 1 123.
166. TOPLEY, W. W. C., and WILSON G. S. Clostridium The Principles of Bacteriology and Immunity and ed. 1936 Baltimore Williams and Wilkins Co. 1941.
167. TRUZZA, J. The Principles and Practice of War Surgery. St. Louis C. V. Mosby Company 1943.
168. TOFFIER, T. Arch. med. pharm. mil., 1918, 69 4.
169. TURNER, J. Royal Melbourne Hospital Clin. Report, 1942 13 31.
170. U. S. Surgeon General's Office. The Medical Department of the U. S. Army in the World War Vol. 12 Washington, 1929.
171. U. S. War Department Technical Bulletin Med. 147 Notes on Care of Battle Casualties, March, 1945.
172. U. S. War Department Technical Bulletin, Med 172 Treatment of Infectious Diseases with Sulfonamide Drugs. June, 1945.
173. VELPEAU Lecons Orales de Clin. Chir., 1841 Vol. 2. Cited by Gurlt. Handbuch der Lehre von den Knochenbruechen. Berlin 1862, 1 561.
174. VISENBERG, A. V. Vest. khir., 1940, 59 179.
175. WAM S. E. Chin. M. J. 1930, 44 97.
176. War Primer on Wound Infection. Lancet, Ltd. Lond., 1940.
177. WEED L. A. and MINTON S., Jr. J. Lab. Clin. M. 1943, 28 1251.
178. WEINBERG M. Bull. Acad. med., Par., 1939 122 224.
179. WEINBERG M., and COMBESCO N. Ann. Inst. Pasteur, 1939, 45 547.
180. WEINBERG, M., and SCOUTIN, P. La Gangrene Gaseuse. Monographies de l'Institut Pasteur Paris Masson et Cie 1918.
181. WELCH, W. H. and NUTTALL, G. H. F. Bull. Johns Hopkins Hosp. 1892, 3 81.
182. WHITE R. J. Texas J. M. 1938 34 271.
183. WOODS D. D., and FEIN A. R., Biochem. J. Lond. 1942 36 501.
184. WYATT Quoted by Millar W. M. Surg. Gyn. Obst. 1932 54 332.
185. ZEISSLER, J. Deut. med. Wochr., 1940 66 340.

# ABSTRACTS OF CURRENT LITERATURE

## SURGERY OF THE HEAD AND NECK

### HEAD

Kazanlian V. H., and Webster R. C.: The Treatment of Extensive Losses of the Scalp. *Plast Reconstr Surg* 9:46 1 360.

Extensive loss of the scalp has always been a difficult surgical problem. Step by step through surgical history the accepted methods of treatment used today have developed.

A brief but thorough review of the anatomy of the scalp is given. The anatomical features have a bearing on the results of trauma, on the treatment of the loss and at times, on the etiology of that loss.

Large losses of the scalp may be caused by (1) burns—thermal agents, chemical agents, electricity or radiation (2) impacts of sharp or blunt objects (3) infection (4) scalping—by paws of animals or by humans, (5) industrial accidents—entangling of hair in rapidly moving machinery.

A brief resumé of treatment through the ages is given and the general care of patients is discussed.

Seven case reports are presented to illustrate the treatment of scalp loss in various circumstances.

Small defects may be closed by extensive undermining in the subaponeurotic area with relaxing or cross-hatching incisions from below through the galea but not through the skin or superficial fascia.

In extensive losses of the scalp every effort should be made to close the wound as soon as possible by skin grafting. If any hair bearing tissue remains, it can be utilized later as flaps to areas best suited for cosmetic purposes.

The periosteum is vascular enough to take skin grafts. Periosteal flaps and tags should be sutured into position and grafts placed upon them. Split thickness grafts cut with the dermatome are most suitable. If the entire scalp cannot be covered at once, the anterior portion should have priority since it is here that the worst deformities (ectropions) occur.

In the second case reported, an attempt was made to reapply the completely detached scalp. Only about 8 per cent of the replaced scalp survived.

If periosteum has been lost a vascular bed for grafting must be obtained. In the author's hands, chiseling away the outer cortex until multiple bleeding points showed themselves has been simplest and most satisfactory. In a week or slightly more granulations well able to sustain a split thickness graft are present.

Inadequate early treatment results in two common, late complications. Late contracture may result in severe ectropion of the upper eyelids. Excision of the scar and replacement with a dermal mesh graft is the treatment. The second late complication

is the breaking down of scar epithelium with occasional carcinomatous degeneration. After removal of the scar or malignancy, or both, it may be necessary to use a tubed pedicle flap for closure.

EARL H. KLARCK, MD

Wass, S. H.: The Odontomes and Other Affections of the Jaws: Their Pathology, Diagnosis and Treatment. *Guy's Hosp Rep* Lond 1916, 95: 1.

Among the odontomes (cysts, tumors, and malformations of the jaws arising from tooth germ) and the dental and dentigerous cysts, the adamantinoma or multilocular cysts are the more important ones, and are discussed as to pathology and clinical picture. Among other lesions, the osteoclastoma, osteofibroma, osteomyelitis, and actinomycosis are discussed and illustrated by roentgenographs and photographs of pathological specimens, and roentgenographs of lesions of differential diagnostic importance (carcinoma) are presented.

In his discussion of treatment, the author stresses the necessity of complete removal even of the benign, noninflammatory lesions (except fibro-osseous tumors in which cases complete removal is not essential) if recurrence is to be avoided.

The malignant lesions comprise the adamantinomas, epitheliomas of the alveolar process, metastatic carcinomas, and sarcomas. The author does not discuss the latter 2 lesions in detail. Epitheliomas respond mostly to irradiation. Adamantinomas are nonradiosensitive and require radical excision followed by bone grafting, which may be a formidable operation in the aged. Curettage may be deemed preferable in some of these cases although it is inevitably followed by recurrence.

Radical operation, likewise, is the author's choice for osteomyelitis of the jaw and neither bone drilling nor penicillin will prevent the spread of the disease. He states that even in late cases with much soft tissue swelling delay is ill advised, and bold approach to the bone and radical and extensive excision is needed.

The author then elaborates on his experiences as to details of treatment. For malignancy of the upper jaw the classical excision of the maxilla is now passed and for cysts and benign tumors the intraoral approach is satisfactory. On the mandible however most all of the more extensive lesions are better approached from the outside. Such an approach gives better exposure and dependent drainage and avoids severance of the mucosa. The author's discussion on the technique of approach should be read in the original.

Wass is impressed by the efficacy of orally administered penicillin in controlling intraoral flora and

postoperative infection when oral mucosa had been opened. Penicillin given systemically will not cure osteomyelitis of the jaws unless all diseased bone has been removed surgically. Penicillin can be used to good advantage preoperatively and postoperatively in cases of oral surgery.

An incision behind the ramus ascendens and below the ramus horizontalis of the mandible gives good cosmetic results if it heals by primary intention. There is danger of injury to a branch of the facial nerve and to the inferior dental nerve the one resulting in objective the other in subjective disturbances. Bone defects of the mandible usually reconstruct themselves rapidly and completely.

HEINRICH LAMM M.D.

## EYE

Adler F. H. Physiological Factors in the Differential Diagnosis of Paralysis of the Superior Rectus and Superior Oblique Muscles. *Arch. Ophthalmol.*, 1946 36 661

The differential diagnosis between paralysis of the superior rectus and the superior oblique muscle of the eye is discussed. According to Bielschowsky most vertical anomalies are due to paralysis of the superior oblique muscle, but according to Duane they are due to paralysis of the superior rectus muscle. Adler attributes most primary or congenital vertical motor paralysis to paralysis of the superior oblique muscle.

The differential diagnosis between paralysis of the superior oblique muscle of one side and paralysis of the superior rectus muscle of the opposite side can be made by the position of the head. Head tilt the most characteristic sign of paralysis of the superior oblique muscle, is attributed to the fact that contraction of this muscle in the primary position results in 56 per cent of the movement being intorsion so that in cases of paralysis, extorsion results which is compensable only by tilting the head in a position which again brings the two vertical meridians into parallelism, that is, tilting of the head to the opposite shoulder.

In paralysis of the superior rectus muscle the tilting is only slight because the superior rectus in the primary position exerts only 25 per cent of its pull as intorsion.

In all cases, the head is tilted toward the side opposite the paralyzed eye, e.g. in right hypertropia (paralysis of either the right superior oblique or of the left superior rectus) the head is markedly tilted toward the left shoulder if the right superior oblique is paralyzed and is only slightly tilted toward the right shoulder if the left superior rectus is paralyzed. Moreover if the patient's head is tilted by the examiner to the shoulder of the same side as the paralyzed eye, this eye will make an upward movement if the superior oblique muscle is paralyzed and it either will not move at all or will move only slightly downward if the superior rectus muscle is paralyzed.

JOSHUA ZUCKERMAN M.D.

Lloyd, I. A Survey of the Results of Lacrimal Strictureotomy. *Brit J Ophthalmol.* 1947 31 51

The author analyzes the results and the causes of failure in 33 cases of lacrimal strictureotomy. The advantages of the French technique compared with those of other methods of treatment of lacrimal obstructions are discussed.

The French method consists of opening the lower canaliculus with a Weber knife for 3 mm. and dilating the canaliculus with a number 3 sound. The strictureotomy knife is then passed down into the sac and engaged in the neck of the duct. It is held vertically and the edge rotated forward through an angle of 45 degrees so that it faces forward in order to prevent cutting of the lower part of the canaliculus where it opens into the sac. Gum-elastic sounds from number 11 to 14 are passed into the duct and the largest one is left in place for 10 minutes. Dilation is done at intervals of from 4 to 6 weeks for a period of several months.

Symptomatic relief was obtained in 76 per cent and complete cure in 52 per cent of this series of 33 strictureotomies. The French claim cure in 100 per cent of the cases with no bony obstruction and in 70 per cent of those with such obstruction. Seven failures were attributed to various causes such as impassable stricture, very tight strictures, infection with mucopurulent regurgitation and burn scars.

The operation of strictureotomy can be performed in the outpatient clinic. Although the presence of a stricture at the junction of the lacrimal sac and the nasolacrimal duct has been denied roentgenologic findings and open operation have revealed that this abnormality exists in many cases of epiphora.

JOSHUA ZUCKERMAN M.D.

Stallard H. B. The Intraocular Foreign Body. A Series of 72 Cases in the B.L.A. *Brit J Ophthalmol.* 1947 31 12

The author reports a series of 72 cases of retained intraocular foreign body. He discusses the methods of x-ray localization, and the various types of giant electromagnets used for removal of foreign bodies. Speed is important when daily convoys deliver several hundred wounded at a time. The average time for each case was 3 minutes for suturing a limbal ring into place, 10 minutes for the x-ray examination, and from 7 to 12 minutes for the extraction of the foreign body by the scleral route.

In most cases the scleral route was indicated for extraction of the foreign body. This route is simpler and less traumatizing than the anterior route. The danger of vitreous loss is negligible. No vitreous was lost in any of the cases in this series. Retinal detachment, generally considered a complication of the scleral route, does not occur if diathermy is used around the incision in the sclera.

Of this series of foreign bodies 69.3 per cent were extracted, 51.3 per cent by the scleral route and 18 per cent by the anterior route.

To extract war muscled of feebly magnetic alloys the terminal of a very powerful electromagnet must



be placed between the lips of the scleral incision and brought as close as possible to the foreign body

JOSEPH ZUCKERMAN, M D

Mann I. Pirie, A., and Pullinger B. D.: Lewisite Lesions of Rabbits Eyes. *Am J Ophth* 1946, 29 125

In this article the authors contrast lewisite induced lesions with the results of mustard gas application. The work was carried out experimentally on rabbits eyes. The effects of lewisite in contrast to those of mustard gas show that:

1. The action is immediate and painful.
  2. There is an immediate strong miotic action.
  3. Perforation and loss of an eye are caused with relatively small doses (0.001 cc.) perforation may occur within a few days without vascularization or later after the entry of blood vessels.
  4. Vascularization is independent of the site of the primary lesion. It occurs when a sufficient dose of the lewisite reaches either the cornea or the limbus.
  5. All lesions run a definite course to recovery or destruction; not all vascular lesions perforate; there are no relapses and no recurrent hemorrhages.
  6. Cholesterol and other lipid scars do not occur and there is no late breakdown due to them. The end result of a nonperforating severe lesion is a dense fibrous scarring with pigment proliferation on the corneal and conjunctival epithelium.
  7. Edema of the lids and conjunctiva is immediate and severe; edema of the cornea is extreme with all but the smallest doses.
  8. Involvement of the iris and ciliary body is early and severe, followed by gradual depigmentation and shrinkage of the iris stroma.
  9. The corneal vessels do not show the characteristic varicosities of vessels subjected to mustard gas. They are straight and evenly and radially arranged. No characteristic vessels appear in the conjunctiva.
- Twenty-seven rabbits were studied in this series and it was concluded that lewisite has a more destructive effect than mustard gas. A table is included to show lewisite lesions and their varying severity in the eyes studied.

HUNTER H. ROMADKE, M D

Thygeson P.: Cytology of Conjunctival Exudates. *Am J Ophth*, 1946 29 499.

The author's investigations were carried out in an attempt to evaluate the cytologic findings of conjunctival diseases. Over 2,000 examinations of conjunctival scrapings, exudates, and follicular expressions stained with Giemsa stain, Wright's stain, and the Hansel stain formed the basis of the article.

The most frequent cytologic reaction seen in acute and chronic conjunctivitis was a polymorphonuclear leukocyte reaction. A high polymorphonuclear reaction was found also in conjunctivitis associated with erythema multiforme, Reiter's disease and psoriasis arthropathica. However, there was no leukocytic response in Newborn catarrhal and diplobacillary infection. It was concluded that the di-

agnostic significance of the polymorphonuclear exudate was of limited value.

The eosinophil was found to be the cell having the greatest diagnostic value since except for ocular pemphigus an eosinophilia proved to be an almost certain indicator of conjunctival allergy. It was invariably present in the conjunctivitis of hay fever, the conjunctivitis due to drug and cosmetic allergy, a vernal catarrh in the acute and usually in the quiescent stage. An eosinophilia is not a characteristic of bacterial allergies and therefore not found in phlyctenular conjunctivitis.

Small numbers of basophils were not infrequently seen in nonallergic inflammations but large numbers were characteristic only of allergic inflammations and tended to parallel the conjunctival eosinophilia.

Mononuclear cells, and the lymphocytes in particular were consistently found in epidemic keratoconjunctivitis and acute follicular conjunctivitis (Beale). A pure reaction was also found in the acute herpetic conjunctivitis and the conjunctivitis secondary to molluscum contagiosum.

Plasma cells were rarely found except in trachoma. The epithelial cells were found to be keratinized and usually covered with xerosis bacilli in vitamin A deficiency. Keratinization also occurred as a result of exposure as in old ectropion, trachoma, or pemphigus. In keratoconjunctivitis sicca there was a keratinization of the epithelium and an increase in the number of goblet cells. No diagnostic changes were found in the epithelium of trachoma patients.

No diagnostic differentiation could be made between the expressions of the nontrachomatous follicles but there was a significant difference between them and the trachomatous follicles. The latter were characterized by the germinal center cell, believed to be a lymphoblast, lymphocytes, plasma cells, occasional monocytes, and large macrophages (Leber cells). The nontrachomatous follicular material contained small mononuclear cells, mostly lymphocytes, a few lymphoblasts, and small monophages, but without the degenerative changes found in the trachomatous follicles.

The author believes that the cytologic examination of the conjunctiva is of diagnostic benefit in many cases of conjunctivitis.

ROGER H. JOHNSON, M D

Moncreiff W. F.: Surgery of Congenital Cataract. *Am J Ophth*, 1946, 29 1513

The author has presented his modification of the technique of needling congenital cataracts in patients between the ages of 1 year and 6 years. After widely dilating the pupil the needle-knife is inserted through the limbus of its temporalmost portion, and a vertical incision is made in the lens capsule and into the anterior cortex. Multiple incisions in the anterior capsule and cortex are then made; the nucleus is cut into several fragments and a few light strokes are taken in the posterior cortex without injuring the posterior capsule. If too much aqueous is lost before completing these maneuvers it is restored with an

irrigate before continuing with a larger needle-knife. When the lens is thoroughly stirred up, the knife is removed and some aqueous is allowed to escape. The lens remnants are then irrigated with an anterior chamber irrigator through the needle knife opening.

The author reports 6 such needlings in which he obtained clear openings with the first needling and without complications.

In discussion the author states that he believes the needling should be done as soon as the pupil can be well dilated and that both eyes should be cared for at once unless there is a definite contraindication. He believes that too much traction on the zonule and ciliary body can cause secondary glaucoma and iridocyclitis. His method of breaking up the lens into small pieces and irrigating them into the anterior chamber is designed to prevent glaucoma by leaving the lens remnants in front of the iris where they cannot push the iris forward. He does not believe that linc extraction or the Ziegler operation should be used in this age group—the former because of the danger of iris prolapse and the latter because of damage to the vitreous.

ROGER H. JOHNSON, M.D.

Feigenbaum, A., and Kornblueth, W. Posterior Ring Abscess of Metastatic Origin in Behcet's Disease. *Brit J Ophth.* 1946 30 729

The authors discuss posterior ring abscess of metastatic origin in association with Behcet's disease. The syndrome which represents a chronic septic condition produced by the staphylococcus aureus generally occurs in patients constitutionally predisposed to the disease by a debilitating illness such as tuberculosis. The following signs are usually present: aphthous stomatitis, ulcers, uveitis (recurrent and a skin condition resembling erythema nodosum). In metastatic cases the infective agent is brought to the eye by the vascular route in traumatic cases it is introduced into the interior of the eye through the perforating wound. In either case the action of the organisms intraocularly is probably the same. Forty two cases are reported in the literature—18 of metastatic origin and 24 of traumatic origin.

A case of metastatic nontraumatic posterior ring abscess of the cornea in a male patient 28 years of age is presented. The authors believe that in combination with other etiologic factors increased intraocular pressure is a factor in the production of a posterior ring abscess.

JOSEPH A. ZICKLERMAN, M.D.

## EAR

Hirschfeld, H., Jacobson, M., and Jellinek, A. New Treatment for Hearing Disorders. *Arch Otol Rhinol* 1944 44 686

The writers describe a new treatment for hearing loss using a combination of amino acid and vitamins. Quick and lasting results seem to occur. A brief comment on the pharmacology of the

The medication was given in two ways. In the first 2 c.c. ampules containing thiamine riboflavin pyridoxine nicotinamide choline glutamic acid histidine methionine and urea were used. The reasons for using these particular drugs were explained. In the second form of treatment the medication was given in capsule form and thus a wider variety of amino acids could be used. Vitamin A, thiamine, riboflavin, pyridoxine, ascorbic acid, nicotinamide, calcium pantothenate, cysteine, urea, tyrosine, choline, glutamic acid, liver concentrate and dried yeast were in each capsule. The amount of each drug used was not given.

During the first 2 weeks of treatment the patient received 2 c.c. intramuscularly 3 times a week and twice a week thereafter for 12 injections but more resistant cases may receive a second series of treatment after a pause of 2 weeks. This was supplemented by the daily oral administration of 3 capsules.

The clinical investigations were carried out in the Hard of Hearing Clinic of the New York Polyclinic Medical School and Hospital. Fifty three patients were examined and treated there and 36 additional patients were treated privately. Thirty of those treated at the hospital showed great improvement 13 to continue treatment and 10 no improvement 4 failed.

The full effect of treatment was usually reached within 2 to 4 weeks. Further treatment did not seem to give any additional advantages. Some patients kept the original gains but in older patients it is advisable to continue treatment with the capsules. Increase in acoustic perception was notable in the speech range but the best gain occurred in the high tones. Some patients showed improvement in the hearing ear only which was usually the one that had the shortest duration of the deafness. A case of bilateral binocular dysbaria was also treated and the phenomenon disappeared nearly completely. The writers state that this medication may be of value in preventing acoustic disorders that occur after exposure to loud noises.

Included are data on the patients treated including audiograms on different patients made before and after treatment.

WILLIAM A. VIBROON, M.D.

Krauss, F. H. Penicillin Therapy in Otorhinolaryngologic Practice. *Arch Otol Rhinol* 1946 44: 647

The authors carried out a study on the effect of penicillin in ear, nose and throat diseases. They recognize the fact that poor results may be obtained in contact with the infection when it is not possible to get the drug in close

A total of 113 cases were studied including cases of acute and chronic sinusitis of otitis media and of the method of treatment as well as on the basis of the nose. The procedure was as follows: 1. 1,000 unit of the penicillin was administered in a strength of 1,000 unit to the culture in a strength of 1,000 unit.

of cases Proetz's displacement therapy was employed. In another series the solution was instilled directly into the maxillary sinuses. In the less severe infections the topical administration of penicillin by nose drops alone was the procedure followed. In infection of the middle ear the penicillin was introduced directly into the middle ear by pressure and finally the topical administration of the drug was fortified by parenteral administration 1000 units being given every 3 hours by intramuscular injection for from 2 to 5 days. This method was employed particularly in cases of associated mastoiditis and chronic sinus infections.

Forty seven cases were treated by Proetz's displacement therapy, all with excellent results. Treatment was given daily and each patient instructed to use 10 drops of the penicillin solution in each nostril every 3 hours during treatment.

About 25 per cent of the patients with acute or chronic sinus infection were treated only by use of penicillin nose drops. The results in this group were inconsistent and not entirely satisfactory.

Four children treated by the Proetz technique had good results.

Ten cases of antral infection were treated by the instillation of the penicillin solution into the maxillary sinuses. Six cases cleared up after the second irrigation and in 2 cases in which permanent windows were present the infection was controlled with penicillin put into the sinuses every 3 hours for 3 days. Some failures occurred even though similar cases gave excellent results.

The patients with chronic otitis who were treated usually had concomitant sinusitis. The latter reacted well to the penicillin medication but the chronic otitis showed no definite improvement that could be attributed to the local use of penicillin. A special clinic was set up and all chronic ear cases were referred there. These were treated by forcing the penicillin solution into the middle ear with a pneumatic otoscope.

Acute titis media responded very well to the intramuscular injection of penicillin when the disease was due to penicillin susceptible organisms. When penicillin injected intramuscularly was used along with mastoidectomy in cases of acute mastoiditis, the results were excellent as shown by the middle ear and the wound became dry in an average of 3 days instead of the normal 7 to 10 days or longer.

The article includes several reports of successful and unsuccessful cases. Several tables are also included which show the results of the penicillin treatment in the different groups of cases.

WILLIAM A. AMROOK, M.D.

Day, E. M.: Appraisal of Fenestration Operations: Report of 160 Cases. *Arch Otolaryngol.*, 94:6 44-547

The fenestration operation is undoubtedly the greatest otological contribution of the present generation. The trend seems to be towards success in a higher percentage of cases but attempts to analyze

reasons for success or failure are needed in the hope of further improvements.

If practical hearing of normal speech can be achieved by the operation, the author believes it is far superior to the distorted hearing obtained with a hearing apparatus. If the improvement is sufficient for the understanding of normal speech, the operation is considered a failure regardless of the amount of improvement since some form of hearing aid is still needed. Speech tests are a better indication of the ability to hear than the threshold level for pure tones. Some patients have practical hearing with a threshold level of 30 to 35 decibels others require closer to a 25 decibel threshold.

The diagnosis of otosclerosis should present little difficulty. Ninety-four of 100 consecutive cases showed fixation of the stapes on testing with a probe at operation. Gelle's test is thought to be useful. The family history was positive in less than one-half of the cases, and some pink discoloration of the medial wall of the middle ear was seen in 30 per cent.

The operation is of greatest value in young adults, and of less and less value after the fourth decade.

Hearing loss by air conduction must be below the practical level for speech bone conduction loss should be slight especially at 2,000 cycles. Bone conduction audiograms are likely to be inaccurate. Patients who are psychologically unstable are accepted with hesitancy. A clean upper respiratory tract and freedom from nasal allergy are important. A rapid loss of hearing with diffuse discoloration of the inner wall of the inner ear indicating extensive involvement makes the prognosis more questionable. The operation has no effect on the otosclerotic process.

Irrigation of the wound with saline during operation is found to be a help whether constant or intermittent.

Three minor changes from the standard technique of the Lempert nov-ovalis operation have been found helpful. The wedge of skin and tissue between the tragus and helix is not removed but a single line incision is employed at that area. A partial mastoidectomy is preferred to a complete exenteration, to produce more rapid healing and reduce the size of the resulting air chamber closer to the original. Melted paraffin has been discarded and small pedgets of paraffin gauze have been substituted to hold the flap. Packs are removed on the fifth day.

Care is directed to the method of preparing the flap and removing tiny scales of bone which have adhered to the periosteal surface.

Results in the first 100 cases are given.

Some improvement followed the adoption of the nov-ovalis operation. In the last 50 consecutive cases out of 60 in which this technique was used, 46 patients have practical hearing, 1 patient has unsatisfactory hearing, 1 patient is unimproved, and in 2 patients hearing is worse. The fenestra closed in but one of the last 50 cases.

There have been no serious complications, no facial weakness, operative infections, nor dead baby

nths in the author's series of 100 cases. Postoperative infections in the cavity have been frequent after the first few weeks, but were superficial and did not affect the results. In 2 patients acute secretory conditions of the middle ears developed some months after operation. In one of these the hearing showed a permanent loss of 10 to 15 decibels, but in the other patient hearing was recovered to the previous postoperative level. Four patients had an attack of suppurative otitis media at some later time but all recovered without damage to their hearing.

In 7 cases of pregnancy following operation no appreciable loss of hearing in either ear was found to occur.

JOHN R. LINDSAY M.D.

### MOUTH

Brown J. B., Peterson LeR., Cannon B. and Moore A. M.: Facial Asymmetry and Malocclusion from Hyperplasia of the Mandible (Correction by Operation) *Plast Reconstr Surg* 1946 1: 284.

The authors report 1 case of facial asymmetry and malocclusion from hyperplasia of the mandible and state that the condition occurs only rarely.

Progressive enlargement of the left side of the jaw with malocclusion was noted over a period of 5 years in a 27 year old female. The asymmetry was due to an increase in length of the ascending ramus and also to thickening of the body of the left jaw. The entire left side was out of occlusion, the discrepancy being 6 mm. in the bicuspid and first molar area. No associated systemic disease was present.

The condyle and its elongated neck were removed through an external incision curved down from the temple close to the crux of the helix and over the tragus.

Elastic traction was attached to previously placed multiple loop wiring and maintained for 4 weeks.

The teeth were brought into occlusion and the deformity was removed. Mastication has been satisfactory.

On microscopic examination the bony substance was found to be normal.

JOHN R. LINDSAY M.D.

McNichol J. W. and Roger A. T.: An Original Method of Correction of Hyperplastic Asymmetry of the Mandible *Plast Reconstr Surg*, 1946 1: 288.

The authors describe an original method for correction of this rare deformity.

Plaster models of the dental arches are made and the existing occlusion recorded. The lower model is cut in reduced in size if necessary by removal of teeth and repositioned so as to correct the facial deformity and produce functional occlusion. The sections of the lower model are united. It now indicates which teeth should be extracted and the best location for sectioning the mandible. The method of fixation of the mandibular fragments is decided. Sectional cast cap splints of German silver cemented to the teeth are usually best. Removable locks are prefabricated by making a plaster model of the lower arch with the splints on the teeth and cutting and adjusting it with reference to the predetermined bite.

The first stage of operation consists in bilateral complete section of the mandible at predetermined points the removal of full thickness section on the long side together with associated teeth and the removal of excess bone along the inferior margin of the mandible on the long side.

Although the mandibular nerves are sacrificed the chances for continued function of the teeth are good.

The second stage of operation consists in the application of bilateral cancellous bone grafts to points of previous bilateral section 3 to 4 weeks after the first stage.

The third stage of operation is undertaken in from 5 to 6 weeks after the second procedure at which time filling out of the concave side of the face by a soft tissue fat fascial dermal graft is accomplished.

The method described is believed to provide better functional occlusion and correction of facial deformity than simple resection of the head of the condylar process on the affected side.

One case successfully treated by this method is described in detail.

JOHN R. LINDSAY M.D.

Brown, J. B. Peterson LeR. Cannon B. and Lischer C.: Ankylosis of the Coronoid Process of the Mandible (and Associated Scar Limitation of Jaw Function) *Plast Reconstr Surg* 1946 1: 277.

In gunshot and shell fragment wounds about the coronoid process fibrous tissue formation or comminution of bone with fixation or both, may produce ankylosis of the mandible and loss of mouth function.

An ankylosing process of the temporomandibular joint may extend to involve the coronoid process. An ankylosis starting in the region of the coronoid process may tend to extend to the joint but early treatment may prevent involvement of the articulation.

Treatment varies according to the extent of fixation. It includes active exercises with the use of a rubber block forcible dilatation and blocking the mouth open section of fibrous tissue and blocking removal of the coronoid process with or without blocking and resection of the jaw below the ankylosis to create a false joint.

While the extent of the ankylosing process may not be evident on examination, the coronoid should be approached first if injury points in that direction.

Of 27 patients with limited mouth opening 8 had bony ankylosis involving the coronoid 3 had severe soft tissue cicatricial involvement, 5 had a strong fibrous attachment between coronoid and zygomatic processes, 4 had trismus due to a foreign body in kinetic muscular areas. In 10 the trouble was due to scarring of muscle and surrounding tissues.

Foreign bodies causing trismus should be removed. Surgical treatment for bony ankylosis involving the region of the coronoid process consists of removal

of the process from inside of the mouth and enough of the surrounding, displaced bone to prevent reunion. The crux of the operation for ankylosis of the temporomandibular joint is removal of a wide enough area of bone and scar to prevent reunion. Fascial transplant is thereby made unnecessary.

Entraheal ether or cranial block anesthesia is used. The intraoral incision extends along the anterior border of the coronoid and the ramus is exposed by blunt dissection. The ankylosis is chiselled free. Usually the entire coronoid process is removed to create a large defect and prevent reunion. Treatment is the same for bony or extensive fibrous tissue fixation. Bleeding may be controlled by packing. Postoperative jaw exercises with the use of a rubber block are important adjuncts to treatment.

JOHN R. LINDSEY, M.D.

Thoma, K. H., and Goldman, H. M.: Odontogenic Tumors. *Am. J. Orthodont.*, 1946 3 763.

The authors review 75 cases of odontogenic tumors for the purpose of (1) formulating a proper classification, (2) describing their structure and (3) illustrating the inductive effects of one tissue on another in the production of mixed tumors.

The following classification is adopted:

I. Epithelial tumors (36 cases studied)

1. Adamantoblastoma
2. Enameloma

II. Mesenchymal tumors (15 cases studied)

1. Odontogenic fibroma
2. Dentinoma
3. Cementoma

III. Mesenchymal mixed tumors—odontomas (24 cases studied)

1. Soft odontoma—epithelium and mesoderm
2. Soft and calcified odontoma—adamantoblastoma arising in conjunction with a forming or completely formed odontoma; all sorts of histological variations due to the inductive effects of one tissue on another

1. Completely formed odontoma with enamel dentine pulp cementum periodontal membrane

- (a) Compound (many small teeth)
- (b) Complex (irregular tooth structure)

As may be seen, the odontogenic tumors are either of epithelial or of mesenchymal origin and are either soft or calcified. The soft epithelial tumor is called adamantoblastoma; the calcified, enameloma. Likewise the soft mesenchymal tumor is called fibroma; the calcified if dentine is produced, is called dentinoma; and if cementum is produced, is called cementoma. The authors designate mixed tumors as odontomas and they may be classified as follows:

The authors  
various forms  
classification.  
The adamant  
may be clinical  
and degenerate

rence after operation is due to incomplete removal. The enameloma, also called enamel pearl, occurs at the bifurcation of the roots of molars and premolars, and between the roots or at the cervical margin of single rooted teeth. The odontogenic fibroma originates from the embryonic tissue of the dental papilla or follicle and, later from the periodontal membrane. It may occur in the coronal or apical region of the tooth. If calcification occurs, it leads either to dentinoma, located in the coronal region, or to cementoma, located in the apical region, although the pure forms of both are very rare. The mixed tumors contain a variety of elements such as enamel dentine cementum pulp and periodontal tissue. In the soft types the stroma predominates, sometimes becoming fibromyxomatous. The epithelium may form a very minor component. In the soft and calcified types of tumor all possible phases of dental production are encountered. Calcification of the epithelial cells leads to the so-called ghost cells. Intermingled cystic areas are common. The completely formed odontomas may be compound, containing numerous rudimentary teeth, and complex when the calcified structures show no resemblance to dental tissue. Both types are usually encompassed by a cyst membrane.

The inductive effects of one tissue upon another are well demonstrated in the mixed odontogenic tumors. The epithelium in these tumors seems to stimulate dentine formation. However dentine production may also be initiated by fibroblastic activity in the absence of epithelial cells. Neoplastic adamantine tissue and enamel forming ameloblasts account, in part for the formation of the soft and calcified odontogenic mixed tumors. T. LUCETTA, M.D.

## NECK

Balter, W. T.: The Circulating Thyroid Hormone in Blood and Lymph. *Act. Ch. Surg.* 1947 55 5.

It appears that circulating thyroid hormone is intimately connected with protein and with protein that can leak through capillary walls. The preliminary formation of this protein carrier perhaps explains the characteristic lack in the response to thyroid medication. The accumulating measurements of protein-bound iodine in the serum indicate that it is our best gauge of net thyroid function. The measurements in lymph and in tissues are only preliminary.

RICHARD J. BERNETT, JR., M.D.

Astwood, E. B., and Vanderliss, W. P.: Treatment of Hyperthyroidism with Propylthiouracil. *Ann. Int. M.* 1946 25 813.

The authors report their observations in 100 cases of hyperthyroidism in which treatment with propylthiouracil was carried out over a period of 1 year. Dosage requirements varied from 50 to 100 mg. per day. The more severe cases, so the optimal dose for restoration of the euthyroid state. In the milder cases usually adequate. The

larger doses were given until the disease was believed to be under control, after which the smaller maintenance doses were employed. There were no significant evidences of poisoning with the doses used.

CLINTON H. THOMES, M.D.

Rawson R. W., and McArthur J. W. What Has Thiouracil Taught Us about the Pathologic Physiology of Graves Disease? *West J Surg.*, 1947 55 27

Studies were made on 7 patients suffering from Graves disease. The histology of the thyroid gland was studied from biopsy specimens taken before any therapy after the administration of thiouracil, and also after the administration of thiouracil and iodine.

The mean acinar cell height before treatment with thiouracil was 13.2 micra. After thiouracil treatment the average was 13.9 micra. After thiouracil treatment plus iodine the average was 7.2 micra.

The excretion of tracer doses of radioactive iodine in the urine was determined in 3 cases before beginning any treatment, and in 6 cases after thiouracil had caused a fall in the rate of metabolism to a standard level. The average excretion before treatment with thiouracil was 25 per cent of the administered dose. In the same 3 cases it had risen to 83.7 per cent after thiouracil treatment. In 6 cases the average radioiodine excretion was 80.3 per cent after thiouracil treatment.

The iodine values of thyroids removed at operation showed a total iodine average of 23.1, a thyroglobulin value of 7.0 mgm. and a noniodinizable iodine average of 8.3 mgm. These values are comparable to the values obtained from the thyroids of thyrotoxic patients upon whom thyroidectomy was performed after treatment with thiouracil only.

These findings suggest that the thyroid gland of Graves disease becomes more hyperplastic under thiouracil treatment that thiouracil prevents the utilization of iodine by the thyroid, and that notwithstanding this block to the collection of iodine produced by thiouracil, iodine causes involution of the thyroid gland in Graves' disease.

RICHARD J. BENNETT, JR., M.D.

Wright, L. E. A.: The Estimation of 2 Thiouracil in Plasma and Urine following Its Administration in Thyrotoxicosis. *Med J Australia*, 1946 2 800.

The author discusses the preparations of reagents, the colorimetric estimation, the estimation of the drug in urine, the preparation of standard curves for oxalated or citrated plasma, the use of whole blood, the effect of altering the hydrogen ion concentration, the estimation of thiouracil in oxalated pooled mouse plasma, the distribution of 2 thiouracil between the red cells and plasma, the effect of other substances on the estimations, and the collection of urine and plasma.

The excretion of 2 thiouracil in the urine of 24 thyrotoxic patients who received different dosages is discussed. It was found that the action of 2 thiouracil

in thyrotoxicosis is "quantitative" in nature. The requirements of the patient at a particular time can be found by estimating the excretion of the drug on normal fluid intake, and then the excretion of the drug on increased fluid intake. It is recommended that a fluid intake which is larger than usual be taken because of the smaller solubility of the drug in the urine in comparison with its solubility in the plasma.

RICHARD J. BENNETT, JR., M.D.

Watson E. M. The Treatment of Toxic Thyroid Disease with Thiouracil. *Edinburgh M J* 1946 53 609

This report is based on a series of 60 hyperthyroid patients treated with thiouracil. The dose of thiouracil used initially for adults was from 400 to 600 mgm. daily. The development of severe toxic reactions is most likely to occur during the first 3 weeks. The time under thiouracil therapy necessary to effect a satisfactory response depends upon (1) the nature of the disease (toxic adenomas respond more slowly than 'primary' hyperthyroidism) (2) the severity of the thyrotoxicosis (3) the duration of the hyperthyroidism (4) the size of the goiter and (5) the previous treatment with iodine.

After from 6 to 9 months of successful therapy with thiouracil it is often possible to stop the drug with a continuation of the remission. This was accomplished in 20 of the author's 60 patients all 20 of whom are still under observation. There is no condition of thiouracil escape or resistance comparable to iodine escape or resistance. However a small percentage of patients, probably around 5 per cent, are refractory to thiouracil for some reason unknown at present. There were 5 such cases in this series of 60.

The author does not believe that thiouracil has supplanted the surgical treatment of goiter except in certain selected cases. He believes that most, if not all, toxic nodular goiters should be treated surgically not only because of the variability of their response to thiouracil but also because of the danger of malignancy. Lugol's solution is administered both preoperatively and postoperatively and thiouracil is discontinued for a week prior to operation.

The blood iodine levels were determined in 43 of the patients. The administration of thiouracil brought a decline of the blood iodine in 32 of the 43 cases in which determinations were made. Similarly in 36 of the 46 cases in which blood cholesterol determinations were made a rise occurred following thiouracil therapy.

The use of thiouracil during pregnancy is a question deserving of careful consideration. Experimentally it has been shown that hyperplasia of the thyroid gland and retarded development were presented by the offspring of mothers receiving thiouracil. Similar reports of thyroid hyperplasia in newborn infants of mothers treated with thiouracil have been recorded. The author believes that if the drug is given with caution thiouracil may be used during pregnancy. He advises that in such cases the basal

metabolic rate be maintained near the upper range of the normal. A high concentration of thiouracil is present in the milk of such mothers, and they should not be permitted to breastfeed their infants.

The author reports that 1 in 200 thiouracil treated patients succumbs to the toxic reaction of the drug. Agranulocytosis, simple leucopenia, drug fever, cutaneous reactions as well as gastrointestinal upsets, jaundice, lymphadenopathy, swelling of the salivary glands, myalgia and arthralgia have been reported as complications of the use of this drug. While individual hypersensitivity is of the greatest significance in the determination of the toxic reaction, excessive dosage and intermittent courses of administration seem definitely to increase the number of toxic reactions.

Newer thiouracil derivatives, propyl thiouracil and ethylthiouracil, appear most promising. Apparently thiouracil acts by interfering with the formation of thyroxine by preventing the utilization of iodine. The use of thiouracil in cases of angina pectoris is briefly commented upon.

F. J. LYNCH, M.D.

Dobyns, B. M.: Exophthalmos and Tissue Changes in the Guinea Pig following Administration of the Thyroid Stimulating Hormone of the Pituitary Gland. *West J Surg* 1946 54:4

Following the injection of thyroid stimulating hormone conspicuous exophthalmos occurs in guinea pigs regardless of the presence or absence of the thyroid gland or the testes. Concurrently a generalized connective tissue reaction occurs throughout the body and a profound change occurs in the body fat. Fat depots are rapidly depleted and replaced by edema and connective tissue. Polymorphonuclear leucocytes and macrophages participate in this reaction and appear to phagocytize fat. Macrophages appear to become fibroblasts which lay down connective tissue.

As further evidence of profound changes in fat following the injection of thyroid stimulating hormone great quantities of lipid appear in the liver, kidneys, muscles, and in some epithelial and reticuloendothelial cells. Values for plasma lipids are elevated and the polymorphonuclear cells of the blood stream have been found to contain increased quantities of fat.

The data suggest that as a result of the administration of thyroid stimulating hormone quantities sufficient to produce exophthalmos there is a generalized alteration in the metabolism of fat throughout the body and a connective tissue reaction is associated with it. Thus, many of the changes in the orbital

tissue which produce exophthalmos are expressions of generalized tissue changes.

Troell, A.: Malignant Goiter. *Acta chir scand* 1945 94:533

In a series of 4,500 patients submitting to surgery of the thyroid gland, the author reports findings of malignancy in 42. In 18 of these, the condition was considered benign prior to operation.

Radical resection was carried out in some of the cases, and in others less extensive resection was done. Since the postoperative course was about the same in both groups, the author believes that usually a less radical operation should be performed.

The prognosis in cases of adenomatous goiters in patients over 50 years of age with a short anamnesis, change in voice, shortness of breath, and a high sedimentation rate is believed to be unfavorable. Diagnosis is difficult and no rigid rules of treatment can be formulated. However, x ray therapy following surgery or in inoperable cases, is believed to be important.

CLINTON H. THURMOND, M.D.

Clerf, L. H.: Sarcoma of the Larynx; Report of 8 Cases. *Arch Otolaryngol* 1946 44:517

The author states that sarcoma is a disease of adult life and that it occurs more commonly in men. Of the 8 cases of sarcoma of the larynx on which the present report is based all were men. Six of the patients were from 49 to 59 years of age, one was 25 and one 75. One had had a similar lesion 21 years previously.

The commonest lesion is fibrosarcoma. The tumor is single, often pedunculated, nodular, firm, usually not ulcerated, and relatively avascular. In the series were also 1 case each of fibro-osteosarcoma, chondrosarcoma, lymphosarcoma, and extramedullary plasmacytoma.

Diagnosis is difficult and can usually be made only by biopsy.

The patients in this group were treated as follows: in the case of chondrosarcoma and the case of fibro-osteosarcoma, laryngectomy was performed.

The case of lymphosarcoma was treated by irradiation. Three of the tumors were removed by thyrotomy; 1 was removed by a snare removing part of the arytenoid, and 1 by removing a segment of the vocal cord with cupped and tissue forceps.

Of 6 patients observed for 5 or more years post-operatively, only 1 patient died of metastases; 3 patients died of unrelated illnesses. Two patients are living and free from recurrence.

Two of the 8 cases have been observed for a period of but 5 months.

CLINTON H. THURMOND, M.D.

# SURGERY OF THE NERVOUS SYSTEM

## BRAIN AND ITS COVERINGS CRANIAL NERVES

Gerlins, P. G.: Pacchionic Granulations and Brain Hernias. *J. Lar. Otol. Lond.*, 1946 61 261

Pacchionic granulations are described by the author to consist of arachnoidal flocks separated by a thin endothelial dura layer and connected with an intradural blood sinus. These granulations have a special function to perform i.e. to influence the brain pressure.

Brain hernias described as bulbous protrusions of brain tissue in the dura mater always developed in pacchionic granulations. The author states that such brain hernias are almost exclusively found at the base of the skull at the same sites of the pacchionic granulations.

The pathological importance of such brain hernias consists in the fact that they can conduct an otogenic infection especially when the infection proceeds through the tegmen tympani or pyramidal apex.

During a mastoid operation when the dura in the neighborhood of the tegmen tympani and in front of it is freed a pacchionic granulation or brain hernia may tear off. Through the dural fistula thus occurring an inflammatory process could quickly give rise to a leptomeningitis. These pathways are considered to be a factor in the intracranial spread of such extradural infections as may arise in the mastoid area.

HOWARD A. BROWN M.D.

Bennett, W. A.: Primary Intracranial Neoplasms in Military Age Group—World War II. *Mil. Surgeon*, 1946 99 594.

The author's material is derived from a comprehensive study of 446 intracranial tumors at the Army Institute of Pathology. These tumors were removed from World War II Army personnel of the age group from 18 to 38 years, inclusive. Accurate correlation with other series of cases is not possible because of the limited age group. Only primary intracranial tumors are included and the general divisions of this series are based on the morphological classification as well as the pathogenesis.

The Cushing classification is followed and the tumors are listed under their appropriate headings. A most complete pathological description of each type of tumor is presented with its general characteristics and special peculiarities. The article is interspersed with 106 illustrations of both microscopic sections and gross specimens. The clinical side is described by noting the symptoms, their duration, the order of their prevalence and the clinical diagnosis. Under each tumor heading there is an enumeration of the minor procedures that were performed such as spinal puncture, pneumoencephalography and ventriculography. In addition the number of craniotomies is tabulated and the

mortality rate carefully evaluated. As far as information is available, an attempt is made to list the number of cases which were given x ray therapy and those cases in which there was an associated history of trauma.

Of the 466 tumors studied, 281 (62.9%) were gliomas and of this group only 3 (0.7%) are listed as unclassified. Glioblastoma multiforme was diagnosed in 102 cases (22.9%) and astrocytoma in 63 cases (14.1%). The authors call attention to the fact that this ratio was reversed in other series based on different age groups. The incidence noted here of medulloblastoma 45 cases (10.2%) and pinealoma, 13 cases (2.9%), was considerably higher than in other series. Fifteen cases (3.4%) of neurofibroma and 39 cases (8.7%) of meningioma are reported a lower incidence than in other studies. This suggests that these types of tumors are more apt to be noted in older age groups. In this series only 16 cases (5.8%) of pituitary adenoma are tabulated. The remaining tumors were sparsely distributed among the rarer types of neoplasms. In the miscellaneous group there were 2 cases (0.4%) which were regarded as unclassifiable.

A few general conclusions are drawn. There is no great variation in racial incidence. The immaturity as well as the location of the lesion is of importance in determining the development and duration of the symptoms. The mortality rate is greater in gliomas than in other major types of tumors. It is directly related to the size, location and type of tumor. The author emphasizes the fact that in this study 10 per cent of all the deaths occurred after spinal puncture, encephalography or ventricularography or before any operative procedure was performed.

RICHARD C. SCHULTZ, M.D.

McKenzie K. G. and Proctor L. D. Bilateral Frontal Lobe Leucotomy. *Canad. M. Ass. J.* 1946 55 433

Frontal lobotomy or frontal lobe leucotomy as the authors prefer to call it, has been the subject of a fairly voluminous literature in the United States for almost 10 years. The authors present a short history of the procedure and its rationale followed by a discussion of the results obtained in 27 cases. The technique, as described, severs approximately three fifths of the various association pathways between the frontal cortex and the thalamus and hypothalamus. These tracts run in the inferior portion of the white matter of the frontal lobes.

The operation is performed with a special instrument called a leucotome which is inserted into the frontal lobe through carefully localized burr holes  $\frac{3}{4}$  inch and  $1\frac{3}{4}$  inches respectively from the sagittal plane, with removal of the intervening portion of bone. The instrument is a sort of wire snare which can be opened or closed with the snare open the in



strument is rotated thus severing the white matter.

Special care is necessary in evaluating the patient from the cardiologist's point of view. Although cerebral hemorrhage is said to be the most serious post-operative complication, no instance of this occurred in the present series of cases. Mild hypersexuality followed operation in about 25 per cent of cases (3 females, 4 males); the intellectual impairment was slight, failure of orientation and memory, persisting from several weeks to several months following the operation.

In the selection of cases for leucotomy all other standard methods of treatment had been tried and in all cases there was an underlying factor of fear agitation, and impulsive behavior. A heavy battery of psychometric tests was employed in evaluating the patient after operation as before operation the patient was inaccessible. The results varied with the type of mental disorder that was evident before operation. In the affective disorders 86 per cent of the patients were improved or cured and 64 per cent were able to carry on life outside a mental hospital. In the schizophrenic group 58 per cent were improved so far as nursing problems were concerned, and 25 per cent were discharged from the institution.

It was calculated that in this small series of 27 cases approximately \$70,000.00 were saved in hospital care. The article is supported by suitable summary tables and instructive diagrams.

ADRIEN VAN BRUGHEM, M.D.

Cawthorne, T.: Peripheral Facial Paralysis. Some Aspects of Its Pathology. *Laryngoscope* 94:6 56 653.

In reviewing Kettel's series (1943) of 93 cases of facial paralysis in which the nerve was operatively exposed, the author shows that 31 of the patients suffered operative injury to the facial nerve in the fallopian canal proximal to where the chorda tympani leaves the nerve trunk. In 1 patient the nerve had been cut during operation at its exit from the stylomastoid foramen. Bell's palsy accounted for paralysis in 26 patients. In all of these patients there had been no response to faradic stimulation after 3 weeks, and in all but 4 patients taste on the anterior two-thirds of the tongue on the affected side had disappeared.

The author does not believe that failure of lacrimation on the affected side is a reliable test for a lesion of the nerve proximal to the geniculate ganglion. In many of these patients the nerve was found to be swollen and bulging above a positive constriction ring just above the stylomastoid foramen. At the site of the constriction many fine hemorrhagic streaks within the nerve were to be seen.

Chronic suppurative otitis media accounted for the paralysis in 15 patients; war injuries produced the lesion in 12 patients; basilar fracture extending into the petrous bone with severe damage to the nerve was present in 4 patients; neurofibroma of the facial nerve in 2 patients and of the acoustic nerve

in 1 patient was surgically verified, and unusual accidents to the ear caused the paralysis in the remaining 2 patients.

Cawthorne has found in agreement with Bunnell, Ballance and Ducl and other modern otologists, that surgical exploration of the facial nerve is feasible and more useful than has commonly been believed.

JOHN MARTIN, M.D.

Lathrop, F. D.: Facial Nerve Surgery in the European Theater of Operations. *Laryngoscope* 56:665.

The author points out that though Ney in 1922, Bunnell in 1930 and Ballance and Ducl in 1931, demonstrated the feasibility of grafting the facial nerve in patients who had suffered traumatic paralysis of the nerve, the methods used for the care of such casualties in World War II were as haphazard as they were in the first world war. The various mechanisms of the military type of injuries, together with the resultant defects, are discussed at some length. This author believes that testing for the presence or absence of increased lacrimation on nasal irritation is of value in determining whether or not the injury sustained by the nerve is located distal or proximal to the geniculate ganglion.

The commoner methods used to treat traumatic facial paralysis are decompression of the nerve within its bony canal, end-to-end suture (not always possible even in a fresh wound), nerve grafting, hypoglossal facial anastomosis, and fascia lata slings for the sagging muscles.

In the author's group of 45 patients, the nerve was decompressed in 10, sutured in 12, grafted in 13 patients and anastomosed with the hypoglossal nerve in 1 patient. In the remaining 7 patients it was impossible to obtain a pathway for neurotization of the facial musculature.

Any procedure which actually puts the nerve ends in approximation, such as end-to-end suture or grafting, is definitely to be preferred to any anastomotic or plastic surgical procedure. The author is a strong advocate of the rerouting method of Bunnell, which may allow end-to-end suture to bridge gaps up to 35 mm. long if the nerve is properly removed from its canal and moved forward of its old bed in the facial canal.

JOHN MARTIN, M.D.

## SPINAL CORD AND ITS COVERINGS

Kennedy, R. H.: The New Viewpoint toward Spinal Cord Injuries. *A. Surg.* 1946 1:4 57.

The appearance of the present article is particularly gratifying in that it indicates a new enthusiasm for improved care of the patient with an injured spinal cord. The author is sufficiently a realist to know that injury to the cord is damage done, and that the essential cord lesion is not reversible, yet he, along with others now active in the care of the military paraplegic, is sufficiently optimistic to believe that with proper early and rehabilitative care these patients can be returned to effective, worthwhile living.

In contrast to the high mortality among patients with injured cords in the first world war it is pointed out that except for those who died early of massive injuries most of these patients have survived as a result of the greatly improved means of evacuation in the theater of war, with better early surgical care and with more intelligent care after reaching this country. He advocates the use of tidal drainage for the care of the bladder together with the other usual chemotherapeutic and vigilant nursing methods of keeping the urinary tract in good condition.

In no other patient is nutrition such an important matter. Up to 300 grams of protein may be needed daily to keep the patient in protein balance, and the diet should at all times be rich in caloric and vitamin content.

A brief discussion of the nursing care of decubitus ulcers is given and it is pointed out that many of these ulcers can be most effectively treated by excision or graft, and that once they are healed it is much easier to keep the patient in a state of nutritional balance.

The rehabilitation of the paraplegic patient is concerned first with the problem of locomotion, be that by walking with braces or crutches or by getting about in a wheel chair. Important too is the aid which these patients must be given toward psychological readjustment, since their great need is encouragement and the development of self confidence. To keep them merely alive as "living memorials to the skill of medical officers during World War II" but to no good purpose is not sufficient. Each patient is a special problem, and each man is worthy of readjustment insofar as his injury will allow it.

JOHN MARTIN M D

Ellis, V. H.: *Injuries of the Cervical Vertebrae*. *Proc R Soc M Lond* 1946 40 19.

The author points out the improvement in care and treatment of cervical fractures and dislocations and the material reduction in the mortality rate, now approximating 16 per cent. Reduction of nearly all dislocations can be achieved by manipulation or traction, and open reduction is rarely required.

Skeletal traction is recommended by means of tongs applied to the cranial vault or the zygomatic arches. The importance of damage to the interapophyseal ligament in cervical injuries is stressed and fusion and stabilization of the spines with stainless steel wire is recommended after reduction has been accomplished. The author's experiences in several typical cases are reported individually.

HOWARD A. BROWN M D

Estrella, J., and Marasuela, J.: *Posterior Dislocation of the Lumbosacral Intervertebral Disc (Luxa ción posterior del disco Intervertebral lumbosacro)*. *Rev. Esp. Ortop.* 1946 3 181.

Two factors are responsible for the fact that the overwhelming majority of dislocations of the intervertebral disc occur in the lumbosacral region: the static factor, namely the large dimension and height

of the discs in that region and the kinetic factor, namely the weight of the body and the mobility of the vertebral articulations.

In regard to location, two types of dislocations may be distinguished: the posterolateral and the central. So-called spontaneous hernias are undoubtedly attributable to repeated minute traumas.

Two groups of clinical pictures may be distinguished. In the first group the symptoms are confined chiefly to the spine: the normal lumbar lordosis may be absent and scoliosis or kyphosis may be found. Movements of the spine are painful and pressure on the apophysis of the fifth lumbar vertebra also produces pain. In the second smaller group the symptoms are confined mostly to the lower extremities. Among them the contralateral Lasègue sign and Bonnet's sign (pain produced by forced flexion and adduction of the thigh) deserve attention.

The authors are of the opinion that myelography is indicated whenever the clinical examination justifies the suspicion of a herniated disc. They consider myelography as preferable to an exploratory laminectomy. While the myelogram in posterolateral hernia especially the disappearance of the so-called axillary pouches is quite characteristic it is not pathognomonic in central hernia because an extrinsic tumor of the cauda equina may produce a similar picture. However extrameningeal tumors in that region are relatively rare.

So-called intermittent hernias (cog wheel of Anglo-Saxons) may furnish negative myelograms.

Two varieties of the cauda equina syndrome may be differentiated in one motor symptoms predominate while in the other sensory and sphincteric disturbances are predominant.

In posterolateral hernias the authors employ hemilaminectomy of a lumbar vertebrae, while in central hernias a bilateral laminectomy is unavoidable.

JOSEPH K. NAKAT M D

Erickson T. C., Maaten, M. G. and Suckle H. M.: *Intrathecal Use of Penicillin*. *J Am M Ass* 1946 132 561.

The use of penicillin has produced brilliant results, but there is the possibility of toxic reactions when it is given intrathecally. This report is concerned with 4 cases in which there were severe neurological complications with death in 2. References are made to the literature of similar complications, and the 4 cases are reported in detail.

The first patient had a staphylococcal meningitis and occipital lobe abscess and received 50,000 units of penicillin intrathecally one day and the next day, 40,000 units by the same route. Eleven days later, and after the drainage of the brain abscess, a flaccid paralysis developed although spinal block was noted before the second injection of penicillin. Laminectomy revealed extensive arachnoidal adhesions.

The second patient was a child of 2 years with a pneumococcal meningitis who received 15,000 units of penicillin daily for 3 days and a fourth dose after

an interval of a week. Following this an extraocular palsy developed and later a spinal block. Intra-ventricular injection of penicillin coincided with a shocklike state which led to death.

The third case was that of a cerebellar abscess of mixed infection. Ten thousand units of penicillin were injected into the drained abscess cavity with immediate and finally fatal untoward results.

The fourth patient had a pneumococcal meningitis and received 10,000 units of penicillin every 12 hours for 48 hours. The spinal fluid was thick and green and after the first intrathecal injection there was marked retraction of the head, neck, and body from which the 6 year old child finally recovered.

The myelopathies usually appear from 10 to 17 days after the initial intrathecal injection of penicillin with the lesion about at the tenth thoracic level. Irreversible damage may have been done to the spinal cord. Some patients are benefited and then have relapses suggesting encysted infection to which penicillin does not gain access. The reaction may not be local as seen in case 4.

The total dosage and the concentration of the injected solution are two factors concerned in the untoward reactions. The reactions can be minimized by greater reliance on maximal parenteral doses of penicillin intrathecally solutions should be of low concentration and a large number of units over 20,000 should be avoided. The intrathecal route should be used as little as possible.

ADRIEN VAN BRUGGEN M.D.

#### PERIPHERAL NERVES

Tarlov I M., Hoffman W., and Hayner J. C.:  
Source of Nerve Autografts in Clinical Surgery  
Technique for Their Suture *Am. J. Surg.* 946  
7 700.

The search for a satisfactory means of filling in large defects in peripheral nerves continues. The

purpose of the present study is to indicate the nerves which are usable as autografts. Homografts have been very unsatisfactory. The autografts must be made up of relatively unessential nerves and used in the form of cable grafts. No special difficulty is encountered in the use of (mainly) sensory autografts to fill gaps in motor nerves.

Actually the problem resolves itself into determining the obtainable length and the diameter of the essential nerve to be used. The choice of nerve to be used depends on several factors: ease of surgical exposure, diameter, available length, and the degree of disability following its removal. The authors indicate the areas of sensory deficit after removal of the nerves.

Use of the following nerves is proposed: intercostal nerves, sural nerve, lateral femoral cutaneous and posterior femoral cutaneous nerves, saphenous nerve, and medial cutaneous nerve of the arm and of the forearm. All of these are about 2 mm. in diameter and from 12 to 25 cm. are obtainable in each. The diameter of the peripheral nerve containing the gap to be bridged is also shown: for instance, the median nerve at the wrist has a diameter of 3.5 mm., and the length of the gap is 7 cm. The intercostal nerves to be used have a diameter of 1.5 mm. and by squaring these figures the ratio is 12.3 to 2.3. Six strips of intercostal nerve 7 cm. long will be required. The cable graft should be somewhat longer than the gap to be spanned.

Hitherto the problem has been that of a technical means of suturing the cable graft to the injured nerve. This is accomplished by using autologous unmodified plasma as a suturing agent. Tantalum foil cuffs are definitely contraindicated. Suitable apparatus in the form of molds is necessary, and good results have been obtained with the method in experimental animals. The results in man are uncertain but the method should be tried before recourse to orthopedic operations. ADRIEN VAN BRUGGEN M.D.

# SURGERY OF THE THORAX

## CHEST WALL AND BREAST

De Santiago A. P.: Tuberculosis of the Breast (Tuberculosis de la glándula mamaria) *Bol Soc cir Uruguay* 1946 17 205

Because of the infrequent occurrence of tuberculosis of the breast, the author reports 3 cases occurring in women. The disease occurs during the age of sexual activity between the ages of 20 and 50 years and is most frequent in parous patients. It is usually unilateral, predominantly on the right side.

There appear to be five avenues of infection (1) through the ducts, (2) through the skin directly (3) by direct extension from neighboring foci (4) by the hematogenous route, and (5) by retrograde lymphatic spread from cervical or axillary nodes.

From the standpoint of pathologic anatomy the lesions may be (1) acute, miliary (2) nodular (3) disseminated nodular (4) confluent (5) a cold intramammary abscess, (6) sclerosing and (7) an obliterating type.

The problem whether endocrine factors play a role in the production of the various types of the disease is brought up.

In the differential diagnosis cancer is the most important consideration particularly in the nodular and sclerosing types. The author advocates the use of x-rays with nitason (an opaque medium). The prognosis is varied the condition ranging from a mild benign entity to one which runs a fatal course in only 10 or 12 months.

The treatment is surgical and ranges from simple resection to radical mastectomy according to the indications of the lesions and should be supplemented by general measures against tuberculous infection.

Numerous illustrative photomicrographs and sample roentgenograms of breasts injected with radiopaque media are included.

HIRAM T. LANGSTON M.D.

Brachet-Brian D.: Five Cases of Sarcoma of the Female Breast (Cinco casos de sarcoma de la mama en la mujer) *Arch Soc argent anal* 1946 8 35

In 10,000 tissue examinations, 350 mammary tumors were discovered of these 138 were benign and 212 were malignant. Two hundred and seven of the 212 malignant tumors were epithelial in origin and 5 were classified as sarcomas. Therefore the sarcomas made up 2.36 per cent of the malignant mammary tumors and 1.04 per cent of all the mammary tumors.

The cases of sarcoma are presented with case records, photographs of the gross specimen and photomicrographs. These 5 sarcomas were classified as reticulum cell sarcoma, fibrosarcoma, adenofibrosarcoma (2 cases) and adenofibrosarcoma.

HIRAM T. LANGSTON M.D.

## TRACHEA, LUNGS, AND PLEURA

Sweet R. H.: Lobectomy and Pneumonectomy in the Treatment of Pulmonary Tuberculosis. *J Thorac Surg* 1946 15 373

In cases of pulmonary tuberculosis it is striking to find with what frequency the hilar structures are relatively free from evidence of active disease. Lymphadenopathy also is rarely encountered except for evidence in the form of calcification of an old infection. The frequent widespread dissemination of the disease throughout the lungs in the early phases of its development is remarkable. In almost all cases the disease is found to be bilateral, and it is often spread throughout all the lobes of both lungs. Only a few of these foci develop into serious lesions but at operation they can be identified as small, yellowish firm nodules which can be seen or felt. In many cases in which apparently new foci of activity develop in the remaining lobes or in the opposite lung one can usually demonstrate that these areas were present but almost imperceptible in the early roentgenograms. These areas are responsible for the so-called postoperative spread of the disease, which is in reality a reactivation of pre-existing small foci.

It is obvious therefore that tuberculosis does not lend itself to surgical extirpation, in the sense that the entire diseased area can be removed.

In the absence of a certain degree of natural resistance no surgical procedure can be expected to succeed in tuberculosis. However no satisfactory method exists whereby this factor can be assessed. Because of this lack of natural resistance, apparently favorable cases present disappointing results and because of its presence apparently unfavorable cases show surprisingly good results.

In both the lobectomy and pneumonectomy groups the greatest number of failures occurred in the cases presenting large cavities with marked pulmonary destruction. The mere fact that a patient develops large cavities in the lungs is evidence that his resistance to the disease is ineffectual. To avoid a high mortality rate and a high incidence of reactivation therefore he should not be subjected to extirpative surgery.

On the basis of the 63 cases in this series it is not possible to say that those in which the disease was considered suitable for thoracoplasty did better in the long run as a group, than they would have if thoracoplasty had been done.

Lobectomy and pneumonectomy in tuberculosis can be performed with a degree of safety which makes it proper to consider their use in the treatment of suitable cases. No absolute indications or contraindications can be applied. The best results followed pneumonectomy in cases of bronchostenosis and thoracoplasty failure, and lobectomy in those

which might otherwise have been treated by thoracoplasty.

Extirpative surgery has failed to solve the problem of management of cases with enormous cavities which do not respond to collapse therapy. Nor is there definite evidence that lobectomy is superior to thoracoplasty with regard to end results.

Because pulmonary tuberculosis is not primarily a surgical disease, the hope for future progress in its management lies in the development of some medicament which will overcome the invading organism and thus prevent further progress of the condition.

SAMUEL KARM, M.D.

Tosti, B., Gramazio, V. and Ingrao, F.: The Surgical Treatment of Large Tubercular Cavities of the Superior Lobe. (Il trattamento chirurgico delle grandi caverne tubercolari del lobo superiore) *Minerva med.*, Tor 1946, 37, 459.

In the treatment of tubercular cavities 5 cm. or more in diameter the author found that intrapleural pneumothorax was inefficient and he advised abandonment of this method. However extrapleural pneumothorax is especially indicated in the cases with an active process in which the large cavity is accompanied by other destructive foci within the surrounding tissue of the lung. Extrapleural pneumothorax should be given preference in the cases which necessitate the intracavity aspiration of Mondaldi in preparation for thoracoplasty. Aspiration diminishes not only the toxic manifestations, but also the size of the cavity so that the number of ribs to be resected is smaller. Because cavities would refill if aspiration alone were used and because a rigid large cavity cannot collapse by this method the treatment of choice is aspiration followed by thoracoplasty. Thoracoplasty with the apicectomy of Semb is limited to the cases in which the cavity is not excessively full.

Extrapleural pneumothorax is contraindicated in cases with cavities close to the periphery of the lung and with inflammatory processes in the extrapleural tissues. As the condition of the lesion in the lung improves, the grave problem of re-expansion of the lung with large cavities presents itself.

ARTHUR F. CROCOLLA, M.D.

Triccerri, F. E. P., Langer, L., and Naclerio, R.: Bronchial Adenoma (Adenoma bronchiale) *Pres-sa med. erged* 1946 33, 307.

This report comprises a review of 18 cases of bronchial adenoma treated by resection (13 pneumonectomies and 4 lobectomies) on the service of R. H. Overholt, Boston, Massachusetts. Since the report in 1946 3 additional cases have been successfully treated. The earliest case was seen in 1933.

The entire topic is reviewed at some length from the standpoint of the clinical picture, diagnosis, pathogenesis, and treatment. The opinions concerning the nature and behavior of these tumors are illustrated in the attitude taken in their treatment.

The possible forms of treatment include (1) irradiation (2) bronchoscopic management, which includes

implantation of radium needles, electrocoagulation, and removal by local resection, and (3) resection in the form of lobectomy or pneumonectomy. These lesions are considered as indications for resection because only in this manner can the frequent extra-bronchial extensions be cured for the potential malignant aspects of the tumor be obviated, and the frequently concomitant and irreversible lung damage secondary to prolonged bronchial obstruction be managed. Irradiation is believed to be of little value, and bronchoscopic management is limited by the hazards of severe hemorrhage and the inaccessibility of the extra-bronchial extensions.

Two of these cases had metastases to the regional lymph nodes.

The extent of resection is dependent on the location and size of the tumor, the extent of the secondary changes, and the associated findings at operation.

Illustrative photomicrographs and roentgenograms are appended.

HERMAN T. LAMONTAG, M.D.

## HEART AND PERICARDIUM

Bialock, A.: The Surgical Treatment of Congenital Pulmonic Stenosis. *Ann. Surg.* 1946, 124, 879.

Because, in cases of congenital pulmonic stenosis, the atretic or constricted area is in the pulmonary conus itself it was doubted that incision or partial excision of the stenotic area would result in permanent improvement. Experimentally it was then found that creation of an artificial ductus arteriosus resulted in an increase in the arterial blood oxygen saturation of animals in which a high degree of chronic arterial unsaturation had been produced.

The author discusses the application of this experimental work to human beings in whom the results were much more striking than had been anticipated. Operation in these cases is indicated when there is evidence of inadequate blood flow to the lungs. Of diagnostic aid are the absence of visible pulsations in the lung fields, fluoroscopy and roentgenographic evidence that the pulmonary artery is small in size. There are many borderline cases wherein accurate preoperative diagnosis is difficult, if not impossible. If in these last cases, the patient seems to have a hopeless prognosis without operation, the author believes that exploration is indicated. If doubt still exists after exposure of the pulmonary artery the intra-arterial pressure of this artery is determined with a water manometer. A pressure greater than 300 mm. of water at present, is held to contraindicate anastomosis. Age limits suitable for this operation have not been established. Operations have been successfully done on an infant of 5 months and an adult of 21 years. It is believed that the operation should be performed on subjects between the ages of 2 and 10 years. Absence of cyanosis in children at rest who have little or no tolerance to exercise, requires that arterial oxygen saturation should be determined under basal conditions and immediately after exercise a definite decrease in the saturation after exercise in cases wherein it is be-

proved that inadequate pulmonary blood flow is the cause, makes necessary a consideration of operative intervention.

The most important change in operative technique has been that instead of the approach on the left side of the chest to utilize a subclavian artery for the anastomosis the approach is made on the side on which the innominate is located, usually but not always, the right side. Exposure of this vessel offers a wider choice of vessels for anastomosis and is also of advantage in case the subclavian artery is used because, when the subclavian branch of the innominate is used the angle caused by the anastomosis of this branch is not as acute as when the subclavian branch of the aorta is used. Despite the multiplicity of variations in arteries arising from the aortic arch there has been in every case a systemic artery suitable for anastomosis to a pulmonary artery. Variations in the position and size of the pulmonary artery were fewer than was anticipated. In the occasional case in which the right pulmonary artery is very short, it may be necessary to ligate and divide the vessel and to use the distal end for anastomosis to the end of the systemic artery. If however the pulmonary artery is freed of its pericardial attachments this procedure will rarely, if ever be necessary. In evaluating the alterations of oxygen saturation of arterial blood resulting from this operation it is rather surprising in view of the septal defect and the overriding aorta in cases of the tetralogy of Fallot, that the arterial saturation has risen so greatly in many of the patients. The improvement in the general condition of the patients has paralleled the alterations in the blood saturation and the decrease in their polycythemia.

The author's series of cases numbers 110 with 25 deaths a mortality rate of 23 per cent. These figures include all patients who were subjected to operation irrespective of whether or not an anastomosis was done. The surgical procedures used were as follows:

1. Anastomosis between the end of a systemic vessel and the side of one of the two pulmonary arteries was done in 91 cases with a group mortality rate of 18 per cent (16 deaths).

(a) The subclavian artery was used in 46 cases with 4 deaths.

(b) The innominate artery was used in 36 cases, with 11 deaths. Two of these patients were subjected to autopsy, the findings were (1) a single ventricle with insignificant pulmonary stenosis and (2) transposition of the great vessels combined with pulmonary stenosis. The most common cause of death in this group was cerebral anemia or thrombosis.

(c) The end of the carotid was anastomosed to the side of one of the pulmonary arteries in 9 patients, with 1 postoperative death 9 months later.

2. An end-to-end anastomosis was attempted between the end of a systemic artery and the end of a pulmonary artery in 10 patients. This method was used because (1) the pulmonary artery was very short or (2) because the patient was very ill which made haste necessary. In this group there were 4

deaths these latter patients had atresia of the pulmonary orifice and the vessel was too small for a satisfactory anastomosis. In the future attempts are to be made, in similar cases to effect an anastomosis between the end of the systemic vessel and a longitudinal opening in the side of the pulmonary artery. The deaths which occurred in this group of patients were due to

(a) Mistaking the right pulmonary artery upper lobe branch for the main vessel which was very short in 2 patients. The subclavian artery was anastomosed to the end of the small artery supplying the upper lobe. Retrospection suggests that the main right pulmonary artery might have been divided and its distal end used for the anastomosis if the condition had been recognized.

(b) Anastomosis was not done in 6 patients. One of these patients died because of failure to locate the pulmonary artery at operation (it was also difficult to find the vessel at subsequent autopsy) and a second died because the patient's condition was too poor to withstand operation.

Postoperatively, none of the patients had empyema, mediastinitis, severe bleeding from the site of anastomosis, heart failure or a *Streptococcus viridans* infection. There was no significant interference with the circulation of the arm on the side on which the subclavian artery was sacrificed or used for the anastomosis. Weakness or paralysis of the opposite side of the body in patients in whom the innominate or carotid artery was used either had cleared or was diminishing in all who had survived the operation. Despite the fact that some of the operations were performed too recently to allow an evaluation to be made of the results it appears that all of the patients with exception of one (whose too vigorously manipulated subclavian became thrombosed) are improved. It is believed that the artificial ductus in the remaining patients is patent although a murmur cannot be heard in at least one of them.

EUGENE J. ABRAHAM, M.D.

Sweet R. H. Findlay C. W., Jr. and Reysersbach G. C.: The Diagnosis and Treatment of Tracheal and Esophageal Obstruction Due to Congenital Vascular Ring. *J. Pediatr.* St. Louis, 1947 30: 1

The authors report a case of successful surgical intervention in patients whose symptoms were caused by a double aortic arch.

The first case, that of a 3½ month old male hospitalized because of progressively severe paroxysms of coughing and wheezy respirations which began 10 days after birth showed normal concentrations of serum calcium, inorganic phosphorus and phosphatase as well as normal wrist roentgenograms. X-ray examination of the child's esophagus, with the aid of barium revealed a posterior indentation at the level of the aortic arch slightly caudal to this there was an indentation of the right lateral margin of the esophagus. Nothing pathognomonic was found by plain chest films in the neck, upper mediastinal shadow or lung fields.

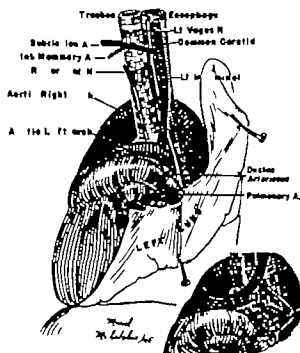
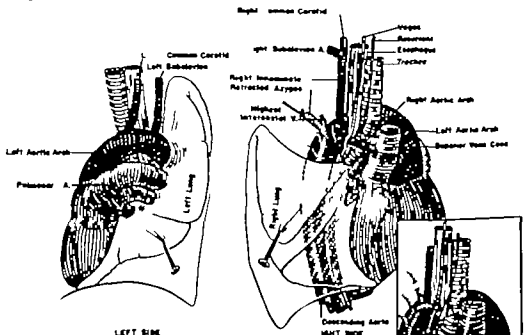


Fig. 1 (Sweet et al)

At operation under ether-oxygen intratracheal anesthesia, an incision was made through the fifth intercostal space on the left side, retraction of the pleura and pericardium overlying the great vessels

revealed a right or dorsal aortic arch which arose from the usual location at the base of the heart. This ascended and then curved over the right main bronchus, proceeding posteriorly and behind the esophagus to emerge at the left posterolateral aspect of that structure. Here it was joined by another much smaller vessel which arose from the first described vessel about 1 cm. above its cardiac origin and passed in front of the trachea and esophagus. From this junction the artery descended in the normal course of the descending aorta along the left side of the vertebral column (Fig. 1). At approximately the midpoint of the anterior vessel or left aortic arch, there arose a long slender artery which extended through the superior mediastinum to the dome of the left chest where it branched into the common carotid, subclavian and internal mammary arteries. This vessel was actually a left innominate artery. A patent ductus arteriosus connected the undersurface of the left arch with the pulmonary artery on that side, at a point approximately 1 cm. distal to the origin of the left innominate artery. The ductus arteriosus, occluded by external pressure without any untoward effect being noted, was divided between two ligatures of braided silk. The ventral component of the double aortic arch was similarly compressed at a point between the innominate artery and the stump of the ductus. The color of the upper extremities remained normal and the radial pulse did not change. The vessel was divided between ligatures at the point of compression. A sudden shift of the great vessels occurred immediately (Fig. 1 inset)



The left innominate artery retracted superiorly and anteriorly. The exposed portion of the dorsal arch receded slightly posteriorly and to the right. The trachea and esophagus appeared to bulge forward and to the left. Postoperatively and following discharge from the hospital the infant's condition improved.

The second case, a male of 9 years had had three previous hospital admissions because of respiratory infections at 9 months (2 admissions) and at 3 years. On his fourth admission he was able to eat only liquids or strained foods and even with these he vomited 2 or 3 times at mealtime. There was audible wheezing when he became excited. He had frequent upper respiratory infections from which recovery was slow. The x-ray examinations on his third admission had shown a prominence of the upper mediastinal shadow on the right. Barium confirmed this displacement and also revealed narrowing of the trachea at the level of the aortic arch posteriorly and on the right probably due to pressure. The aortic arch appeared to be in normal position but an aortic arch on the right side could not be excluded.

A second operation was necessary in this case because it was found that the normally arising aortic arch instead of following its usual course down the left thoracic gutter curved behind the esophagus into the right chest. A right posterolateral thoracotomy incision was then utilized the pleura being entered through the fifth intercostal space. It was found that the aorta emerged from behind the esophagus at a slightly lower level than that at which it was seen to disappear on the left side. It descended down the thorax along the right lateral margin of the vertebral column curving gently to the left at its distal end so that it went through the diaphragm in the midline. At the point where the aortic arch became the descending aorta, a large artery branched off and was traced to the apex of the thorax. This was an innominate artery which bifurcated to form the right common carotid and right subclavian arteries. Further dissection of the mediastinal structures revealed a vessel connecting the ascending and descending portions of the aorta. It was found to arise from the ascending aorta just above the base of the heart and traversed the left posterolateral border of the superior vena cava. It then passed dorsally slightly superiorly, and to the right passing over the first portion of the right main bronchus at the point of its origin from the trachea. It joined the descending aorta at the level where the right innominate artery arose. The diameter of this vessel was about one-eighth that of the aorta. This was thought to be a persistent right fourth aortic arch. This superfluous segment of the vascular ring was doubly ligated with silk ties and divided, the severed ends separating immediately after division (Fig. 2 inset). No ductus arteriosus or ligamentum was found on the right. The postoperative course of this patient was uneventful except for an unexplained tachycardia which gradually subsided after several weeks.

The authors make the point that the observation in infants of respiratory wheezing or stridor even without dysphagia (which is aggravated by deglutition) should arouse suspicion of the presence of a double aortic arch. These symptoms are usually noted shortly after birth often become aggravated when the infant is fed are absent during normal sleep and are markedly aggravated by upper respiratory infections. Dysphagia becomes noticeable only when solid food is added to the infant's diet. Usually these infants do not have other congenital anomalies.

The most informative special examination is that of the esophagus following the ingestion of barium.

A study of previously reported cases suggests that an approach on the left side of the chest is the wisest for the surgeon to use because the surviving left fourth arch is usually more amenable to division as the right aortic arch almost always conveys most of the arterial blood. Of help in deciding which pleural cavity is to be entered is the fact that the lateral esophageal deformity usually indicates indentation by the larger of the persistent arches. The visualization of the side on which the main aorta descends along the vertebral column also is of aid in locating the lesser aortic arch the vessel to be divided which is usually on the same side. The embryology of the reported cases is described and illustrated.

EUGENE J. AUB, M.D.

#### ESOPHAGUS AND MEDIASTINUM

Holt J. F., Haight, C. and Hodges F. J.: Congenital Atresia of the Esophagus and Tracheoesophageal Fistula. *Radiology* 1946 47 457.

Esophageal anomalies have been classified into three large types:

- 1 Complete absence of the esophagus
- 2 Atresia of the esophagus with an upper and lower esophageal segment, each ending in a blind pouch.
- 3 Atresia of the esophagus with tracheoesophageal fistula (a) with a fistula between the upper segment and trachea (b) with a fistula between the lower segment and trachea (the commonest anomaly) and (c) with a fistula between both segments and the trachea.
- 4 Single tracheoesophageal fistula without esophageal atresia. This type is very rare.

The signs and symptoms of esophageal atresia are fairly characteristic. The inability to swallow fluids attacks of choking, dyspnea, and cyanosis especially during attempted feeding, and intermittent accumulation of mucus in the pharynx with resultant respiratory obstruction constitute a clinical picture which should not go unrecognized. Inability to pass a catheter into the infant's stomach permits a presumptive diagnosis of partial esophageal obstruction but roentgenological examination is necessary for a positive diagnosis of complete atresia.

Since the anomaly of congenital atresia of the esophagus has now become amenable to surgical



treatment, the various methods of roentgen examination have assumed added significance in the diagnosis and management of the condition, and are discussed in some detail.

Surgical exploration of the anomaly was undertaken in 36 patients of a group of 45 and intrathoracic reconstruction of esophageal continuity was accomplished in 36

SAMUEL KAHN M.D.

Rienhoff W F., Jr.: Intrathoracic Esophagojejunostomy for Lesions of the Upper Third of the Esophagus. *South. M. J.* 1946 39 928.

Lesions and dysfunction of the esophagus have been a veritable challenge to surgeons throughout the world since Billroth in 1871 demonstrated experimentally that this structure could be successfully removed surgically. The observations of Billroth were soon applied clinically and as early as 1874 Czerny successfully resected the cervical esophagus for carcinoma in that region. Since that time many surgeons have applied themselves not only to the problem of extirpating the esophagus for growths occurring within that organ but to the far more difficult feat of re-establishing the continuity of the gastrointestinal tract following an extirpation of this kind.

In the last decade and a half great advances have been made in what may be termed visceral thoracic surgery in contradistinction to operations upon the chest wall. In addition, patients with disease of the esophagus are not only recognized at a much earlier stage, but are better prepared for operation. The use of parenteral or intravenous feeding, penicillin lozenges, sprays, as well as intramuscular or intrathoracic injections, both preoperatively and postoperatively and the maintenance of a high blood level of one of the various sulfonamides affords the surgeon today a far better operative risk than those of earlier years. Various forms of intratracheal anesthesia, particularly with cyclopropane, maintain the patient in a normal state of oxygenation with a minimal respiratory motion. Sometimes a state of suspended respiration can be maintained for quite long intervals. At this time there is also the free use of blood due to our blood banks which enable one to employ not one but two or even three transfusions at the same time.

Cesar Roux in Lausanne in 1907 made the first attempt at total antithoracic esophagoplasty by mobilizing the jejunum with the mesentery.

The first successful case was the operation performed in Moscow in 1907 by Peter Herzen. In 4 months he succeeded in making an artificial esophagus for a woman who had poisoned herself with sulfuric acid. Herzen added very important improvements to the methods of Roux (1) unilateral exclusion of the mobilized intestine with anastomosis instead of the bilateral exclusion used by Roux, and (2) the passage of the intestine through a slit in the mesocolon and gastrocolic ligament in order to prevent the possible compression by the transverse colon on the way to the subcutaneous

tunnel. Herzen joined the intestine with the stomach by an anterior anastomosis.

The use of the jejunum as a substitute for the esophagus was given up for a number of years because of the difficulty in maintaining an adequate circulation in the mobilized loop. The method suggested by Roux, that is, dividing the first five vasa recta jejuni, was found to be hazardous to the maintenance of a sufficient circulation to the mobilized loop of jejunum except in quite young individuals who were victims of corrosive strictures of the esophagus. The length of the jejunum necessary to reach from the abdomen over the costal margin to the cervical region above the clavicle could not be obtained unless at least the first five vasa recta jejuni were divided. In 1942 although unfamiliar with the previous work of Roux, the author in the Johns Hopkins Hospital successfully employed the jejunum as a substitute for the esophagus in a patient with a lye stricture running the entire length of the organ. This patient is now completely well and represents the first instance in which the jejunum was transplanted intrathoracically.

It became apparent that the intrathoracic transplantation of the jejunum would permit the use of a shorter length of the mobilized loop of the jejunum than that which would be necessary to encompass the subcutaneous route. Instead of ligating the first five vasa recta jejuni it was found necessary to divide only the second, third, and fourth vessels, which assured an adequate circulation to the entire length of mobilized loop necessary to be employed. In other words sufficient length of mobilized jejunum to run along the entire length of the thoracic cage may be obtained by interlying with the circulation to a far less extent than by the method of Roux. Preservation of the first branch of the superior mesenteric artery is of the greatest importance in maintaining an adequate circulation to the mobilized loop of the jejunum. This first branch is the largest of all the vasa recta jejuni which diminish in size caudalward. To obtain the benefit derived from the preservation of this vessel, transection of the jejunum is performed far below from 30 to 40 cm. from Treitz's ligament.

After division of the jejunum the oral end of the proximal loop instead of the aboral end of the distal loop, is then brought into the chest. Peristalsis does not interfere with the function of this loop.

The importance of the following facts has not been emphasized in the past namely (1) that the intrathoracic transplantation of the jejunum requires a shorter loop of intestine less mobilization and less interference with the mesenteric circulation than the long loop required by the subcutaneous route and (2) that the transection of the jejunum 30 to 40 cm. from Treitz's ligament permits preservation of the first intestinal branch of the superior mesenteric artery and this insures a more vigorous circulation to the mobilized jejunal loop.

The case histories of 3 patients with different lesions that have been successfully treated by the

intrathoracic transplantation of the jejunum as a substitute for the esophagus are presented in detail.

The operative technique is carefully described.

The advantages of the use of the jejunum in reconstruction of the esophagus following resection of the latter for carcinoma are as follows:

1 The operation can be divided into two or more stages which makes it unnecessary to subject the patient to an extremely formidable one stage operation as in the case when the stomach is employed.

2 The abdomen can be explored at the time of mobilization of the jejunum for metastases. The importance of this step needs no comment.

3 A gastrostomy may be performed without interfering with the subsequent operative procedure. If the stomach is anchored in this manner its use will be made more difficult whereas the use of the jejunum is not interfered with. The ability to feed the patient by gastrostomy particularly in the presence of extreme dysphagia may result in a far better operative risk because of the general improvement in the clinical condition.

4. In case the cardiac end of the stomach as well as a portion of the esophagus is involved to such an extent that a major portion of the stomach must of necessity be resected then the jejunum is available and can be used in almost any length desired.

It is believed that particularly in patients afflicted with lesions of the upper third of the esophagus the intrathoracic transplantation of the jejunum as a means for the reconstruction of an artificial esophagus has many advantages over other methods advocated in the past. Esophagojejunostomy would seem to be an operation that can be safely performed provided the jejunum is properly mobilized.

JOHN E. KIRKPATRICK, M.D.

Brea, M. M., and Santos, A. A. Mediastinal Fibromyxosarcoma (Fibromyxosarcoma del mediastino) *Rev. Acad. Argent. Cir.* 1946 30 977

This is a report in considerable detail of a case of fibromyxosarcoma originating in the mediastinum projecting chiefly toward the right. The patient was a female 34 years of age.

Symptoms had been present since 1939, consisting chiefly of chest pain. On December 22, 1943 this lesion situated in the posterior part of the chest was surgically exposed as it was assumed to be a hydatid cyst. However aspiration of the mass indicated its solid nature. In the absence of intratracheal general anesthesia, its removal by an extrapleural approach was undertaken. The fistulized encapsulated tumor was removed. The pleura was torn in the process and an empyema resulted. The patient however made an entirely satisfactory recovery and has remained well for 3 years.

A brief review of the literature is given without a formal bibliography.

The report of this case is illustrated by roentgenograms and a gross and microscopic photograph of the surgical specimen.

HIRSH T. LANGSTON, M.D.

## MISCELLANEOUS

Adams, H. D.: Arterial Injuries of the Thorax. *J. Thorac. Surg.*, 1946 15 305

Technically, the surgical management of some of the more proximal arterial injuries was undoubtedly one of the most hazardous and difficult operations in war surgery. Those in the extremities low enough to permit use of a tourniquet and a direct dissection accomplished in a bloodless field were relatively simple. Those injuries located in the groin, neck, shoulder and chest however required an entirely different approach and surgical management if the patients were to survive their operations. This was true particularly of the arterial injuries of the thorax with its close anatomic relationships in which there is difficulty in obtaining wide and easy exposure.

The author describes in detail his operative treatment of wounds of the mammary and intercostal arteries, the axillary artery and the subclavian and innominate arteries. These wounds were all acquired in warfare.

There were 14 cases of false aneurysm, many in combination with arteriovenous communications as well—6 axillary, 6 subclavian, and 2 innominate. There were no deaths or complications aside from occasional swelling and weakness of the upper extremity. No amputations were necessary and no treatment was required for any unusual circulatory disturbance in this respect. The patients recovered rapidly. Return of function of the upper extremity was variable depending on the degree of the original associated nerve and muscle damage. The lack of circulatory complications was undoubtedly the result of the age of these patients and most probably this procedure could not be done in an older group of patients without more serious circulatory complications.

JOHN J. MALONEY, M.D.

Lahey, F. H.: Pharyngoesophageal Diverticulum. Its Management and Complications. *Ann. Surg.* 1946 124 617

Pharyngoesophageal diverticula originate at the junction of the esophagus and the pharynx from the pharyngeal dimple, a triangular space bounded above by the lowest fibers of the inferior constrictor and on each side by the oblique fibers of the cricopharyngei.

If there is any inco-ordination of the swallowing mechanism pressure from the constrictors and the obstruction below from the unrelaxed cricopharyngei results in a bulge at the pharyngeal dimple.

Recurrent pressure on this weak point causes the bulge to become a sac, a false diverticulum made up of mucosa and submucosa and covered by a few remaining cricopharyngeal fibers.

As the sac enlarges it extends downward and becomes filled with food until it lies parallel with the esophagus with a true sac body, a true neck, and a small midline aperture into the true esophagus.

The third stage is the eventual outcome as the sac enlarges and extends further downward into the superior mediastinum.

Each of these stages has its own group of symptoms. Stage 1 usually has no symptoms. An occasional lodging of a dry piece of bread or cereal within the bulge results in attempts to dislodge it by hawking. Operation at this time is neither necessary nor advisable.

The symptoms of the second stage are produced by the sac when it is filled with food which is mixed with air and mucus. The sac moves with swallowing and is compressed against the vertebral bodies by changes in pressure of the sternomastoid, omohyoid and sternothyroid muscles and of the overlying thyroid gland. This produces unpredictable expulsion of food and mucus which may come into the mouth any time during the day or night. In addition audible and frequently embarrassing gurgling may come from the patient's throat with swallowing. Unexpected nocturnal regurgitation may result in inspiration of the sac contents strangulation and the danger of lung abscess.

The third stage presents all the symptoms found in stage 1 with the addition of obstructive symptoms. It is important to understand this obstruction as attempts to pass an esophagoscope, bougie or feeding tube may result in perforation. This obstruction is not due to the pressure of the large filled sac against the lateral esophagus as was first believed but is due to traction on the esophageal wall by the heavy sac. This converts the diverticulum opening into a semitransverse one and the true esophageal opening into a semilateral one. This traction tends to pull the two lips of the opening into the true esophagus together and converts it not into an aperture but into a slit. Attempts at instrumentation cause the tube or esophagoscope to pass into the blind sac and may easily lead to perforation with serious mediastinitis. The author has seen 4 cases of this.

Besides obstruction, complication of an esophageal diverticulum of the pulsion type may be produced by the development of a carcinoma in the wall of the sac. One may be suspicious of this diagnosis when blood tinged mucus is expelled from the sac or x rays show the sac edges to be irregular instead of having the usual sharp clear outline.

Dilatation is the only nonoperative treatment of pulsion esophageal diverticula and is applicable only to the stage 2 type. It is impossible in stage 3 and of doubtful value in stage 1. While dilatation in stage 2 may lessen the obstructive symptoms, it does not delay the increase in sac size, allay the noises, or prevent the danger of food or mucus in aspiration. All dilatations should be done by passing a bougie over a string previously swallowed.

In the differential roentgen diagnosis of a pulsion diverticulum one must consider a high esophageal web, a high stricture of the esophagus, or a scar of a previously removed esophageal diverticulum. The distinguishing feature of a true diverticulum is the demonstration of its body and neck, and the spill over into the true esophagus of the thin barium mixture after the sac is filled. In the lateral view the

thin line can be seen running from its neck down behind the sac, while in a spherical dilatation the thin line will emerge from the bottom.

The most desirable time to operate on a patient with an esophageal diverticulum is in the early portion of stage 2. At this time the sac is small, there are no inflammatory adhesions, there is a good neck, the opening in the esophagus is small, sac dissection is not difficult, and the patient is free of obstructive symptoms which may affect his health. The second stage of the operation is carried out without difficulty at this time and there is less likelihood of recurrence. Operation during the third stage with a large sac is complicated by inflammatory adhesions, adherence of the sac to the posterior aspect of the pleura, a large rigid mediastinal cavity, the necessity of implantation of the sac on the neck, and a large opening in the esophagus which must be closed.

The patient is fed for 7 days through a Levine tube introduced into the stomach through the nose. Healing usually occurs by primary intention but with large sacs occasional leakage may occur.

These wounds close by granulation and there is no danger of mediastinitis or fascial plane cellulitis when a 2 stage operation is done.

The author first operated upon these cases under local cervical block, but now he uses general anesthesia entirely, mainly ethylene, given with an intratracheal tube. The advantage of being able to find the sac under local anesthesia more easily is far overbalanced by the discomfort of the patient during the long operation.

The author stresses exposure and recommends a longitudinal incision parallel to the anterior border of the left sternocleidomastoid muscle extending from above the level of the junction of the superior thyroid artery and the external carotid down to the sternal attachment of the sternocleidomastoid muscle.

After the incision is made and the platysma cut, the anterior edge of the sternocleidomastoid is freed from the underlying prethyroid muscles. When it is retracted the anterior belly of the omohyoid is identified. This is ligated at its insertion and tendinous part, a d removed. The internal jugular vein is exposed and the inferior thyroid veins passing from the thyroid to it are ligated and divided. When the thyroid is retracted medially the inferior thyroid artery is exposed. This is ligated and divided, as the sac of the diverticulum comes from beneath it (Fig 1b).

The dissection of the sac is then carried out. The sac should be pulled away from the longitudinal esophagus so that the dissection between the inner wall of the sac and the lateral wall of the true esophagus can be carried accurately up to the neck of the sac. This is extremely important. In order to be sure one has completely accomplished the dissection of the neck of the sac, this dissection must be carried completely around the neck until the pale white membrane of the submucosa is shown (Fig 2a).

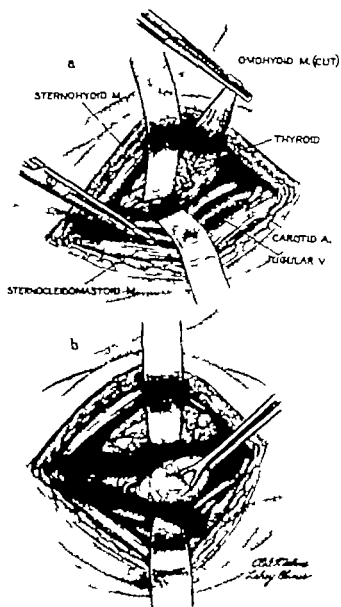


Fig. 1. (Lahey) a, Note in this illustration that the omohyoid has been severed at its tendinous portion and the point of insertion is not shown in this illustration as clamped. The anterior belly is, however, to be removed. Note the retractor pulling the thyroid inward and the retractor ready to pull the common carotid and the internal jugular outward. b, Note in this illustration the inward retraction toward the midline and the outward retraction of the large vessels. The diverticulum sac is completely dissected from its attachment to the longitudinal esophagus and pulled upward. Note the remaining circular fibers of the cricopharyngeal or inferior constrictor muscles about the lower angle of the sac neck. These are to be severed.

There is a tendency for the inexperienced to stop short of complete dissection of the lower angle of the neck of the diverticulum sac. The use of a Berens-Beebe loupe will magnify the field and aid in dissection. If this angle is not completely freed the resulting shelf or ledge will catch food and throw it into the incompletely removed sac which will result in a recurrence.

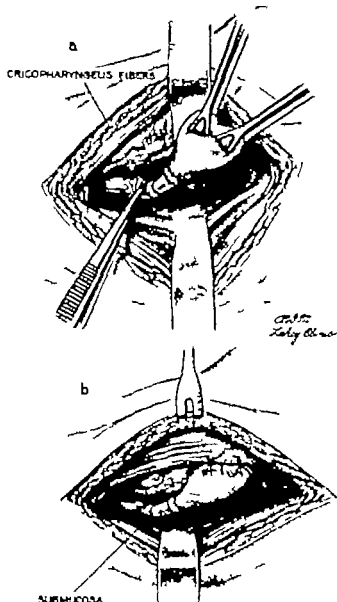


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Dissection of the sac on the right side often is very difficult because it cannot be visualized. There is great danger of unwittingly making a hole in the sac neck at this time. If there is any difficulty or uncertainty about the safety of the procedure, the freeing of the right side should be delayed until the second stage when it can be done just as easily.

Each of these stages has its own group of symptoms. Stage 1 usually has no symptoms. An occasional lodging of a dry piece of bread or cereal within the bulge results in attempts to dislodge it by hawking. Operation at this time is neither necessary nor advisable.

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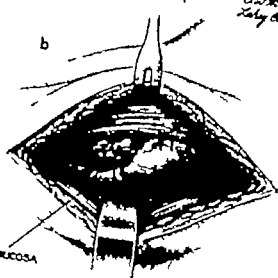
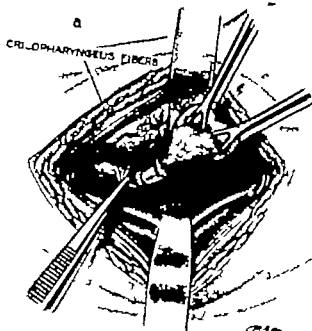
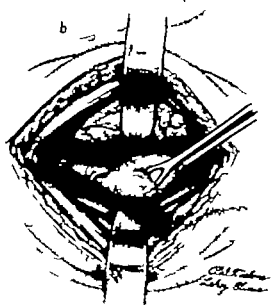
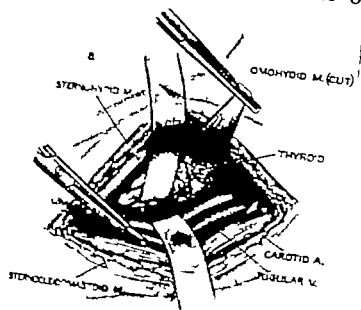


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Dissection of the sac on the right side often is very difficult because it cannot be visualized. There is great danger of unwittingly making a hole in the neck at this time. If there is any difficulty at all, certainly about the safety of the procedure, the freeing of the right side should be delayed to the second stage when it can be done just as easily.

There is a tendency for the inexperienced to stop short of complete dissection of the lower angle of the neck of the diverticulum sac. The use of a Berenson Beebe loupe will magnify the field and aid in dissection. If this angle is not completely freed the resulting shelf or ledge will catch food and throw it into the incompletely removed sac which will result in a recurrence.

with the added safety that the fascial planes and mediastinum are sealed off. When the sac is completely dissected it is implanted in the wound and in the neck for 7 or 8 days if large. If small its tip is sutured high up to the outer edge of the sternohyoid muscle, care being taken not to put a needle through the wall of the sac.

If the mediastinum has been widely opened a good sized pack is introduced into it and carried up along the edge of the esophagus to the level of the neck of the diverticulum. This is removed 4 days later. Care must be taken not to angulate the esophagus during implantation of a large sac in the wound.

The second stage of the operation can best be undertaken from 7 to 9 days later. As the wound is reopened the finger can be inserted in the old drainage canal and this permits easy separation of the granulation covered internal jugular vein and common carotid artery from the prethyroid muscles, thyroid, and esophagus.

The black silk sutures anchoring the sac to the prethyroid muscle are located and the sac is severed from its attachment. Its neck is easily wiped out with gauze. When the neck has been well freed at the first operation its relation to the true esophagus is easily established at the second operation. In patients with a small sac and narrow neck it can be doubly ligated with chromic catgut flush with the

esophagus. The neck of the sac distal to the ligatures is clamped and the neck severed. A small amount of sodium sulfathiazole is placed over the ligated neck, a cigarette drain layed over this and the wound reclosed.

The author advises complete reopening of the wound at the second stage since closure of the sac posterior to the esophagus may be very difficult. In every case the Levine tube should be inserted through the nose into the stomach at the time of the second operation. All feeding should be maintained for 7 days through this tube to allow the closed esophagus to heal by primary intention.

In suturing a large sac opening in the true esophagus one should be careful not to narrow the esophagus. In one's enthusiasm to get rid of the entire sac, part of the right lateral wall of the esophagus may be pulled over and sutured to the left side this would narrow the esophagus. A drain is inserted into the mediastinum and along the edge of the esophagus for 4 days.

The author has had 3 deaths among 209 cases. The mortality, hospital stay and recurrence rate of the one and two-stage methods are about the same. The author prefers the two-stage method because of the safety from mediastinitis and fascial plane infections when occasional leakage occurs.

ROBERT R. BRIDLOW, M.D.

# SURGERY OF THE ABDOMEN

## GASTROINTESTINAL TRACT

Jones, C. M.: Symposium on Gastrointestinal Bleeding. Diagnostic and Therapeutic Considerations of Gastrointestinal Bleeding. *N England J M* 1946, 235 773

Any consideration of bleeding from the gastrointestinal tract holds the immediate implication that the problem may be either medical or surgical. This is of primary importance and must never be forgotten, either in the discussion of the general problem or in the making of decisions in the individual case.

Because of the possible necessity of surgical intervention, gastrointestinal hemorrhage must invariably be considered from three distinct points of view. It must be thought of in terms of the actual site of the bleeding which implies the necessity for accurate diagnosis whenever possible. The mechanism underlying the hemorrhage must also be carefully evaluated so that proper therapeutic measures may be decided on. The third consideration is the condition of the patient who is bleeding. Even before diagnostic or definitive therapeutic measures are undertaken, a decision must be made regarding the urgency of the situation in terms of shock and circulatory collapse.

A clear differentiation is needed between abrupt hemorrhage of shock proportions and minor oozing that, in the long run, may lead to more or less serious grades of anemia but is not an immediate threat to life. In major acute episodes, the immediate concern is the safety of the patient. Even under the pressure of exsanguinating hemorrhage, however, selected diagnostic procedures are indicated if successful definitive measures are to be carried out. At the same time, a knowledge of the hazards involved is essential in arriving at a final decision concerning therapy whether medical or surgical.

The author reviews gastrointestinal bleeding in detail and stresses certain important points. Determination of the site and character of the hemorrhage—that is, exact diagnosis—is essential to proper detailed therapeutic measures. Treatment must be directed toward immediate control of the sequelae of massive hemorrhage and subsequently toward adequate cure or management of the underlying cause. To achieve satisfactory results the close co-operation of a well trained roentgenologist and of a competent surgeon is essential.

JOHN E. KIRKPATRICK, M D

Schatzki, R.: Roentgenological Examination in Patients with Bleeding from the Gastrointestinal Tract. *N England J M* 1946 235 783.

Massive hemorrhage from the gastrointestinal tract, particularly hematemesis, is one of the dramatic events in medicine that deeply impress both patient and physician.

The roentgenologist is burdened with the responsibility of finding the source of bleeding in a patient who is often sick and difficult to examine. If there is no clinical hint regarding the location of the point of bleeding—that is, whether it is in the upper or the lower part of the gastrointestinal tract—a scout film of the abdomen and examination of the large intestine should precede that of the esophagus, stomach and duodenum. A careful study of the small intestine forms the last part of the examination. Usually however the type of hemorrhage indicates roughly which part of the gastrointestinal tract is the source of bleeding and the suspected region should be examined first. Massive hemorrhage in the majority of cases arises in the upper part of the digestive tract and the question to be decided first is when the patient can best and safely be submitted to barium and meal studies.

In the past the tendency was to delay such examination for 2 or more weeks since it was thought that one at an earlier date not only endangered the patient, but also because of his precarious condition furnished somewhat unreliable results. In recent years this attitude has changed and the manifold advantages of early roentgenological examination are recognized.

The author has not hesitated to examine the patient shortly after bleeding has stopped or even during bleeding although he does not examine patients in shock. The examination without any palpation is made with the patient in the horizontal position peristalsis and gravity (turning him from side to side) being used as the means of distributing the barium over the inner surface of the esophagus stomach and duodenum. So-called spot films—that is films taken during fluoroscopy at the optimal moment of filling and projection—are taken whenever they are deemed advisable, and are of great help.

The routine procedure in the roentgenological examination of the upper gastrointestinal tract in a patient who has had a recent hemorrhage is described in detail.

Good clinical judgment and common sense are essential in the selection of bleeding patients for early examination. Obviously a patient should not be examined during clinical shock. It is usually unnecessary to examine one while he is actively bleeding. Blood clots that lie in the stomach handicap the proper interpretation of the roentgenograms although they do not prevent the diagnosis of varices of the esophagus of large ulcers of the stomach or of the duodenum. It appears reasonable to wait for a period of at least 24 or 48 hours after an acute massive hemorrhage.

Any patient in whom early examination has not demonstrated the cause of hemorrhage should be re-examined at a later date when palpation is possible and he is permitted to stand. Some bleeding lesions



are better demonstrated during the early examination and others at the later more convenient and more thorough one. In spite of every diagnostic maneuver known to the roentgenologist the source of bleeding in a certain number of cases will remain obscure.

A few examples have been selected to demonstrate the problem with which the roentgenologist is confronted in dealing with a bleeding patient. A large number of other lesions especially those in the small intestine and colon have been omitted from this discussion.

The roentgenologist plays an important role in the handling of a patient bleeding from the gastrointestinal tract. In most cases he is burdened with the responsibility of demonstrating the anatomic lesion that has caused the hemorrhage and to do so it may be necessary to examine every portion of the gastrointestinal tract.

Indications and contraindications for roentgenological examination soon after a rupture during hemorrhage are discussed. JOHN KIRKPATRICK, M.D.

Linn, H. W.: An Analysis of Peptic Ulcer in South Australia, Based on a Study of 1,027 Case Reports. *Med J Australia* 946-949.

The author presents an analysis of 1,027 cases of peptic ulcer admitted to the Royal Adelaide Hospital, Adelaide, Australia during the period between 1930 and 1944. The three main objects of the investigation were (1) to review the incidence, death rate, and symptomatology of peptic ulcer in South Australia, and to see if and where these differ from the findings in other localities; (2) to differentiate between gastric ulcer and duodenal ulcer in the light of etiology and diagnosis; (3) to inquire into the incidence and symptomatology of the combined ulcer and stomal ulcer.

The incidence, death rate and symptomatology of peptic ulcer vary the world over. Duodenal ulcer was found to occur in younger people than gastric ulcer, while the proportion of males to females in both gastric and duodenal ulcer was 7 to 1. In the case of ruptured gastric ulcer males predominated in the ratio of 10 to 1 and for ruptured duodenal ulcer 18 to 1. The author is convinced that both gastric and duodenal ulcer are produced by the same etiological factor and that the variation in incidence and rupture rate between males and females may be due to a combination of varying anatomic and physiological factors with differing external and predisposing causes.

The all-over mortality rate was 8.0 per cent. Of these 82 fatal cases, 40 deaths occurred as the result of chronic ulcers, 39 of the patients had had ruptured ulcers and 3 had had acute erosions of the stomach or of the duodenum. In the entire series of 1,027 cases there were 159 ruptured ulcers and 763 chronic ulcers. It can be seen therefore, that the mortality rate for the former is very high.

Fifty per cent of the patients in this survey were alcohol drinkers. This fact would appear to rule out

the regular use of alcohol as a major cause in the etiology of peptic ulcer although it is undeniably the cause of some recurrences of symptoms. Eight per cent of peptic ulcer patients smoked tobacco, but most men in the community do so also hence smoking must be eliminated as a primary factor especially since 20 per cent of patients were nonsmokers. However in a susceptible subject there is no doubt that tobacco is an added irritant. Etiologically no difference could be found between duodenal and gastric ulcer.

Conspicuous by their absence in this survey are references to psychosomatic factors, recurrences coincident with economic and emotional crises, and seasonal variations in incidence. Ruptured gastric ulcer is twice as common as ruptured duodenal ulcer in South Australia, while the author states, the reverse is the case elsewhere.

The results of test meal examinations reveal a lower incidence of hyperchlorhydria, and a higher incidence of hypochlorhydria and achlorhydria than is usually expected. So much was this so that in any one case the result of the fractional test meal examination could not be taken as an aid in the diagnosis. 30.6 per cent of patients with chronic peptic ulcer who had undergone a previous gastroenterostomy were found to have a stomal ulcer during the 6 years of investigation.

The author makes a plea for similar inquiries to be undertaken in large centers of population elsewhere. HAROLD LAUTMAN, M.D.

Wick, A. H.: Conservative Treatment of Acute Perforated Peptic Ulcer. *Brit. J. Surg.* 1946, 3: 94.

A gradual trend towards conservatism has occurred during the past 25 years in the management of acute perforated peptic ulcer. Having noted the frequency with which upon laparotomy the perforation were found to be already sealed off by adhesions and having observed several times during the course of some 400 gastrectomies the presence of dense sheets of adhesions which were interpreted as being the spontaneous closure of previous perforations, the author followed the lead of Bedford Turner who, in 1915 reported a series of 6 cases of acute perforations which were treated nonoperatively.

During the past year the author has treated conservatively a total of 14 consecutive unselected cases of acute perforation, including 12 duodenal ulcers, 1 gastric ulcer and 1 stomal ulcer. Essentially the treatment consisted of the complete relief of pain by adequate morphine dosage, the prevention of further leakage by intermittent gastric aspiration, and the administration of intravenous sulfathiazole. Upon discharge 11 of the patients were symptom free, although 1 patient subsequently required drainage of a subphrenic abscess, and 1 had a recurrence of severe pain within a month. Two patients died of pneumonia and 1 patient died of subphrenic abscess and uremia.

The author concludes that there is justification for the further trial of conservatism in the treatment

of acute perforated ulcers and pleads that this perforation may be anticipated and prevented by more urgent surgical treatment of chronic peptic ulcers causing severe symptoms

WAYNE CAMERON M D

Greengard H Atkinson A J Grossman, M I and Ivy A. C.: The Effectiveness of Parenterally Administered "Enterogastrene" in the Prophylaxis of Recurrences of Experimental and Clinical Peptic Ulcer *Gastroenterology* 1946 7 615.

A method is described for the preparation of an enterogastrene concentrate of uniform potency and suitable for parenteral injection in the human being. Therapeutic trial on 43 Mann-Williamson dogs and on 58 patients suffering from proved peptic ulcer over a period of years has demonstrated the probability that the material is effective in preventing recurrences during the period of its administration and for some time thereafter as yet of undetermined length.

Röntgenological examination at the inception of treatment revealed that 57 of the patients had duodenal ulcers, 4 had postoperative jejunal lesions, 2 had gastric as well as duodenal ulcers, and 1 patient had a gastric ulcer. Many of the patients reported symptomatic relief within a few days after the injections were begun and most of them were free of distress after 2 weeks. In the remaining few approximately 3 months elapsed before relief from pain and distress was complete. In most instances an interval of from 2 to 5 months was required before evidence of improvement in the condition was manifest on x-ray examination as interpreted by a trained radiologist.

The protection afforded cannot be explained on the basis of the action of enterogastrene in inhibiting gastric secretion and the true nature of the agent concerned cannot be defined at present.

CHARLES BARON M D

Bruer G J: The Surgical Aspects of Hemorrhage from Peptic Ulcer *N England J M* 1946 235 777

There is a related group of patients who have massive, and sometimes fatal, hemorrhage but who fail to present a demonstrable ulcer. This group of patients has been a particularly discouraging one. Pathologically the information regarding the source or sources of hemorrhage has been meager. At autopsy the pathologist has generally speaking failed to find an ulcer or other causes of hemorrhage.

A study of 337 patients admitted to the hospital because of massive hemorrhage due to peptic ulcer is presented. Of these, 27 (8 per cent) died from hemorrhage—18 without having been subjected to operation, and 9 following operation performed on 31 patients during active bleeding.

On the surgical ward service of the New York Hospital, 49 (15 per cent) of all patients admitted with massive hemorrhage presented a fatal type of hemorrhage and in all probability would have died without the intervention of surgery.

Two hundred and eighty-eight patients (86 per cent) who were admitted because of hemorrhage recovered without immediate or early surgical intervention.

In patients with the fatal type of hemorrhage the location of the ulcer, if duodenal, is on the posterior duodenal wall, and if gastric, on the lesser curvature. The blood vessels causing the hemorrhage are the pancreaticoduodenal and the right and left gastric arteries or their major branches.

In an attempt to differentiate patients with fatal and nonfatal types of hemorrhage the most consistent criteria are failure to improve promptly under a strict regimen of bed rest, moderate doses of morphine, the withholding of fluids and food by mouth, adequate blood transfusions and the recurrence of hemorrhage while the patient is on a strict regimen.

If operation to save life is decided on it should be done within 24 or 48 hours of the onset of hemorrhage. The mortality in patients operated on early was 50 per cent, whereas that in patients operated on late (after 48 hours) was 70 per cent.

Large amounts of blood administered as transfusions before, during and after operation are of great value in operations performed for the control of hemorrhage.

Local ligation of the vessels giving rise to hemorrhage, has not consistently and permanently controlled hemorrhage. Local excision of the bleeding ulcer and gastric resection including removal of the ulcer have given the best results.

In patients who recover from hemorrhage on a strict medical regimen the question of recommending surgery or of continuing a medical regimen is vital. No definite criteria for differentiating those who should be subjected to surgery and those who may properly be continued on a medical regimen have been developed. On the other hand the occurrence of repeated hemorrhages, the chronicity and unfavorable location of the ulcer and failure in the past to respond to a medical regimen in persons over 50 years of age, are factors indicating surgical treatment.

JOHN E. KIRKPATRICK M D

Hollander F: The Insulin Test for the Presence of Intact Nerve Fibers After Vagal Operations for Peptic Ulcer *Gastroenterology* 1946 7 607

This report contains a detailed description of a physiological test for the presence of intact vagus nerve fibers in ulcer patients following any operation designed to interrupt all vagal stimuli to the stomach. The clinical success or failure of such operations is not discussed in this report. The test is based on the production of a degree of hypoglycemia of 50 mgm./100 c.c. or lower. To produce such a hypoglycemia 25 units of insulin are administered intravenously and its production must always be proved by a series of blood sugar determinations. A fractional gastric analysis is performed to determine whether the resulting vagal stimuli set up centrally are able to evoke any secretory response from the stomach.

The validity of this procedure for the purpose stated is supported by evidence derived from studies on dogs with a gastric pouch and on patients.

A positive response to the insulin test—consisting of a distinct rise in the curve for free acidity of the gastric aspirates, accompanying the production of an adequate hypoglycemia—indicated that some uncut para sympathetic fibers still connect the vagus center in the medulla with the stomach. This acidity curve affords no indication of the proportion of such fibers which remain intact reasons for the qualitative character of the test are discussed. A negative response is suggestive but not necessarily conclusive proof that all the vagal fibers which pass to the stomach have been interrupted. First of all, there must be no doubt that an adequate hypoglycemia had been attained and that neither a permanent nor a temporary acidity was present as shown by a fractional analysis with a suitable test meal. Second, in the presence of a gastroenterostomy or a subtotal resection of the stomach the intestinal regurgitation may neutralize a small acid output and thus mask a true positive response.

Such an equivocal result can frequently be resolved by a repetition of the insulin test especially if the dosage of insulin be increased somewhat. Only after these possibilities have been eliminated can a negative response be interpreted to indicate the presence of no uncut vagal fibers.

CHARLES BARON, M.D.

Sarnek Ludovici, E.: Malignant Lymphogranuloma of the Stomach (Linfogranuloma maligno dello stomaco). *Minerva med. Tor.* 1946 37 315.

The author adds a case of primary lymphogranuloma of the stomach to the 62 reported cases. This condition occurs chiefly in middle life and clinically is almost indistinguishable from cancer. The symptoms include epigastric pain appearing 2 or 3 hours after eating, often accompanied by nausea, vomiting, anorexia nocturnal sweats, and weight loss. Achlorhydria may be present, hematemesis and melena may also occur and lead to death. A generalized brooding of the skin is sometimes observed, with a secondary anemia. The leukocyte count is variable, with eosinophils up to 14 per cent. The temperature is apt to be low. The roentgenological picture closely simulates carcinoma but may show thickened gastric rugae or even concomitant foci in the stomach and intestines suggestive of lymphogranuloma.

The case reported was that of a 60 year old woman in whom the diagnosis of carcinoma was made. Gastric resection was performed and the typical tissue of Sternberg was found to be replacing the mucosa and widely infiltrating the muscular layer. The post-operative course was uneventful and the patient was treated with arsenicals with satisfactory results until 3 months later at which time the symptoms reappeared and a mass was discovered in the epigastrium. Death occurred 3 months after surgery.

EDITH B. FARKSWORTH, M.D.

Höyer, A.: Ulcus Simplex Jejuni. *Acta chir. scand.* 1946 94 350.

About 100 cases of simple ulcer of the small intestine have been reported in the literature. In 51 of these, the ulcers have been localized in the jejunum. Dyspepsia and frequently melena are the essential symptoms and the condition is rarely recognized prior to perforation. Grossly simple ulcer of the small bowel is similar in appearance to ulcer of the stomach or duodenum. The etiology of the condition is unknown, and by definition, ulcers associated with tumor, syphilis, tuberculosis, foreign body, Meckel's diverticulum and postoperative jejunal ulcers are not included in the group.

In the present article the author reports an additional case of perforated ulcer simplex jejunal which, following excision and suture of the defect, went on to uncomplicated recovery.

WAYNE CAMERON, M.D.

Wilbur, D. L., and Camp, J. D.: Amebic Disease of the Cecum: Clinical and Radiological Aspects. *Gastroenterology* 1946 7 335.

The present report comprises the cases of amebiasis of the cecum observed at the U. S. Naval Hospital, Oakland, California. The authors suggest that with the return of military personnel from areas in which people are heavily infected with amebiasis, it is important that clinicians and roentgenologists be on the alert for signs of this disease.

The syndrome varies widely and masquerades with a variety of clinical pictures resembling those of almost all types of cecal and appendiceal lesions. Symptoms may be absent. In such cases a diagnosis usually had previously been made of acute appendicitis, appendiceal abscess or carcinoma of the cecum. It is important to rule out the erroneous diagnosis of acute appendicitis in such cases because of the disastrous results of surgical therapy in the presence of amebiasis. The mortality of such therapy incident to the Chicago epidemic of 1933 was 40 per cent.

The significant roentgenological changes in the cecum consists of spasm, dilatation, relaxation and abnormal patency of the ileocecal valve, inflammatory ulceration with "coning," and inflammatory tumefactive defects. The earliest lesions are those involving the mucosa and the cecal walls lose their sharp, smooth character and are replaced by a finely granular or irregular contour of the mucosa, which may be associated with varying degrees of cecal spasm.

Cecal lesions of amebiasis were found by barium enema studies in 9 of 37 patients with stools which, on routine examination, contained cysts or trophozoites of ameba histolytica.

In the experience of the authors the most valuable method of examination was the roentgenological study of the colon, whether or not symptoms were present or the stool examination was positive. Roentgenological examination was particularly useful in indicating the diagnosis of amebiasis in patients with a history suggesting previous disease of the appendix, and in those with hepatitis or otherwise un-

explained enlarged livers with abscesses of the liver when amebæ or cysts could not be found in the stools or pus

HAROLD LAUFMAN M D

Tashiro, S. and Zinninger M M Appendicitis:  
A Review of 936 Cases at the Cincinnati General  
Hospital Arch Surg 1946 53 545

The present report is the third one in the authors review of a series of cases of acute appendicitis treated at the Cincinnati General Hospital Cincinnati Ohio, since 1915 and covers the five year period from 1939 through 1943

The incidence of acute appendicitis without perforation showed an absolute and relative increase and the incidence of perforation showed a corresponding and gratifying decrease. A reduction was also noted in the use of catharsis and in the time elapsing between the onset of symptoms and admission of the patient to the hospital. However negro patients as a group were admitted to the hospital at a significantly later period of illness than white patients and as a group showed a higher incidence of catharsis. The McBurney incision has been the customary approach to the appendix at this clinic for a number of years. The question of drainage remains unsettled. The incidence of pelvic abscess was greater in patients with perforation when the peritoneal cavity was not drained but the mortality in this group was lower

The mortality among patients with acute appendicitis without perforation was 0.49 per cent as compared with mortality figures of 0.80 per cent and 1.03 per cent for the first and second series reported from this hospital. The mortality among patients with perforation and generalized peritonitis was 13.77 per cent as compared with 33.9 per cent and 17.2 per cent reported among patients in the two preceding reviews. The mortality for the group with abscess formation was 4.3 per cent as compared with 11.4 per cent and 10.1 per cent for cases included in the first and second reviews.

Penicillin was not used in any case of appendicitis included in this report. Sulfonamides were given to 114 of the 167 patients with perforation and generalized peritonitis with a mortality rate of 11.3 per cent as compared with 18.8 per cent in the untreated group. The mortality among 93 patients with appendicitis and abscess formation was 4.5 per cent and 4.1 per cent respectively for the treated and untreated groups.

The reduction in mortality reflected in this review is attributed at least in part, to an intensive educational campaign begun in Cincinnati in 1934.

EDWARD W. GIBBS, M D

Simpson, D. G. Acute Appendicitis in the Aged  
Brit. M. J. 1946 2 986.

The author states that from 1 to 2 per cent of all cases of acute appendicitis occur in patients over 60 years of age and the mortality in this group is from 25 to 30 per cent. The signs and symptoms in elderly persons are considerably different from the usual

clinical picture in younger patients. With advancing years, the structure of the organ has altered the lymphoid tissue has largely disappeared and fibrous atrophic changes associated with vascular changes are present that cause an inability of the circulation to respond to the demands of inflammation. Hence the devitalized appendix, when subjected to obstruction by a fecolith soon perforates. As the omentum and peritoneum frequently lack their 'pristine ability' to localize the infection, general peritonitis results and a fatal termination is common. Thus the usual sequence of events in appendicitis is altered pain though nearly always present is poorly localized and only becomes intense with the onset of peritonitis. As constipation is frequent, the pain is often misinterpreted as due to this. The general reactions of nausea and vomiting, fever, and elevated pulse rate are not found, and the localizing signs of rigidity and tenderness, and pain on rectal examination are vague and inconclusive or absent. As a result the patient neither feels nor appears ill, and frequently delays seeking advice until peritonitis has developed.

With the onset of perforation pain, distention, vomiting and fever appear and particularly with the presence of a mass an incorrect diagnosis of intestinal obstruction may be made. In one series the obstruction was 38 per cent. Elevation of the white count is of help in the differentiation.

In the operative treatment it is recommended that incision be made in the right iliac fossa rather than near the midline to minimize peritoneal contamination. Where the diagnosis is in doubt this route may be utilized well for the performance of a cecostomy to relieve obstruction of the large bowel.

An illustrative case at the age of 85 with survival is discussed.

WATKIN CAMERON M D

Cohen S E., and Matthews B L. Diverticuli of the Colon  
Surgery 1946 20 823

Attention is called to a type of diverticulum of the colon which heretofore had not been described. The patient underwent a resection of the left colon for what was thought to be an obstructing carcinoma. The specimen revealed, in addition to the usual sacculations of diverticulosis, one long (9 cm.) diverticular structure which had apparently burrowed within the muscular structures. Microscopically the sinus space was lined with a chronic vascular granulation tissue with occasional remnants of mucosal glands still present.

The authors interpret this type of intramural saccululation as a diverticulum which had its progression through the wall arrested, was turned distally and then was propelled isoperistaltically within the wall of the bowel. When this cavity became filled with feces or gas, the patient developed signs of obstruction. The cloaca of the intramural diverticulum was edematous thereby apparently causing closure and a ball valve or tension mechanism. The authors apply the term diverticuli (intramural) diverticulitis of the colon to this lesion.

HAROLD LAUFMAN M D

Ochaner, A., and Hines, M. O.: Carcinoma of the Colon: Analysis of 113 Cases. *South S. J. Surg.* 1946 12: 269.

The etiology of colonic carcinoma as in carcinoma elsewhere, is not known except that in many instances the malignant neoplasm originates in solitary or multiple polyps. It is the belief of the authors that congenital polyposis is so definitely premalignant that carcinomatous change is prevented only by removal of the involved bowel or the relatively early development of carcinoma is inevitable. Sites at the flexures which are relative points of fixation are thought to be factors in producing malignant changes in these areas.

Carcinomas of the colon and the rectum are adenocarcinomas and may vary considerably pathologically from a large bulky fungating mass which is likely to be found in the cecum to a relatively small cicatrizing lesion producing complete obstruction of the bowel which is found most frequently in the left colon particularly the sigmoid or to a small polypoid tumor with no encroachment on the bowel lumen. A relatively infrequent type of rectal and colonic carcinoma is colloid adenocarcinoma in which there is an overproduction of gelatinous material. Colloid carcinomas although they occur infrequently are of significance because they usually offer a relatively poor prognosis. As a matter of fact gelatinous tumors of the rectum have been considered by Miles as not being curable by any known means. This entirely pessimistic viewpoint is rarely justified however even though the prognosis is bad.

Gilchrist and David showed that lymphatic involvement in these lesions is much more extensive than commonly considered. By employing a special technique in which the involved bowel and the lymph bearing areas were cleared according to the technique of Spalteholz, they were able to demonstrate malignant involvement of a large number of lymph nodes. The size of the tumor also had little influence on the number of nodes involved. Although the extension is generally upward in cases in which there is blockage of the normal lymphatic drainage retrograde extension may occur. Tumors at the level of the levator ani have a double drainage, i. e., upward along the superior hemorrhoidal artery and also laterally along the superior surface of the levator ani muscle. There can also be direct extension through the bowel and beyond the bowel to the surrounding and adjacent structures. Hepatic metastases must always be considered because of the possibility of the tumor cells getting into the portal system and being carried through that system to the liver.

The sexual relationship in large bowel carcinomas varies according to different statistics. In the authors' 113 cases, 52 (45.6%) were males and 61 (54.4%) were females.

The contents of the right colon are fluid, whereas the contents of the left colon are solid. Because tumors of the right colon are bulky and fungating, but do not produce a great deal of narrowing of the

lumen obstruction is relatively infrequent. On the other hand because left-sided lesions are cicatrizing, particularly those in the sigmoid and because the contents of the left side of the colon are inspissated, constipation is a relatively early manifestation. The passage of blood and mucus, an unexplained anemia, in an individual who otherwise is well and who has no symptoms, may be caused by a fungating, ulcerating tumor in the cecum.

The complaint of hemorrhoids or any other rectal disorders requires thorough investigation, because most rectal carcinomas have associated hemorrhoids. In all rectal complaint a malignancy must be considered first. Most rectal lesions are within the last six centimeters of the anus, and these lesions can be detected usually by the examining finger. By means of proctoscopy or sigmoidoscopy it is possible not only to visualize lesions in the rectum and sigmoid but also to obtain biopsies of the tumor.

Röntgenography is of little value in low-lying lesions. Fluoroscopic visualization of the filling of the bowel is essential. All patients with colonic and rectal carcinoma should have double contrast studies in addition to the ordinary roentgenogram following a barium enema.

The treatment of rectal and colonic malignancies might be divided into two types, the preventive and curative. Since many if not the majority of colonic malignancies begin as benign polyps, the recognition of these benign lesions and their complete removal will prevent the development of a cancer. If the polyp is located in the rectum, below the peritoneal reflection it can be removed through the proctoscope. Those lesions above the reflection of the pelvic peritoneum should be operated upon transabdominally and the polyp removed. The curative treatment of colonic and rectal malignancies consists of complete removal of the involved segment of the bowel together with the possible sites of extension both the direct and the lymphatic extensions.

In the presence of obstruction, decompressive procedures must be done as early as possible in preoperative preparation. If this is not done the danger of perforation of the cecum which is the most vulnerable site in a colonic obstruction, is considerable. After the performance of a decompressive cecostomy or colostomy sufficient time must be allowed to elapse for the acute inflammation to subside and for the gut to regain its tone before any resection of the involved segment is attempted.

After the relief of acute obstruction, it is important to re-establish the normal nutritional status. Since many of these patients have lost weight and have been ill for some time they are likely to have a contracted blood volume with resulting hemoconcentration. The ordinary blood studies give false values because they do not represent the amount of the total circulating blood constituents. Sufficient whole blood to re-establish the normal levels of cellular elements, hemoglobin, and protein should be given before operation is contemplated.

# SURGERY OF THE ABDOMEN

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Sulfasuxidine and sulfathiazine have been used in the preparation of these patients. Neither of these substances is absorbed readily from the intestinal tract the latter is effective in relatively small amounts

Whenever possible the operative procedure and anastomosis when done should be carried out aseptically. In abdominal perineal resections the operation is performed almost entirely aseptically, because the bowel is divided by means of the actual cautery between clamping. The clamp on the proximal end of the distal bowel is small enough so that it can be shoved down in the hollow of the sacrum together with the mobilized sigmoid and rectum without any contamination. The obstructive resection is done aseptically and also it is desirable when possible to perform a 'septic' anastomosis when a primary anastomosis is made. In the author's series a resection formed in 37 cases of which 17 (62%) were performed aseptically and in 10 (37%) an open anastomosis was used

Spinal anesthesia was preferred and used with very few exceptions. In the case in which there is some question concerning the resectability or operability of a case in this way it is not preferred because acting in this way it is not preferred because the incision used for right-sided lesions is either a long paramedian or transverse incision. A transverse incision is used for lesions of the colon acting for splenic flexure and descending colon. A transmedian one which permits a better access to the pelvis. In all right-sided lesions, a right colectomy is done. Unless there is a great deal of inflammatory reaction with fixation of the tumor to the abdominal parietes a one-stage resection of the right colon is preferable. In the one-stage procedure resection of the right colon followed by an end-to-side ileotransverse colostomy is done as a preliminary procedure later the right colon is removed

Lesions of the transverse colon the splenic flexure descending colon and sigmoid are treated by resection with end-to-end anastomosis or by obstructive anastomosis performed preferably with end-to-end aseptic technique is better than obstructive resection because of the shorter convalescence and the more complete removal of the bowel and its mesentery. In 42 of the abdominal resections was done with colonic resection was done and an obstructive resection in 15 cases an aseptic technique was used in 17 and an open anastomosis in 10

Although the authors resect and re-establish continuity of the bowel in sigmoidal lesions with the exception of those at or near the rectosigmoid junction, they believe that this procedure is not justified in the low-lying lesions. They have used it in only one patient in whom a primary anastomosis

was done for a rectosigmoidal lesion. Fortunately it was the first case in which the conservative procedure was done, and although it is believed that a fatality occurred unnecessarily in this case it is the authors opinion that had an abdominoperineal resection been done originally the man would probably be sitting the taking of an enema every 2 or 3 days is a relatively cheap price to pay for the cure of a malignant disease as contrasted with the price of a few months to a year a normal sphincteric control to be paid for with one's life

Wide resection of the mesentery and the lymph bearing area is essential. High ligation of the superior hemorrhoidal vessels and removal of the accompanying lymph nodes is necessary in rectosigmoidal and rectal lesions

In 103 of the authors cases, the tumor was graded according to Broder's classification, grade I 12.6 per cent grade II 51.4 per cent grade III 36.8 per cent grade IV 1.9 per cent

In the entire group of 113 cases 96 resections were done (84.8%) 125 (92.8%) left the hospital alive whereas 8 (7.1%) died in the hospital. The mortality rate following operation for cancer of the colon varies according to the location for cancer of the colon varies according to the location for cancer of the colon which a portion of the left colon was removed for cases as a palliative procedure. In 30 cases in which rectosigmoidal resection was resected (in 4 procedures) there were 2 deaths (6.6%). In 48 cases as an abdominoperineal resection was done usually were 2 deaths (4.1%). Although there may be some question about the advisability of a palliative resection in malignant lesions of the colon and other viscera this procedure seems perfectly justifiable to us because not only is the patient relieved of the tumor of the bowel but following the removal of a primary tumor the growth of metastatic lesions is less rapid than before the extirpation of the original tumor

In the authors series of cases the resectability of lesions in the right colon and those of the rectosigmoid were approximately the same 81.8 per cent and 84.3 per cent respectively. The resectability of lesions of the left colon exclusive of the rectosigmoid and rectum was 65 per cent, due to the fact that in this group extension to the abdominal parietes was present in a much higher incidence which many times precluded resectability

Although re-establishment of the continuity of the bowel in low-lying lesions has become a popular procedure the authors believe that in any lesion except the extremely small ones in which there can be no extension distally abdominoperineal resection is the operation of choice, and that as long as attempts are made to preserve the sphincter the recurrence rate and death rate from carcinoma will continue to be high

L. F. PUTLICK M.D.

D Allaines, F. and De Vernejoul, R.: Conservation of Sphincter Function in the Operative Treatment of Rectal Carcinoma (Conservation de la fonction sphinctérienne dans la cure opératoire du cancer du rectum) *J. chi. Par.* 1946, 62: 374.

In rectal carcinoma one of two operations can be done: either the mutilating amputation, or resection of the rectum with conservation of the sphincters. A considerable number of surgeons reject the resection because of the supposedly greater risk of recurrence. However, the recent work on the anatomy of the lymphatics makes it possible, in appropriate cases, to conserve the sphincter without increased danger of metastases or recurrence. Of equal importance is an exact knowledge of the anatomy of the nerves of the sphincteric apparatus.

Although the resection is by far preferable to the amputation, it is applicable only under certain conditions. The resection should be as extensive as possible, at least 15 cm. above the superior border of the tumor and at least 5 cm. below the inferior border. As a certain portion of the anal canal should be left intact to assure a good functional effect, the operation is possible only if the inferior border of the tumor is at least 9 or 10 cm. distant from the anus. It is important to save not only the sphincter muscle and its nerves but the mucous membrane, if possible, to an extent of at least 4 cm. as the mucosa possesses a specific sensibility indispensable for the mechanism of continence. Only if the resection has to be done rather close to the sphincter must the mucosa be sacrificed (technique of Hochenegg, modified by Babcock and Bacon).

Another point of great importance is the radical ablation of the lymphatics. The recent literature on the invasion of the lymphatics in rectal carcinoma indicates that they have to be examined and removed, often as far as the inferior mesenteric trunk.

The authors discuss the different methods of conservative operation: abdominal, transsacral coccygoperineal, transanal, and transvaginal resection. In the transanal and coccygoperineal methods it is essential to conserve the motor nerves of the external sphincter at least on one side. A number of statistical papers are quoted to show that resection gives better results than amputation of the rectum, not only functionally but also with regard to the post-operative mortality and the incidence of recurrence and metastases.

WERNER M. SOMMER, M.D.

#### LIVER, GALL BLADDER, PANCREAS, AND SPLEEN

Rehfsuss, M. E.: The Etiology of Cholecystitis. *Gastroenterology* 1946 7: 665.

Biliary tract disease is now known to be the most common form of digestive disturbance affecting the upper abdomen in later life, as many as one-half of the individual over 50 years of age are afflicted. There is no unanimity of opinion as to the cardinal factors in the production of biliary tract disease or the mechanism by which they operate. Only by

correlating a large number of careful prospective studies with anatomic and histologic examinations of the organ can we hope to reach more exact conclusions.

Clinical and experimental observations have supported the possibility of several active factors in the etiology of cholecystitis. These are infection, alteration of the gall bladder contents (particularly the bile salts), reflux of the pancreatic juice, lesions of the cystic duct (probably secondary), dissemination of bacteria and their toxins through lymphatic, arterial, or venous channels, and sensitization.

The author briefly cites the evidence for and against each of these factors and reviews the literature pertaining to each one.

The author then describes his work on producing experimental cholecystitis by injecting bacteria. He has demonstrated that every form of human cholecystitis can be obtained by experiments in which bacteria are injected. Histological studies of the experimentally diseased gall bladders show that any or all layers of the wall can be affected; the mucosa and submucosa seem most vulnerable while the muscularis seems to be the least vulnerable. This is true in human cholecystitis. Originally the author was able to produce experimental cholecystitis in only 22 per cent of his series, but later, by altering his technique and giving more frequent inoculations over longer periods, he increased the incidence to 63 per cent. In about 10 years of experimentation he has observed the effects of a single antigen, the nonhemolytic streptococcus, in nearly 700 animals.

It appears that cholecystitis can follow a transient bacterial infection and that subsequent changes emphasize the fact that structural damage of various grades may follow relatively few inoculations. A chronic lesion may result from a single injection if its effect is sufficiently severe. It has been the author's experience that repeated injections over months have resulted in a marked increase in the chronic lesions. If the injections are stopped the lesions may be arrested.

Bacterial infection would seem to be the most likely condition capable of inducing an acute change with tissue destruction in a gall bladder in the absence of calculi. There is no indication that any particular strain of bacteria is to be incriminated in the production of cholecystitis.

In experimental cholecystitis, the antigen is not specific for the gall bladder but may produce lesions in the joints and some of the viscera. The evidence indicates that the bacteria or their toxins may localize in any or all parts of the biliary tract. The author is unable to state the nature of the action, whether it is a protoplasmic poisoning, necrosis of the cells, a profound disturbance in cellular chemistry or enzymic activity.

Therapy of any kind should be directed toward the arrest of the acute lesion and control of the contributing factors by combating infection, regulating the metabolic mechanism, correcting biliary stasis, and preventing additional changes which might fur-

then damage the organ. If these measures fail, we then have recourse to surgery.

The dietary approach is of primary importance in therapy since by reducing the amount of fat in the diet one decreases the demands on the organ during inflammation and infection. Detection of the injurious agent such as infection toxin or allergy and its control are important. The author is convinced that many of the systemic infections, virus diseases and local foci in sinuses and tonsils are important. If these are restrained general systemic resistance is encouraged. Penicillin and sulfonamides aid in controlling acute biliary infections. Carefully supervised vaccine, filtrate and other forms of bacterial therapy should be considered. Many measures to modify the bile entering the gall bladder can be employed. To combat stasis the bile should be fluidified.

The author believes that cholecystitis may be an acute process but it is more likely to be due to mild repeated infections acting slowly upon different parts of the gall bladder wall. Such changes may bring about or favor undue concentration of certain elements of bile or produce a pancreatic reflux. It is also possible that bacterial sensitization may play a role.

ROBERT R. BROZLOW M.D.

Elman, R.: *Surgery in Acute Pancreatitis*. *Gastroenterology* 1946 7 656

Because of the confusion existing in the minds of most clinicians as to whether acute pancreatitis should be treated medically or surgically the author has prepared this article. He defines acute pancreatitis as a primary inflammation of the pancreas sometimes associated with biliary disease but not the type secondary to mumps, diabetes, arteriosclerosis, nephritis or alcoholism. The disease usually has an acute stormy onset with severe abdominal pain in an otherwise healthy individual.

In reviewing the literature on acute pancreatitis the author recognizes three distinct periods. In the early period before 1900, practically all cases were observed at autopsy. Only one type of disease, hemorrhagic pancreatitis, was recognized before death, and the pathological changes were classically described by Reginald Fitz in 1889. In the second period, the early decades of the present century the disease was encountered at operation, often performed without a definite diagnosis. There was a high mortality (50%) and as time went on the trend was toward more conservative treatment. The third period began 20 or 15 years ago when medical treatment was given in view of the high operative mortality.

Much of the confusion in the literature is probably the result of the existence of at least two types of the disease, each strikingly different. Zieppel, in 1922 first described a type of acute pancreatitis not necessarily fatal and not accompanied by necrosis or hemorrhage. The author believes this was an early stage in the development of true pancreatic necrosis which for some reason was aborted. The

findings at operation were confirmed by many later surgeons, and it became obvious that the mortality varied greatly and depended on the type of pancreatic lesion present.

The uncertainty in making a bedside diagnosis of acute pancreatitis has led to difficulty in evaluating results of therapy. It was not until 1929 that the diagnostic use of the serum amylase test established the diagnosis of pancreatitis and tended to clear some of the confusion. It then became clear that many patients with acute abdominal symptoms which subsided rapidly and spontaneously actually suffered from pancreatitis as described by Zieppel. Unfortunately the serum amylase test will not differentiate between the two types of acute pancreatitis mentioned. More accurate data are necessary in order to evaluate the effectiveness of conservative as against operative therapy.

The author reviews his experiences with 17 cases of pancreatic necrosis as shown at autopsy or operation. Of his patients only 1 survived and this patient was operated on. Seven patients entered the hospital with profound circulatory failure and died soon afterward. It was doubtful if any form of therapy would have been successful in this group of patients.

Elman recommends routine serum amylase determinations of all patients with acute abdominal disease. The test takes a little over 30 minutes and shows high values in all patients with acute pancreatitis unless the patient has been sick for many days. Acute parotitis will also give high values. The problem of differentiating acute pancreatic edema from necrosis is not easy. About 80 per cent or more of the cases will prove to be of the interstitial or edematous type or occasionally of the subacute type and such conditions may be expected to subside spontaneously.

The necrotic type may show three clinical features: (1) the appearance of true circulatory impairment or shock, (2) the tendency for manifestations to be those of a spreading perforative peritonitis and (3) the failure of the pancreatic necrosis to subside.

In suspected cases of necrosis operation should be seriously considered unless, of course, conservative therapy is less likely to be followed by a fatal outcome. There is slight evidence that suppurative pancreatitis has occasionally healed without operation but it seems justifiable to assume that extensive necrosis of the pancreas should be looked upon as a perforating lesion leading to suppuration or spreading peritonitis. As such it inevitably would require surgery even if only for drainage of the site of perforation, the lesser peritoneal sac.

Operation to be adequate must provide satisfactory drainage of the pancreas. It is doubtful if any incision into the organ is justified. There is evidence that cholecystostomy diverting bile from the common duct to the outside may be useful. Extensive procedures such as cholecystectomy or common duct drainage prolong the operation and increase the mortality. Operation should be associated with



nonoperative treatment such as gastric suction, both blood and plasma transfusions, and chemotherapy.

The view that acute pancreatitis is universally a nonoperative disease should be abandoned. Operation probably is not indicated in a vast majority of cases. Once the diagnosis is made by the aid of the serum amylase determination each case should be carefully evaluated. Those obviously subsiding present no problem. Should the acute manifestations not subside even though the serum amylase falls, the patient may be suffering from pancreatic necrosis and may require operative drainage of the lesser peritoneal sac. Even patients admitted in profound circulatory shock must be considered as possible candidates for surgical therapy. Just when operation is to be performed cannot be categorically stated, but when pancreatic necrosis is present, operation must be considered to avoid death if possible.

Pancreatic necrosis is to be differentiated from acute edematous pancreatitis and indicates actual destruction usually with hemorrhage into, and gangrene of the pancreatic parenchyma. Fat necrosis may be seen with both types but when this is extensive and involves the greater omentum it is nearly always associated with a true necrosis of the pancreas.

The answer as to whether acute pancreatitis requires surgical or medical treatment must be based on the differentiation between acute pancreatic edema and necrosis. This can be decided only by a careful study of the patient's clinical progress.

ROBERT R. BLOXLOW, M.D.

Whipple, A. O.: Radical Surgery for Certain Cases of Pancreatic Fibrosis Associated with Calcareous Deposits. *Ann Surg* 1946, 124: 991.

The author records 2 total pancreatectomies and 9 other radical procedures with the removal of a large part of the organ for intolerable pain associated with pancreatic fibrosis and calcareous deposits and pancreatic calculi. A history of acute pancreatitis or of chronic alcoholism is common. Disturbed carbohydrate metabolism in the form of mild diabetes is found in about a third of the cases. The same is true of abnormal fat digestion and abnormal stools. Mild pain in the epigastrium is present in the majority of the patients. In some patients the pain is so severe and constant frequently radiating through to the back, as to be intolerable.

The most important laboratory examination is a plain film of the upper abdomen to demonstrate the presence and extent of the calcareous deposits which may appear in the head, the body, or the tail of the pancreas or the entire organ may be outlined by the calcareous material. Next in importance is the finding of a marked deficiency in one or more of the pancreatic ferments, as determined from duodenal aspirations with the administration of methohyl chloride.

The extent of removal of pancreatic tissue in these radical procedures is determined by the part of the organ showing the calcareous material as seen in roentgenograms, and the amount of fibrosed tissue.

The author states that all of these patients require transfusion therapy during and after operations. The close co-operation of an internist experienced in the treatment of diabetes before and after operation is essential.

EMIL C. ROSSMACK, M.D.

# GYNECOLOGY

## UTERUS

**Figarella J** Surgical Treatment of Prolapse of the Uterus (Le traitement chirurgical du prolapsus utérin) *Gyn. édit. Par.*, 1946 45 110

In many cases the operation for prolapse of the uterus gives good results in the beginning but recurrences take place after a few years. The author discusses a series of 77 cases in which prolapse recurred after surgery had been done with good primary results.

One cause of recurrence is incomplete operation. There are three lesions involved in a prolapse: descent of the uterus, cystocele, and relaxation of the perineum. The descent should be corrected by a fixation of the uterus to the anterior abdominal wall, the cystocele by anterior colporrhaphy, and the perineal relaxation by posterior colpoperineorrhaphy. All three operations should be done in every case.

The second cause of recurrence is a lesion complicating the prolapse. The most important lesions are hypertrophic elongation of the cervix, endometriosis, and tumors of the uterus.

Finally faulty technique or poor preoperative and postoperative care may be responsible for recurrences.

The choice of the kind of operation to be done (Schautz Wertheim, Le Fort, Halban, Bouilly) depends on the age and on the kind of lesion in the individual case. Patients with hypertrophic elongation of the cervix should be treated by the Bouilly operation.

WERNER M. SOLMITZ, M.D.

**Gleadow, L. W.** The Surgical Treatment of Myomas of the Uterus, with Particular Reference to Myomectomy. *Austral N Zealand J Surg* 1946 16 30.

The present report concerns the experience of the author in the surgical treatment of 376 patients with uterine myomas, of whom 66 were subjected to myomectomy.

The indications for surgical treatment were as follows: (1) size of tumor—the patient is operated upon if the abdominal enlargement causes embarrassment; (2) rapid increase in the size of the tumor; (3) pain and bleeding after the menopause; (4) secondary anemia; (5) certain cases of sterility.

Factors influencing the selection of cases for myomectomy were:

1. Age of the patient. In many instances the length of time the patient had been married and her desire for children were considered more important than age.

2. The number of tumors. The fewer the number the more acceptable is the patient for myomectomy.

3. The situation and size of the tumors. The site except for central cervical tumors, does not matter.

4. Pregnancy. Interference is rarely indicated during pregnancy. Cesarean hysterectomy is a safer procedure than cesarean section and myomectomy.

Factors which are believed to be unfavorable to myomectomy are:

1. Adnexal pathology. Cystic ovaries may be resected and neoplasms removed at the time of myomectomy, but tubal plastic procedures are contraindicated.

2. Suspicion of malignant disease.

With regard to operative technique, the author states that careful asepsis is important: the vagina is prepared with zephiran 1 to 400 and Bouney's blue is injected into the uterine cavity. Absorbable sutures are preferred and the dead space must be completely obliterated. An anterior incision is preferable because it can be peritonealized more completely. The uterine cavity may be opened to reach tumors of the posterior wall unless they are subperitoneal in location, in which event a posterior incision may be made. The vesicouterine fold may be used to cover the anterior incision, or the round ligament may be sutured over it. The posterior incision may be covered by the round ligament, the pelvic colon, or the mesosigmoid.

The results of myomectomy were as follows:

Of 21 patients who had complained of menorrhagia, 18 were cured of 15 patients who had been sterile and who tried to become pregnant after operation. 9 conceived; patients with abdominal swelling were relieved of 14 patients who had complained of pain, 12 were relieved of 10 patients with dysmenorrhea, 6 reported improvement. 2 of 4 patients who had had repeated miscarriages were delivered of full term infants, and 1 patient was relieved of dyspareunia.

Three of the 66 patients (4.5%) who were subjected to myomectomy developed symptoms requiring further surgery. There were no deaths. Fifteen patients had febrile postoperative courses due to chest complications, wound infection, intestinal obstruction, or bladder injury.

J. ROBERT WILLSON, M.D.

**Cusmano L.** Clinical and Statistical Notes on Cancer of the Cervix of the Uterus (Note clinico-statistiche sul cancro del collo dell'utero) *Ginecologia*, Tor. 1946 13 249.

During the past 12 years, from 1933 to 1944, inclusive, 7,666 gynecological cases have been admitted to the author's clinic at the University of Parma. Of these, 367 or 4.77 per cent, were carcinomas of some part of the uterus, and 281 or 3.66 per cent were cancers of the cervix. Details are given in regard to the disease, the age of the patient, the number of childbirths she has had, her civil status, and her hereditary tendencies. The cases are then divided into three groups: those treated surgically (85 or 30.24 per cent), those treated first with

radium therapy (125 or 44.43 per cent) those treated first with roentgen therapy (59 or 20.99 per cent) and those treated only medically (12 or 4.37 per cent).

Tables are given showing the immediate and late results in all of these cases.

Among the 85 cases treated surgically by Wertheim's amplified hysterectomy there was an immediate mortality of 7 or 8.2 per cent. The results were followed up to 5 years after operation in 39 cases, and among these there was absolute cure in 19, or 48.71 per cent. In 4 there was death from the operation and in 16 death within 5 years after operation but among the latter, death occurred from intercurrent disease in 4 and from recurrence in 12; therefore the mortality from the latter cause was 30.76 per cent.

Among the 125 cases treated with radium there was death immediately after the operation in 5 or 4 per cent. Among the 48 cases followed up for 5 years there was cure in 16 or 33.3 per cent while the remaining 32 patients died within 3 years of operation.

These statistics indicate that changes should be made in the usual method of treating cancer of the uterus: radiotherapy should be given in beginning cases of cancer and those still limited to the uterus, and radiotherapy should precede surgical treatment even in the more advanced cases.

AUDREY G. MORROW, M.D.

Scartozzi, G.: On the Treatment of Cancer of the Cervix (Sul trattamento del cancro del collo dell'utero). *Mi sera med Tor* 946, 37-396.

Five hundred cases of cancer of the cervix observed at the Institute of Surgical Pathology of the University of Torino are reported by Scartozzi. Only operable cases were included in the series, inoperable ones being referred for irradiation treatment. All patients were thoroughly examined prior to surgery in order to determine accurately the extent of the lesion. The operation performed was the classical Wertheim. Iodooperative irradiation of the pelvis was found to be of value and therefore was regularly practiced.

Conditions did not permit follow-up studies. It can be stated however that the prime mortality was extremely low and that many patients were known to be in good health 7, 8, 9 and even 20 years after the surgical intervention.

EDITH B. FARNSWORTH, M.D.

#### ADNEXAL AND PERIUTERINE CONDITIONS

Bianchi P.: The Significance of the Microcystic Ovary in the Fetus (Sul significato dell'ovale microcistico I tale). *Riv ital. gine.*, 1945 23-30.

The histopathological findings of a fetus at term are described with particular respect to the ovaries which were approximately twice the normal size and contained follicles and follicular cysts. A precocious differentiation on was also noted in the cellular elements of the hypophysis. Basing his discussion upon these

observations as well as upon accepted concepts of the humoral relationship between the hypophysis and ovary the author proposes the following hypothesis:

1. There exist in the neonatal ovary possibilities of follicular maturation characterized by a certain maximum point.

2. That maturation may proceed so far as to approximate a pseudolutein phase without showing migratory movement of the follicle toward the surface of the ovary.

3. Microcystic degeneration is an involutionary process characteristic of such abnormally developed follicles, the end result of which is atresia.

4. This anomalous behavior of the ovary is secondary to an augmented activity on the part of the anterior lobe of the hypophysis.

5. This sequence of events is in turn the probable result of a functional deficiency of the placenta which gives rise to maternal and fetal compensatory action.

EDITH B. FARNSWORTH, M.D.

Nicol-Costimano, G.: Postclimacteric Metrorrhagia and Malignant Tumors of the Ovary (Metrorragie postclimateriche e tumori maligni dell'ovulo). *Riv ital gine* 1945 3-364.

Three cases of metrorrhagia resulting from a malignant tumor of the ovary are reported. In all 3 the histological diagnosis was a denocarcinoma with hyperplasia of the endometrium. The author reviews the course of opinion concerning the pathogenesis of endometrial hyperplasia and hypertrophy and corroborates the theory that they are the result of the production of folliculin in irregular quantity and rhythm. Such production is postulated as being stimulated directly or indirectly by the attacked ovary.

The precocious appearance in the cases reported of postclimacteric bleeding before the presence of an ovarian tumor could be clinically determined, is emphasized, and the recommendation is made that metrorrhagia be considered as a potentially malignant sign until all necessary measures be taken to establish the underlying cause. As a reliable routine the author suggests diagnostic curettage to exclude early evidence of malignant degeneration in the endometrial tissue with fortnightly pelvic examinations to determine any increase in the size of the ovaries and prompt exploratory laparotomy on the earliest indications.

EDITH B. FARNSWORTH, M.D.

Vare P.: Connective Tissue Tumors of the Ovary (Ueber Bindegewebsgeschwulste des Eierstocks). *Ann. chir. gyn. fenn.* 1945, 35-112.

Among 653 cases of tumors of the ovary the author found connective tissue tumors (fibromas and sarcomas) in 36 cases. Frequently it is difficult to differentiate these neoplasms from granulosa cell tumors. The tumors occurred at all ages, before as well as after the menopause; they were nearly always unilateral and their size varied from that of a pigeon's egg to that of a man's head. Thirty were fibromas and 6 sarcomas. They never caused any hormonal disturbances. Ascites occurred in 17 per

cent of the fibromas and in 33 per cent of the sarcomas. Adhesions were rare in the fibromas but rather frequent in the sarcomas. The prognosis was good, even in the sarcomas. All of the patients were free from symptoms 5 years after the operation.

WERNER M. SOLMITZ, M.D.

Nobili L.: Neoplasms of the Broad Ligament: A Critical Review of the Literature with a Report of 3 Cases (Le neoplasie del legamento largo Rivista di ginecologia e ostetricia con contributo personale di tre casi) *Riv. ital. ginec.* 1945 28 312

Three cases of primary sarcoma of the broad ligament are reported. A review of the literature brought to light 21 adequately documented cases of such tumors originating in the broad ligament to which Nobili adds his 3 under the histopathological diagnoses of (1) polymorphous fibromyxosarcoma (2) fibroreticulosarcoma and (3) fibrosarcoma respectively. These neoplasms occur more frequently in individuals between the ages of 30 and 50. Their form is ordinarily round or oval and their surface smooth or finely nodular. Their consistency is that of dense elastic tissue and their weight may reach 113 gms. The varieties of sarcoma in order of frequency are pure sarcoma, fibrosarcoma, chondrosarcoma, sarcomatoid myoma, telangiectatic sarcoma, pseudotumor and fibroreticulosarcoma. Metastases were found in 30.4 per cent of the cases, but no characteristic site of the metastases was indicated. The symptomatology of these tumors is ill defined and the diagnosis is made on pelvic examination.

Although these tumors are highly malignant histologically the clinical course appears to be somewhat more benign and the cases which constituted the 30 per cent mortality rate were those in which surgery was undertaken at such a time when the large size of the tumors and the presence of adhesions presented special mechanical difficulties.

EDITH B. FARNEWORTH, M.D.

### MISCELLANEOUS

Collins, C. G., and Nelson E. W.: Phlebotrombosis and Thrombophlebitis in Gynecology and Obstetrics. *Am. J. Obst.* 1946 53 946

To emphasize their full importance the complications arising from intravascular clotting in gynecologic and obstetric practice have been reviewed by the authors. A study of the records of all deaths, and of autopsy records when autopsy was obtained showed that intravenous clotting was present in 50 of the 536 deaths from all causes exclusive of abortion, that occurred in 32,198 admissions to the gynecologic service at Charity Hospital in New Orleans during the period from July 1, 1939 to January 1, 1946.

The authors maintain that by simple preoperative and postoperative measures the incidence of intravascular clotting either aseptic or septic can be lowered and in this way a number of deaths and dis-

abling and disfiguring sequelae can be prevented. The routine postoperative or postpartal examination of the patient's legs is as important as examination of the abdomen. No complaint of thoracic pain, pain in the leg or swelling of the leg should be casually dismissed.

Patients with pelvic tumors and unilateral or bilateral edema of the legs should be considered as having phlebotrombosis of the deep veins of the extremity or pelvis until otherwise proved. One should be careful about ascribing the edema or swelling to pressure produced by the growing tumor. In all cases in which phlebotrombosis or thrombophlebitis is found to be the etiologic factor, adequate therapeutic measures should be instituted prior to surgical attack on the abdominal tumor.

In patients with suppurative pelvic thrombophlebitis failing to respond to conservative measures and especially those in whom infection has occurred surgical therapy should be instituted. If surgical therapy is undertaken the return flow of the blood from the uterus should be ligated, i.e. the vena cava and both ovarian veins should be ligated. This ligation will save a number of lives and the complications (if any) following this procedure are slight. Following ligation of the vena cava, the risk of postoperative complications may be minimized if the patient is given routine postoperative lumbar sympathetic blocks or if the sympathetic lumbar chain is interrupted at the time of operation.

JOHN R. WOLFF, M.D.

Burns E. and Butt A. J.: The Significance of Chronic Urethritis in Women. *South Surgeon* 1946 12 352

An analysis of 100 cases of chronic urethritis in women is presented. Carelessness in vulvar hygiene, endocervicitis, pyelonephritis, radium application, sexual trauma, catheterization and the presence of a rudimentary prostate as described by Folsom may be predisposing factors.

The chief symptoms are those of bladder irritation and pain. The mucosa of the posterior third of the urethra and the vesical trigone present an irregular, red granular appearance. Congestion of the blood vessels, small cysts and inflammatory polyps may be present. The urinalysis generally yields negative findings.

The disease can be cured within 6 or 8 weeks by irrigation of the bladder, dilatation of the urethra with sounds, and the instillation of silver nitrate solutions into the posterior urethra.

GEORGE BLUMBERG, M.D.

Keller R.: Appendicitis and Sterility (Appendicitis et sterilitas) *Rev. fr. gyn. obst.* 1946 41 261

It is not uncommon during gynecological operations to see the effects of an old, heretofore unsuspected case of appendicitis. In thoroughly reviewing the patient's history a syndrome can sometimes be elicited which in retrospect can be considered an appendicitis with a clinical course which has been in

sidious. Then at the level of the internal genital organs one can notice the presence of adhesions, especially in the right side of the pelvis.

It is not surprising that acute appendicitis, particularly the perforated type requiring drainage can produce adhesions in the immediate vicinity especially at the level of the uterine tubes. The same local reactions can also take place following an attack of appendicitis that has occurred prior to the marriage state and which has given but very mild symptoms.

Various parts of the internal female genitalia may participate in the process of appendicitis but the lesions involving the tubes themselves are particularly liable to impair their function and have the most detrimental effects on fecundation. The uterus and the ovaries may also be involved and be the seat of changes so important that they may constitute the only cause of sterility. Sometimes the sterility is the result of various influences which differ in their degree of participation.

In order that fertilization can take place one of the essential factors is the patency of at least one of the tubes and it is precisely the patency of the tubes that may be impaired following appendicitis. The presence of adhesions can either produce a kink in the tube or exert a pressure on its outer surface. In both instances, the final result is the same—partial or total obliteration of the lumen of the tube. It is understandable that such adhesions can take place following an appendectomy for a severe form of acute appendicitis, especially if drainage has been instituted. Nevertheless, the formation of adhesions should not always be attributed to the establishment of drainage. It may follow any acute inflammatory process which has healed spontaneously without operation.

The adhesions may develop at the abdominal orifice of the tube which may become partially or totally closed. These adhesions may subside disappear and leave a patent tube. Nevertheless, following such an inflammatory process, the tubal wall will lose some of its contractile power which interferes with the progression of the fertilized egg toward the uterine cavity. In these instances, salpingography reveals the perfect patency of the tubes and yet the woman is sterile.

It is not exceptional for the appendicular infection to reach the lumen of the tube where it produces the known effects of endosalpingitis, which finally leads to the welding of the mucosal folds and sometimes to complete obliteration of the lumen of the tubes with the formation of blind recesses, true traps in which the fertilized egg can be immobilized.

A certain number of tubal pregnancies must be found in those anatomical disorders of the lumen of the tube secondary to a colibacillary infection, the primary focus of which is the appendix.

Needless to say the closer the appendix is to the tubes, the more often one will see the dissemination of the appendicular infection to the tubes.

The infection spreads from the appendix to the tube either by direct continuity or through the lymphatics.

Direct contamination is almost fatal when the tube is very close to the infected appendix. It occurs early after the manifestation of the infection in the appendix. Infection by way of the lymphatics may occur late. The latter mode of spread explains why the salpingitis following the appendicitis is sometimes bilateral. On the other hand, the infection may spread from the right to the left side through the uterine mucosa.

Often the ovaries are involved by the infectious process originating in the appendix. The hyperemia associated with the infection produces a permanent congestion of the ovary and finally a sclerocystic oophoritis. Oligomenorrhea and even amenorrhea have been reported to occur following appendicitis.

Appendicitis rarely exerts a direct influence on the uterus as far as sterility is concerned. A retroverted uterus fixed in the pelvis by adhesions is often the cause of sterility.

The charts of 213 patients admitted to the hospital for sterility between 1935 and 1945 were reviewed. 104 or 49 per cent, were classified as having primary sterility and 109, or 51 per cent, as having secondary sterility.

Among these 213 patients, 123 were sterile without having had appendicitis and 90 or 42 per cent, had had appendicitis. In 53 instances it consisted of a simple acute appendicitis which was operated on early under satisfactory conditions without post-operative complications. In 38 instances it consisted of a severe acute appendicitis with peritonitis requiring drainage.

Only 3 of these 90 women underwent appendectomy in childhood. Thus it seems that the appendicitis exerts greater influence on the genital organs of the adult than on those of the child.

If the existence of an old appendicitis can be detected in the history of these 90 sterile women, one is not yet justified in concluding that the appendicitis is the cause of the sterility. In fact, after a careful study of the charts of these 90 patients, it was found that in only 34 patients could the appendicitis be incriminated as the cause of the sterility. Of the 34, 15 had had simple appendicitis and 19 had had a severe, complicated type.

In 56 patients the appendicitis was considered as a coexisting condition and not as the cause of the sterility.

From these studies, the incidence of sterility following appendicitis is 16 per cent.

GERARD GUDON, M.D.

Mastect. F: Hemoperitonism from Ectopic Chorionepithelioma (Emperionoma da corioepithelioma ectopico). *CH. ital.*, 1946, 45, 80.

The author reports the case of a young woman of 25 years a primipara, who spontaneously delivered a vesicular mole in the fourth month of pregnancy without having had the usual clinical symptoms of this condition. The puerperium was uneventful. However during the next 15 months she had a series of hemorrhages at varying intervals without any

great impairment of her general condition. Surgical exploration did not show any tumor of the uterus or ovaries. The Friedmann reaction was definitely but not intensely positive during the whole course of the illness. Suddenly at the end of that period she had a copious retroperitoneal hemorrhage with infiltration of the retroperitoneal tissues from the left iliac fossa to the kidney bed on that side. Postmortem examination showed a small tumor on the sacroiliac wing situated near the bifurcation of the common iliac artery.

There was some question as to whether this tumor was a sarcoma or a chorioepithelioma, but after careful weighing of the evidence the author decided in favor of the latter. The confusion is not surprising as there is a close relationship between these two forms of tumor. There were nodules in the lung which the author believes were metastases, although the histological evidence was not absolutely conclusive.

The only possible method of treatment in cases of primary ectopic chorioepithelioma of which the site cannot be discovered is medical, the disintegrated chorionic villi being prepared by the method of Sivor and Rebaudi. This method of treatment was first used successfully in 1937.

AUDREY G. MORGAN, M.D.

De Giorgi, L.: The Relation of Tumors of the Small Bowel to the Genital Organs in the Female (I tumori del tenue nel rapporto con gli organi della sfera genitale femminile). *Arch. ostet. gin.* 1943 6:27.

The author reports a case of leiomyoma of the ileum with multiple secondary nodules in which the sarcomatoid structure and cellular polymorphism confirmed the clinical impression of malignancy. Although relatively undifferentiated myoblasts were found, it is suggested that the genetic interpretation be evaded and the tumor be defined as an 'atypical' immature leiomyoma, a term which indicates the degree of differentiation as well as the cytological character of the neoplasm. This choice of term arises from the fact that although the degree of dedifferentiation is often directly related to the degree of malignancy, a high grade of malignancy is sometimes found to be associated with a rather strictly adult type of cell, and in certain other cases the tumor clearly stems not from the myoblastic but from the mesenchymal elements.

In the case reported, a history of irregular menses, frequent and painful urination, a low grade elevation of temperature, and a tumor mass in the right iliac fossa led to a discussion of the differential diagnosis between tumors of the pelvis and those of the small bowel.

EDITH B. FARNSWORTH, M.D.

## OBSTETRICS

## PREGNANCY AND ITS COMPLICATIONS

Josephy H., and Hirsch E. F : *Eclampsia. Report of a Case in Which There Was Extensive Destruction of the Brain Arch Path Chk 1946*  
43 191

The authors describe the pathological changes occurring in the brain of a woman who died 3 months after having eclamptic seizures. There is the literature only one other recorded description of the brain of a patient who survived eclamptic seizures for any essential period: that of the brain of a woman dying 7 years after her illness, which showed widespread cortical degeneration and centrum ovale change. This was reported by Lowenberg and Loomis in 1931.

The patient was a 15 year old primigravida who had had maternal albuminuria and elevation of blood pressure beginning at the eighth month and had expected generalized convulsions almost continually during induced labor and delivery. Sodium amyltal was given but was successful in eventually controlling the convulsions however there was a sharp fall in blood pressure at the time of delivery and oxygen was necessary. The patient never regained mental consciousness and died a few days later for the next 3 months. On the level of the parturient lay generalized tonic-clonic convulsions (grand mal) appeared and persisted until death. At autopsy the brain was found ranging from 10 to 104 mm. long during the postpartum period, and a gradual increase in cerebral spinal fluid pressure was noted.

1 central 4th cranioanatomical diagnosis at autopsy was a marked encephalomalacia and atrophy of the cortex of the brain, the nonneurological findings were consistent with chronic Uremia. The brain with the upper half of the dura weighed 900 gm. The pinal fluid was abundant clear and colorless. The pia arachnoid at the base of the brain was thin and transparent. The arteries at the base had thin walls. The sulci of the cerebellum, pons and brain stem were firm but those of the cerebral hemispheres were soft the cisterns were atrophic and flattened a fish tail narrowed convolution were retained although under the post report on the parietal occipital. The dura and the arachnoid were not unusual. After formalin fixation to the gulfication was reduced cerebral hemispheres a cerebral cyst narrow and generally separated from the centrum ovale by a narrow layer of loose tissue parallel to the gyral surface. Convolution ectopic pale and friable white matter consisting of the lateral ventricle, normal basal ganglia cerebellum, pons, and brain stem.

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method) d school thickened ma-machoid. vring di

lated with occasional extravasations, poorly stained white matter in the parietal lobe and ventral third temporal gyrus in contrast to the darkly stained first temporal gyrus, thin temporal and parietal cortex, focal regions of demyelination in the frontal gyri, marked cortical destruction in the anterior portions of the cerebral hemispheres with marked loss of nerve cells and fibers and mesenchymal growth along with glial proliferation, conglutination necrotic cortical capillary and venous dilatation and mural thickening, dilatation of the perivascular spaces with occasional small hemorrhages. In brief observation did not advanced organization and scarification of cerebral tissue and demyelination of the centrum ovale. Only minimal destructive changes were seen in the cerebellum.

Autopsy reports of brains of women who died during eclamptic seizures have shown in general more diffuse than focal changes. Edema, degeneration of ganglion cells, reaction of pia and meninges, a few hemorrhages are the chief findings, all represent on a small scale what was observed by the authors in the form of diffuse damage. All circulation disturbances in the brain are generally thought to be functional rather than actually organic.

Whereas Lowenstein and Losman<sup>1</sup> assumed that the initial process in the genesis of the disease was necrosis of the nervous parenchyma caused either by functional circulatory disturbances or toxicity, the authors believe that a vascular genesis rather than a primary parenchymal degeneration is present. Softening in cortex and white matter point to a disturbance in blood supply as does glial proliferation without meningeal involvement and also the enormous dilatation of capillaries and small vessels adjacent to nerve changes.

In conclusion the authors state that vasopar-  
41 a well a venous and capillary thrombosis is  
responsible for most of the lesions observed by them.  
Anorexia may be a secondary factor producing the  
diffuse demyelination observed in the region of the  
central canal.

The authors conclude that probably central nervous system damage occurs following eclampsia more often than has been reported. Occasional references have been found to psychoses, personality changes after eclampsia but no systematic neuropsychiatric examination of such patients has ever been done.

Prof. Dr. H. C. Kr. M. D.

Will G. Rupture of the Capsule in the Felis hepatic  
Liver (Rupture of the capsule in the liver)  
For etiology 1916 6 1 2

Rupture of the liver is generally brought about by external violence but fatal results may be caused in some cases by toxins such as those of pregnancy toxemia, malaria type of fever and tuberculous peritonitis.

A case of this type of rupture is described in a woman of 32 in the sixth month of her eighth pregnancy. The night before her admission to the hospital she had intense epigastric pain as her blood pressure was very high the attending physician sent her to the hospital the next morning with a diagnosis of high blood pressure from pregnancy. She presented anuria but no convulsions.

Soon after admission to the maternity hospital she collapsed. Her blood pressure fell to a very low level. She was given antitoxic serum and a blood transfusion. A diagnosis of rupture of the uterus was made and operation decided upon. On operation a large amount of blood was found in the abdominal cavity but the uterus was intact. The meson was enlarged upward and an enormous hematoma of the liver 5 cm. in height, was found. The capsule had ruptured and the blood poured into the abdominal cavity. As ligation was impossible a Mikulicz tampon was applied and the abdomen closed. The patient died a few hours later without having regained consciousness.

Autopsy confirmed the presence of a subcapsular hematoma over the whole upper surface of the right lobe. The capsule was ruptured. The liver parenchyma showed multiple recent focal hemorrhages and fatty degeneration. Histological examination revealed complete disintegration of the liver cells. There was also marked parenchymatous degeneration of the kidney cells.

The toxins of eclampsia may therefore have practically the same effect on the liver as external violence.

AUDREY G. MORRAN M.D.

Rechat, R. L.: The Etiology of Spontaneous Abortion—Excepting Syphilis (*Étiologie de l'avortement spontané—en dehors de la syphilis*). *Gyn. F. et. Par.*, 1946 45 299

This article gives a general report of our present knowledge regarding spontaneous abortion. Although in about 40 per cent of the cases of spontaneous abortion no definite cause can be established modern research in histopathology, biochemistry, endocrinology, serology and genetics has cast new light on the problem.

The belief that syphilis is the most frequent cause of abortion is erroneous. According to French, Italian, and Swiss statistics, not more than 2 per cent of abortions observed in hospitals are due to syphilis. The other etiologic factors can be classified according to whether the etiologic defect lies in the gametes in an anomaly of the ovum and its adnexa or in some general or local deficiency of the maternal organism. Factors which may cause weakness or defects of the sperm or ovum include old age, overexertion (sexual, physical or intellectual), intoxications, infections or unknown constitutional conditions (incompatibility of the partners).

Since according to Williams in abortions of the first trimester the death of the fetus almost always precedes the abortion it is essential for the solution of the problem to find the cause for the death of the

embryo. As a matter of fact, malformations of the embryo and anomalies of the placenta play an important role. In a series of 1,000 abortions, Hertig found abnormal ova in 48 per cent, localized fetal malformations in 32 per cent and anomalies of the placenta in 9.6 per cent. Among the anomalies of the placenta hydatidiform degeneration was the most frequent, arteritis obliterans of the villous vessels was seen frequently also. Furthermore acute hydatidiosis often seems to be the cause of abortion.

Acute or chronic infectious diseases may be transmitted from the mother and cause death of the fetus. According to De Lee certain contagious diseases like scarlet fever and variola may be transmitted to the fetus although the mother does not show any signs of infection. Also of great interest is the question whether focal infections of the mother (teeth, tonsils) may be transmitted to the fetus and cause abortion (Curtis).

Pathological conditions of the uterus causing abortion include endometritis, fibroids (especially the submucous form), retroflexion and hypoplasia whereas malformations seem of minor importance.

Diseases and deficiencies of the mother that may lead to abortion are acute infections like typhoid, smallpox and measles, by way of fetal infection in toxemia or hyperpyrexia. Of the chronic diseases the various forms of nephropathies have been discussed the most. It seems, however, that only chronic hypertensive nephritis plays a certain role in repeated abortion. This occurs mostly in the second trimester and is usually caused by placental hemorrhages.

That diabetes has a most unfortunate influence on pregnancy is a well known fact. Before the insulin era, from 60 to 80 per cent of the cases resulted in abortion. Under insulin therapy the percentage of abortion still is 25 per cent (White). The cause of the interruption seems to be acidosis.

Cardiac conditions seem to play a minor role, if any. The author reports in detail modern researches concerning vitamin deficiency as the cause of abortion. According to Rosemann the vitamin C content of the placenta increases progressively during normal pregnancy whereas the content in the circulating blood decreases proportionally. At the time of spontaneous abortion the vitamin C in the placenta drops rapidly. Most probably ascorbic acid is essential for the formation of progesterone in the corpus luteum. The need of vitamin C is tripled during pregnancy (from 70 to 100 mgm.). However the author asks the following question: If the role of vitamin C is really very essential in pregnancy, how can it be explained that the percentage of abortions and premature deliveries in the European countries did not increase during the war in view of the very low supply of vitamin C?

As to the influence of vitamin E a striking discrepancy exists between the experimental and clinical experiences. Rats fed with food deficient in vitamin E aborted on the thirteenth day of pregnancy, but this abortion could always be prevented by a



supply of vitamin E natural or synthetic (tocopherol). The clinical experiences were not equally satisfactory. Whereas some authors published very encouraging results others did not have any success. This apparent contradiction is easily explained if the vitamin E content of the blood is examined in every case. Success of vitamin E therapy can be expected only in cases of vitamin E deficiency. The vitamin E content of the blood should be above 400 gamma per cent (the average is 678 gamma per cent). All cases with a content below 400 should be subjected to treatment and in these success is obtained in almost 100 per cent.

Among the various hormonal deficiencies that of progesterone plays the most important role in habitual abortion. In normal pregnancy the amount of pregnanediol in the urine increases between the seventh and nineteenth days. This increase is not observed in habitual abortion. Browne and his collaborators believe that in these cases there is a gap between the cessation of corpus luteum function and the beginning of intraplacental secretion. Many cases of failure following progesterone treatment may be due to insufficient frequency of the injections. Since progesterone is eliminated quickly it should be given in a preparation of slow resorption (luteocycline) and continued for a long time. However this treatment may lead to missed abortion if it is started after the death of the embryo.

As to estrogenic hormone deficiency as well as excess secretion has been believed to be the cause of abortion. Insufficient secretion may lead to hypoplasia of the endometrium (infantilism) which endangers nidation.

The role of the anterior pituitary lobe is still undecided. However experiments seem to indicate that its normal functioning is essential for the continuation of gestation. Whether hypothyroidism predisposes to habitual abortion, as some men believe, appears doubtful. In a series of 501 cases the author did not observe a single case of hypothyroidism.

No definite evidence has been found pertaining to the Rh factor as a cause of habitual abortion.

It appears rational that the mechanism of immunization may present a new etiologic element in habitual abortion but the observations are still too incomplete to form a definite opinion. The influence of lethal genes may also have a bearing on habitual abortion. Although experiments on mice have proved definitely that the lethal gene is a fact nothing is known as yet about its action in man.

WERNER M. SOLMITZ, M.D.

### LABOR AND ITS COMPLICATIONS

Da Cunha, D. P.: Abdominal Cesarean Section (Cesaria) (Lithotomy) *Rev. J. St. Maternal* 104

The author reviews the history of cesarean section and describes the details of various forms of the operation. He then discusses 168 cases which he has treated—13 by high or low cesarean section on 129

by low section 7 by the Portes operation and 12 by cesarean operation accompanied or followed by hysterectomy. He believes that the low operation is to be preferred to the high one as being less dangerous to both the mother and child. The lower segment of the uterine wall is much thinner than the upper one and does not contract during labor. The author's low operation is transperitoneal while that of Portes is extraperitoneal. There was infection in 83.4 per cent of the author's cases. The fetal mortality was 3.0 per cent. The total maternal mortality for the whole group was 5.95 per cent. Subtracting 2 cases in which the patients died from the anesthesia and one case of death due to brain failure 18 days after the operation the real operative mortality was 4.1 per cent. The mortality in the low operation was 2.3 per cent and in the high operation 13.5 per cent. There were complications in 20 per cent of the cases which incidence is lower than usual. Siegel reports from 36 to 58 per cent. A. Jau report 20 per cent of very severe complications. ADREY C. MORAY, M.D.

### PUERPERIUM AND ITS COMPLICATIONS

Greenberg, E. M.: The Fourth Stage of Labor *Am. J. Obst.* 1916, 52, 746

The sequence of intrauterine event which transpires during the postpartal hour comprises a distinct physiological and clinical entity. Their collective recognition as the fourth stage of labor would help save the lives of those mothers who die of unattended postpartal hemorrhage and spare the survivors the complications of sepsis and anemia that lie in its wake.

As the sulfonamides and antibiotics seal the doors of puerperal infection puerperal hemorrhage will eventually take first place among the causes of maternal mortality and the attempt to combat puerperal hemorrhage gain in momentum the critical first postpartal hour will necessarily have to be accepted as a normal part of every labor for as a series of individual but interrelated physiological components the fourth stage of labor will have to be recognized and treated with understanding lest one of its component rebel under maltreatment and cause destruction.

The physiology of the fourth stage of labor consists of a contractile and a hemorrhagic phase. The contractile phase includes the stages of (a) uterine myotomponade or immediate uterine contraction (b) uterine thrombotomponade or secondary relaxation with the formation of placental stenosis and intrauterine hematoma (c) myotense indifference and (d) fixed myotense contraction. The hemorrhagic phase includes traumatic hemorrhage from uterine tract bleed, uterine atonic hemorrhage with a clotted hemorrhagic component associated with placental separation and a nonclotting hemorrhagic component probably arising from denuded myometrium. Both the contractile and hemorrhagic phases are multicausal and inter-

related. The normal nonclotting component of postpartum blood may be analogous with the nonclotting component of menstrual blood which this author believes also consists of two components—a clotting and a nonclotting. The same uterine enzyme which may be responsible for the failure of one of the postpartum blood components to clot may be responsible for the failure of one of the menstrual components to clot. Postpartum hemorrhage when not due to uterovaginal tract trauma, may consist of a hemorrhage of (a) one of the clotting components (b) the nonclotting component or (c) a combination of any two or all three. Shock bleeding may be a superimposed late complication.

The official recognition and physiological appreciation of the fourth stage of labor would result in a reduction of mortality from postpartum hemorrhage, which is assuming first place among the causes of maternal mortality. A questionnaire concerning the fourth stage of labor should be a part of every labor record.

JOHN R. WOLFF, M.D.

### NEWBORN

Page E. W. Hunt, M. and Lucia, S. P.: The Antepartum Prediction of Hemolytic Disease of the Newborn. *Am J Obst* 1946 52: 794.

Despite the intensive researches on the relationship of erythroblastosis fetalis to the Rh factor, the obstetrician is handicapped because he is unable to forecast the outcome of pregnancy in Rh negative women. Not only is he in doubt about the presence

or absence of erythroblastosis fetalis in utero but he is also unable to predict its gravity when there are reasonable clinical indications that it may exist.

Ideally all pregnant women should be typed routinely regardless of parity and in those Rh negative patients having Rh positive husbands the first sample of blood for antibody determination should be obtained not later than the twenty fourth week of pregnancy. If this be strongly positive for either agglutinating or blocking antibodies an Rh positive fetus will probably be too seriously affected by hemolytic disease to warrant any interference before term while an Rh negative fetus will escape the disease. As yet there is no way of distinguishing these possibilities except to prove that the father is homozygous for the Rh factor. If the antibodies are present only in traces or if a small amount is found on a single determination and is unconfirmed by subsequent tests the fetus is probably unaffected and again it would be unwise to interfere.

If the initial sample is free of antibodies but a significant amount appears later a period of 8 to 10 weeks may be allowed to pass before hemolytic disease becomes a probability. After this time induction of labor might be warranted provided the expected date of confinement is within the ensuing 6 weeks.

That a relationship exists between the duration of exposure to maternal antibodies and the fetal prognosis seems apparent. Further study may alter the critical time periods established by the data of this preliminary analysis.

JOHN R. WOLFF, M.D.

# GENITOURINARY SURGERY

## ADRENAL, KIDNEY AND URETER

Wagner, F. H. Jr.: *Arteriography in Renal Diagnosis*. J. Urol. Balt., 94: 56-65.

Roentgenological delineation of the abdominal aorta and its branches in humans following direct translumbar injection of a radiopaque medium attracted considerable attention but its seemingly formidable nature prevented general adoption. Although the technique is exacting the indications limited and the films some times difficult to interpret the encouraging reports warrant its further trial in properly selected cases by qualified personnel.

The purpose of the present article is to stimulate further interest in this subject by the description of a simplified technique, critical evaluation of the procedure and the presentation of some unusual arteriograms.

A team consisting of a surgeon, an x-ray technician and an anesthesiologist is required.

The necessary equipment: an anesthetic solution gauze squares drapes rubber gloves normal saline solution talcum powder rubber tubing with Luer lock adapters a 15 cm. No. 18 gauge needle with side skin puncture needle a 10 c.c. Luer lock syringe 80 per cent sodium iodide.

The x-ray machine should be capable of delivering 300 milliamperes. A high speed Bucky diaphragm should be used all wing exposure with one fourth of a second.

The anesthesiologist should be provided with pentothal anesthesia equipment and an oxygen machine. The preliminary preparations are as follows:

1. On the day of the procedure a soap-sud enema is administered to the patient in the morning and followed with a bowel.

2. Morphine and atropine preanesthetic medication is given three-quarters of an hour before the procedure.

3. The tentized arteriography tray the pentothal anesthesia equipment an intravenous set 1000 c.c. of 5 per cent glucose in normal saline solution, a syringe containing 1 c.c. of epinephrine solution (1:1000) and another syringe containing 15 c.c. of evamaine are sent to the examination room with the patient.

4. With the patient in the supine position, an abdominal film is taken in order to note adequacy of the colon preparation to determine the best centering of the film with respect to the area of diagnostic interest and to check the x-ray technique.

5. When the film is satisfactory or after necessary corrections have been made the cassette is again loaded and the patient is anesthetized lightly with sodium pentothal.

6. The skin of the lower chest and back prepared with antiseptic solution and draped.

The technique of aseptic insertion is as follows:

The twelfth rib on the left side is palpated. With a short stout needle the skin is punctured just below this rib 4 fingers breadth from the spinous process. The 15 cm. needle is then introduced through the puncture hole and directed anteriorly medially and cephalically toward the body of the twelfth thoracic vertebra. When bone is encountered, the needle is withdrawn about 2 cm. and the point is directed more laterally so as just to pass by the vertebral body. The stylet is then removed and the needle cautiously advanced to within a few centimeters of its hub. The aortic wall is encountered as a resistance through which the needle snaps, imparting to the operator a sensation similar to that experienced in penetrating the dura mater during a spinal tap. Almost immediately bright red blood emerges from the needle as a pulsating drip which descends as a rivulet on the flank. In patients with hypertension the flow more rapid and pulsation somewhat more vigorous but the amount of blood lost in making the necessary adjustments for injection is trivial. In some instances the needle itself may be seen to move rhythmically with each heart beat.

The needle is then connected to the rubber tubing and syringe which have been previously filled with sterile saline solution. Barbotage is carried out, note the ease of flow in both directions. A trial injection of 10 c.c. of saline solution within 6 seconds is made in order to estimate the force required. The stopcock is then closed, and the syringe is disconnected and filled with approximately 10 c.c. of 80 per cent sodium iodide solution. The syringe is again connected the stopcock opened, and blood withdrawn as a final proof that the needle is well within the lumen. The signal "ready" is given to the x-ray technician the solution is injected at a rate of 2 c.c. per second and the signal "shoot" is given as the final cubic centimeter or two leave the syringe. Since the tubing holds about 2 c.c., the total amount delivered to the aorta is about 10 c.c. Immediately following exposure of the roentgen film the needle is withdrawn.

It has been the author's experience that the technique as just described is best suited for visualization of branches of the celiac axis and superior mesenteric artery. Visualization of the renal artery and its branches appears to be better if the needle is inserted one vertebral level lower.

Promptly after injection, the patient usually moves slightly and breathes more deeply. During this period oxygen is administered by the anesthesiologist with careful watch kept of the patient's color respirations, and pulse. The needle through which the pentothal was given is left in place and used for the administration of 1000 c.c. of 5 per cent glucose in normal saline solution. Within 10 minutes the patient usually conscious and has no complaints. Several hours later the patient is allowed a regular tray.

ambulation is permitted if there are no other contraindications.

The author states that before abdominal arteriography is undertaken one should be fully acquainted with the difficulties and potential dangers. In the first place the patient is exposed to the hazards of anesthesia, acute iodism, extravasation of radiopaque medium, and hematoma following puncture. Secondly the operator must acquire a thorough knowledge of the relational anatomy involved in the procedure. Aortic puncture should first be practiced in the dissecting or postmortem room in order to acquire experience and confidence. Thirdly the actual technique, though relatively simple is exacting and demands perfect co-ordination of the team for the slightest error may yield an unsatisfactory film. Finally even an excellent arteriogram in some instances may be difficult to interpret accurately because of the present lack of experience.

Even if the risk of abdominal arteriography in the hands of a competent team is granted to be minimal the question arises as to whether sufficiently valuable information is obtained by the procedure to justify its performance. It is my opinion that this study is of value, just as arteriography elsewhere in the body as an occasional diagnostic adjunct in carefully selected instances. From the standpoint of renal diagnosis the study may be indicated when all other studies have been exhausted and further information is desired regarding (1) hypertension in which surgical treatment is contemplated (2) aberrant renal vessel as a possible cause of hydronephrosis, (3) renal or adrenal tumors (4) possible renal aneurysm and (5) suspected aortic obstruction near the renal arteries.

Further investigation and pooling of information with respect to interpretation of the arteriograms will, no doubt establish the normal range of variation as well as the abnormal patterns. A rotating cassette, permitting multiple exposures during injection of the radiopaque medium, would afford a more certain method of obtaining a good film during maximal concentration of the material in the area of diagnostic interest. Stereoscopic films would permit even more precise arteriographic delineation. Finally in the near future cinerentgenography and the fluorographic multiple exposure technique may be successfully incorporated into the method.

JOHN A. LOEF, M.D.

Abelhouse B. S., and Tankin L. H.: Renal Complications of Sulfonamide Therapy. *J. Urol.* Balt., 1946 56 658.

The authors discuss the following renal complications of therapy with sulfanilamide, sulfapyridine, sulfathiazole, sulfadiazine and sulfamerazine: (a) crystalluria (b) hematuria (c) oliguria and anuria, (d) renal or abdominal pain or colic, (e) tenderness over the kidneys, and (f) azotemia.

Clinical reports of renal complications of sulfanilamide are rare. The authors have observed an unusual case of anuria following the intraperitoneal injection of from 75 to 85 gm. of sulfanilamide. Complete

anuria occurred but an autopsy was refused and the exact nature of the renal changes could not be ascertained.

In their series of renal complications of sulfapyridine hematuria was observed in every one of the 12 cases and was accompanied by renal colic in 2 cases and by urolithiasis, azotemia and anuria in 1 case each respectively. Cystoscopy was not done in any case. There were no fatalities.

In the authors' series of 12 cases of renal complications following sulfathiazole therapy there were 7 cases of hematuria (3 cases uncomplicated, 1 with azotemia, 1 with crystalluria, 1 with oliguria and 1 with anuria), 2 cases of crystalluria, and 3 cases of anuria. Cystoscopy and ureteral catheterization were employed in 3 cases. There were no deaths in this series.

Fourteen cases of renal complications of sulfadiazine are reported. Hematuria was encountered in 10 cases (2 cases uncomplicated, 4 with renal colic and azotemia, 1 with crystalluria, 1 with renal stone, 1 with oliguria and 1 with anuria), oliguria and azotemia in 2 cases, anuria in 1 case, and crystalluria in 2 cases. There was 1 death in this series. The death was preceded by anuria and at autopsy thrombosis of both main renal arteries was found.

The authors observed only 2 cases of anuria following sulfamerazine. 1 was accompanied by hematuria and 1 by renal pain. One of them was successfully treated by ureteral catheterization and the other responded to conservative therapy.

Certain diagnostic aids are suggested. A daily urinalysis may allow detection of microscopic hematuria, one of the earliest signs of renal change. The presence of crystals in the urine without other signs or symptoms does not necessarily mean renal damage. Urinary infections predispose to the development of renal or ureteral complications. Obstructive lesions in the upper or lower urinary tract favor the accumulation of crystals or the formation of uroliths within the obstructed area.

Cystoscopy and ureteral catheterization usually establish the diagnosis.

The following precautions will reduce the incidence of renal complications: (1) determination of previous sulfonamide medication, sensitivity or idiosyncrasy, (2) evaluation of the state of renal function prior to the administration of the drug, (3) evaluation of the state of hydration, (4) administration of the drug in adequate dosage, and (5) administration of adjuvant alkali therapy.

It is believed by the authors that the drug should be stopped immediately upon discernment of evidence of kidney damage, i.e., hematuria, renal pain or tenderness, suppression of the urine and increased nitrogen retention. The fluid intake should be increased and solutions of hypertonic dextrose and isotonic sodium lactate given intravenously. Sodium bicarbonate should be given by mouth until the carbon dioxide combining power of the blood reaches between 70 and 90 per cent. However there is a warning against giving excessive amounts of fluids.

The use of mercuric compound is and acid diuretic is absolutely contraindicated. Ureteral catheterization and poly c lavages with warm water isotonic saline solution or from 2.5 to 10 per cent sodium bicarbonate solution are indicated when the pelvis or ureters are obstructed by sulfamide crystal. When all these measures fail nephrostomy pyelotomy or ureteropyelostomy with or without renal decapsulation have proved to be lifesaving in otherwise hopeless cases.

The cases reported by the authors were from the Sinai Hospital Baltimore Maryland.

JOSEPH L. MATHIAS, M.D.

Lundström, E.: A Belt for Compression of the Ureters (Cuert för Kmpression der Ureteren). *Läkaretidning* 1946 57 385.

Compression of the abdomen with the purpose of preventing the escape of contrast material into the urinary bladder is used for intravenous as well as retrograde pyelograms. The usual compression band which is attached to either side of the roentgen table causes pain in the patient whose back is pressed against the table. Furthermore it immobilizes the patient and makes multipositional (especially oblique) roentgenography impossible.

The author describes an improved compression belt the description of his first belt having been published in 1937. The present belt consists of an abdominal and a dorsal shield of radiotranslucent material connected by straps. Rubber balloons of varying sizes (for unilateral or bilateral ureteral compression) can be inserted underneath the front piece and inflated to from 40 to 80 mm. Hg by means of a hand pump with a manometer.

The patient can be moved freely while the compression is being maintained. On the other hand release of the compression can be accomplished by

removing the front piece of the belt without disturbing the patient's position.

CITRA T. S. W. (ALB, MD)

## BLADDER, URETHRA, AND PENIS

Emmett, J. L.: Management of Cord Bladder by Transurethral Resection. *J. U. N. Balt.* 1945 57 20.

The author analyzes 45 cases of cord bladder caused by transurethral resection at the Mayo Clinic during the years of 1944 and 1945. Thirty patients had transverse lesions of the cord and 15 had longitudinal lesions. All of the patients carried a residual ranging from 50 to 1,200 c.c. The pattern of vesical dysfunction varied greatly but consisted for the most part of involuntary active emissions of varying amounts of urine at intervals of from a few moments to an hour or more. This type of vesical dysfunction has been termed the automatic or reflex bladder. Most of the patients were reconciled to their partial motor paralysis but complained bitterly of a severe urgency of micturition which made the wearing of some type of urinal necessary.

Transurethral resection as carried out in these cases has as its object the destruction of the internal sphincter's capacity to contract and the removal of any obstructing tissue so that there will be no resistance of any kind between the bladder and the external sphincter. To do this, the entire circumference of the vesical neck, well out to the verumontanum, must be resected. Multiple resections are frequently necessary before the patient can empty completely.

The results in 30 cases of transverse myelitis were encouraging. Twenty-three patients were considered to have obtained a good result, 4 were improved in 2 patients the results were fair and in 1 patient, poor.

Fifteen patients with multiple sclerosis or miscellaneous lesions of the cord, were studied. Usually these patients were found to have frequency and urgency of micturition with a poor stream. In all "mild" cases the patients complained of a prepotent urgency. Three of 7 such patients obtained a good result; in the remaining 4, the results were classified as fair.

It is emphasized that the performance of resection by no means treats the neurological lesion. In the final analysis the attempt with this procedure is to eliminate residual urine so as to allow the patient to remain dry until an amount equal to that of residual urine accumulates in the bladder. This accomplished, he may be kept dry and free from cumbersome catheters and urinals, thus greatly aiding his entire program of rehabilitation.

Excellent charts analyzing each of the cases are presented.

ROBERT O. BLUMBERG, M.D.

Lewis, E. L.: Tuberculous of the Penis. *J. U. N. Balt.* 1945 56 737.

Tuberculosis of the penis is a rare clinical entity. Two types have been recognized: (1) that which is secondary to other lesions in the genitourinary system,

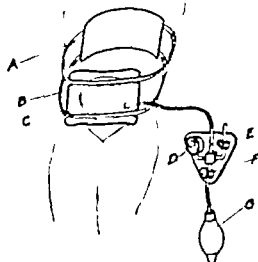


Fig. (Lundström)

(a) upper tract, (b) genital tract and (c) both and (3) that which is primary i. e. no other source of tuberculosis in the body is present. There have been only 3 cases reported in which the penis became involved following pulmonary tuberculosis without there being some other genitourinary focus first.

Tubercle bacilli may involve the skin the urethra or cavernous bodies. Tuberculous cavernitis is a very rare disease and is not considered in the present study except where it may arise secondarily to skin tuberculosis.

The urethral mucosa is remarkably resistant to the tubercle bacilli, which may pass through it for years without producing clinically recognizable lesions (Young). Even so tuberculosis of the urethra is a more common disease than that of the penis it was present in 2.6 per cent of the cases of upper tract tuberculosis in the author's files, whereas penile tuberculosis was present in just less than 1 per cent of cases.

In a comprehensive review of the literature there have been found 110 cases of penile tuberculosis. In 89 of these the condition was primary in 9 cases, not stated in 8 secondary in 1 case, undetermined and in 3 cases, hematogenic.

Of the 89 cases of primary tuberculosis 72 were the result of ritual circumcision in Jewish infants. The actual incidence of tuberculosis of the penis following this rite was much higher than a review of the literature would indicate. Part of the ritual consisted of the mohel sucking the circumcised penis in the act of the *Mezizah*. The purpose of this act which was compulsory as described in the Camera by Rev. Rav Pope in the fifth century and later by Joseph Karo and Maimonide in the Beth Joseph of the twelfth century was that of a hemostatic and styptic. Syphilis and diphtheria have also been contracted through this act. After the turn of the last century this act was practically eliminated from the ritual so that tuberculosis of the penis is seen only rarely now.

Of the remaining 17 primary cases, 12 were definitely stated as being the result of coitus 2 were the result of nonritual circumcision 2 the result of buccal coitus, and 1 case resulted from the wearing of infected clothing.

Of the secondary cases 4 patients had tuberculosis involving the genital system 2 had renal involvement and both the urinary tract and genital tract were involved in the other 2 patients.

In the Brady Urological Institute there have been seen 7 cases of tuberculosis of the penis 5 of which the author reports.

As has been demonstrated, the penis may become infected with the tubercle bacilli through three sources (1) hematogenous from lungs, (2) direct contact, and (3) following tuberculous infection of other organs in the genitourinary system by one of the above methods or by some other method not demonstrated as yet.

The hematogenous route without involvement of other genitourinary organs is an extreme rarity.

The direct contact source is by far the most common source of infection. One can easily see how the bacilli could gain a foothold during circumcision, but

the contraction of the disease through coitus is another matter. The tubercle bacilli can be found in the vagina in cases of pelvic tuberculosis in women, and even though cervical tuberculosis is a rare disease it has been seen and shown to be of primary as well as secondary origin. This being so and the fact that the lesion appears around the corona and frenulum most commonly leads one to speculate that the bacilli are inoculated in these points of irritation the normal mucosa having been shown to be highly resistant.

There have been many descriptions in the literature of the typical lesion of tuberculosis of the penis. Brunati describes 3 periods in the development of the tuberculous ulcer. The first period is one of a tuberculous pustule which he calls a 'bouton' or raised pimple. In this stage there is little or no induration. In the second period there is ulceration but still little or no induration. The third period is marked by a progression of the ulceration, and the presence of infiltration and induration around the edges. The base, in the early stages of this period, is usually clean and has the appearance of irregular granulation tissue. With extension of the lesion there is necrosis the base becomes gray or yellow and usually there is secondary infection.

The differential diagnosis of penile ulcers is not simple. There are many diseases to be considered viz. balanitis, herpes progenitalis, chancroid, luetic chancre, epithelioma, carcinoma, gummatous ulceration, granuloma inguinale, and leprosy.

Because of its rarity the diagnosis of tuberculosis should not be made until all other possibilities have been ruled out. The diagnostic proof should consist of smears stained for acid fast bacilli, biopsy and finally animal inoculation. In only the last of the cases here presented was all this done.

The treatment of penile tuberculosis has been most unsatisfactory. Suggested therapy has been heat, light (both ultraviolet and infra-red), x-ray, various chemicals and surgical excision. None of these methods has proved to be a panacea. In some cases excision with the electric cautery can be done with some optimism for the patient but the prognosis generally is quite poor.

JOHN A. LOHR, M.D.

# MISCELLANEOUS

Reaves, J. U: Surgical Injuries of the Urinary Tract  
J. Urol. Balt. 1947 57 65

Injuries to the urinary tract are of two types (1) those which allow urinary absorption without extravasation and (2) those which allow extravasation and absorption. When urinary extravasation is set up the urine follows every conceivable plane, giving unlimited variety to the fistulous tract. The scope of the present paper deals only with those cases which are due to surgical trauma, or to external violence as is sometimes encountered in private practice.

Accurate diagnosis of fistulas following injury to the kidneys can be made as a rule by the properly combined use of urologic and roentgenographic sur-

vey The presence or absence of hematuria is noted, and either intravenous or retrograde pyelograms are made according to the operator's judgment, remembering that temporary anuria can result from either moderate or severe trauma of the kidneys.

Immediately following an injury in which the kidney is involved the patient complains of pain and tenderness in the iliocostal area. The pulse rate is rarely accelerated and the blood pressure will remain at a safe level. Muscle spasm in the area is usually due to the degree of injury to the muscle. Pain, tenderness, and muscle spasm may be accompanied by shock, though shock is rarely severe unless the kidney injury is complicated by injuries to other structures. If the pulse rate is accelerated and accompanied by restlessness and the pain and muscle spasm increases, one may be certain that progressive bleeding is going on. Likewise a fall in blood pressure several hours following injury is often caused by bleeding. In the opinion of the author this should put an end to expectant or conservative treatment, and exploratory surgery should be instituted.

The anatomical position of the ureters, together with elasticity gives them a large degree of protection from injury. The possibility of the ureter being nicked or severed by a gunshot or stab wound is remote though this could happen. If the ureter is injured at the same time the kidney is damaged the kidney disease is dealt with primarily and in so doing the ureter also comes in for attention. This may be simple ligation of the ureter and removal of the distal portion thereof during a nephrectomy or drainage and plastic repair accomplished according to the presenting indications. Sometimes the ureter is injured during resection of the sigmoid for malignant growth rendering a condition which is so aggravating that nephrectomy has to be resorted to.

Injury to the ureter is not always recognized at the time of operation. A fatal peritonitis may result from an unnoticed rent in the urinary tract with the escape of urine into the peritoneal cavity. Complete anuria or the presence of hematuria may reveal ligation or other injury to the ureters. The appearance of urine on the dressings or through the vagina may be the first notice of operative injury.

Newell states that there are no definite symptoms in unilateral ligation of the ureter that the death of the kidney occurs before the ligature is absorbed and in such cases the effect of this ligation may not be observed.

Distortion of the urinary tract by pelvic disease can be ascertained by a preoperative urological survey. This will also show up double ureters, Y ureters and the like and make it easier for the gynecologist to be on the alert to avoid injury to the ureters. Likewise an early urological survey postoperatively will show the degree of damage of malplacement left with the patient following the operative procedure.

Operative injuries to the bladder are more rare than ureteral injuries, as it is extremely difficult to injure the bladder when it is empty and contract

ed however fatal peritonitis may result from an unnoticed rent in the bladder allowing the escape of urine.

One of the most difficult urological problems is that which accompanies or follows posterior resection of the rectum, or combined abdominoperineal resection. The urinary retention and infection must be held to a minimum when this complication is present. The explanation most frequently accepted is that which attributes this complication to injury to the parasympathetic nerves which control the urinary bladder. Just why this urological condition should exist at all has never been adequately explained. Trauma to the prostate, posterior urethra, and seminal vesicles and further disturbing the supporting structures around the base of the bladder during this operation tend to set up a condition wherein the bladder decompensates, and is found unable to expel urine through a moderately obstructed vesical neck. When this condition exists the vesical neck should be weakened by resection, thus obviating the imbalance existing between the vesical neck and the detrusors. This procedure is not to be attempted until enough postoperative time has elapsed for the patient to regain his vesical function.

Hinman classifies rupture of the urethra as being of four types: (1) of the pendulous portion, (2) of the bulbous portion anterior to the triangular ligament, (3) of the bulbomembranous portion anterior to the triangular ligament, and (4) membranoprosthetic portion at or posterior to the triangular ligament. Dodson states that, with few exceptions rupture of the urethra occurs as the result of a direct blow of the perineum forcing the urethra against the pelvic arch, or as the result of fracture of the pelvic bones.

The author has seen 9 cases of fracture of the urethra, followed by extravasation of urine, in which the bladder was filled close to its capacity at the time of injury. It is believed that the weight of bladder urine, and the movability and sudden jerk caused by the traumatizing agent makes a more complete and extensive laceration of the urethral tear. In such cases the patient's attempt at voiding is not met with success, and it is usually accompanied by such severe pain that immediate relief is sought.

If perineal repair of the divided urethra is required, the urinary diversion and urethral repair can be accomplished and the hemorrhage controlled by exposure per perineum. It is not always easy to find the distal ends of the severed urethra. In some cases it is necessary to open the bladder suprapubically and to pass a sound posteriorly as well as through the perineal wound, or through the urinary meatus, in order to approximate the severed ends of the urethra. Retrograde instrumentation is always best in these cases. After the 2 ends of the urethra are located the repair is easy. The author uses end-to-end anastomosis and perineal closure after a free resection of all bruised tissue and the traumatized ends of the urethra, together with closing of the bleeding points in the ruptured membranous bulb, if such existed.

JOHN A. LOER M.D.

Deming, C. L. : Drainage and Irrigation of the Urinary Tract. *J Urol* Balt. 1947 57 49.

The modern conception of drainage and irrigation of the urinary tract not only implies relief of obstruction and cleansing of the tract by irrigation but also embraces a consideration of the physiology, bacteriology and pathology of the tract as well as the prevention of cardiovascular disease renal complications and hypertension. To accept the principle that any drainage or any so-called tidal irrigation will function continuously without attention is like expecting that your automobile will run continuously without regular and proper adjustment. The fact that the insertion of a drainage tube into any uninfected bladder or kidney will result in an infection of that organ is not yet universally recognized. Irrigations including the so-called tidal drainage for the bladder do not prevent invasion by bacteria, nor does an irrigation completely sterilize organs lined with mucous membrane, it causes only a mechanical cleansing of the epithelial surface and consequently any irrigation which will cleanse the surface without producing a chemical irritation will be efficacious.

The directives issued by the Army during the last war relative to so-called cord bladder lesions have required suprapubic drainage and indicate recognition of the inadequacy of interval catheterization and tidal drainage. Slow decompression of the distended bladder is now generally conceded unnecessary if precautions are taken against a sudden and serious infection. Likewise it would seem that tidal drainage is doomed or that it will be replaced by less complicated mechanisms. The author has not used the so-called tidal drainage for more than 4 years because of its inadequacy and complexity.

The apparatus for urethral bladder drainage and irrigation which has been used for several years is simple efficient, economical, and gives little trouble. The author claims no priority with its use. It consists of a three way catheter and flask of irrigation fluid so constructed as to be a closed system. The apparatus used is the ordinary Fenwal flask which contains physiological saline and is the same apparatus as is used for clysis and intravenous therapy. The flask always has a ready supply of flasks filled with sterile physiological saline. When one bottle is empty it is just a matter of removing the glass rod from the empty flask and inserting it into the new one always keeping the irrigating fluid sterile and the system a closed one. Patients never complain of burning or smarting from the irrigation. If the outflow becomes occluded the inflow usually ceases. If the return fluid becomes cloudy it is a simple matter for the nurse or doctor to allow the flow to run faster for a minute or two or until the return fluid is clear. This can be done at any visit at the bedside. No added apparatus or personnel are necessary to irrigate the bladder adequately. The bladder remains collapsed except now and then and the base is constantly irrigated so that there is very little opportunity for absorption of infection and development of upper urinary tract complications. It is an im-

provement on tidal drainage, even when used for irrigation of the paralytic bladder.

By means of this apparatus preoperative prostatic patients with residual urine are given a continuous saline irrigation by means of a Foley 18F or 20F catheter. Transurethral resection cases are treated similarly as the catheters rarely become obstructed and the bleeding is not exaggerated or prolonged. Following suprapubic prostatectomy irrigation is carried out similarly via urethral catheter and suprapubic tube. After 3 to 5 days the suprapubic tube is removed and the wound is allowed to heal. Patients are treated in the same manner following perineal prostatectomy by continuous irrigation through the perineal tube and perineal tube. After removal of the urethral catheter is continued as long as the catheter remains to keep the bladder and the wound clean.

Much has been written about the drainage of the space of Retzius, and many surgeons seem to have been bogged down in this space. Numerous methods of drainage and various kinds of drains have been inserted. Prolonged drainage has produced complications of a permanent fistula and even osteomyelitis of the pubic bones. The author wishes to call attention to the last contribution of the late Henry Morton in which he stressed the fact that when the operator exposes the bladder suprapubically he should incise the pubovesical or prevesical fascia transversely turn it down and thus avoid opening the space of Retzius. If the space of Retzius is not opened it is unnecessary to drain this area in operations on the bladder.

Boyd has shown the advantage of a rubber tissue drain inserted down to the muscular layer at the upper angle of a long incision in a fat abdominal wall or when the wound is severely contaminated by the bladder contents. However due to the advent of sulfa drugs and penicillin this is now rarely necessary. Drainage of the ureter has given some surgeons much concern and as one visits various sections of the country one finds draining ureteral fistulas. It has been our fortune not to have been troubled with ureteral fistulas. It must be remembered that ureteral wounds heal readily if given half a chance provided that there is freedom of flow of urine in the incisions heal well if a closure of the serous layer is done with fine catgut (00000). If the incision is made on the under side or posterior side similar to a posterior pyelotomy wound there is rarely any leakage. In cases in which the ureter is large and the urine is purulent a gall bladder T tube inserted for a couple of weeks has given the most satisfactory drainage. It allows for irrigation of the whole ureter and free drainage, and the wound rarely leaks urine after the T tube has been removed. The T tube is also of advantage in making an anastomosis of an accidentally severed ureter or in segmental resection of the ureter with end to end anastomosis. The surgical drainages of the kidney are too numerous to describe also the various tubes and



combinations of tubes are many. However the irrigations of the kidney are few and limited mostly to an attempt to dissolve renal calculi with phosphoric acid or the so-called Suby's solution. It is a generally accepted fact that if the kidney is to be drained surgically nephrostomy drainage is preferable to pyelostomy drainage. It is agreed by all that large pyonephrotic kidneys respond better to a large nephrostomy tubular drain passed through the cortex into the pelvis of the kidney and that such drainage shall remain until as much of the restoration of the renal function as possible has been obtained.

The solution of the problem of reconstruction of the kidney pelvis and its drainage in cases of hydronephrosis has been attempted by a number of surgeons, with success by many of them. Two facts are paramount: the first is that if there is an infection the pelvis must be drained; the second is that enough of the hydronephrotic pelvis must be removed to prevent pooling of the urine which often causes a rupture of the suture line and a perirenal infection or recurrent fibrosis at the operative area. After excising the ureteropelvic junction and excess pelvis the anastomosis of the upper ureter is made to the dependent portion of the pelvis over a T tube 12 to 16 F. whichever best fits the ureter. It is unnecessary to disturb the renal cortex or drain the kidney with a nephrostomy tube. The T tube acts as a splint and

is removed about the sixteenth day. In only one of the author's cases was there a leakage of urine after removal of the tube and that occurred for only part of a day.

Operations upon the uninfected obstructed kidney now more than ever before are due for more serious reflection. We recognize the fact that hypertension may be due to renal ischemia. Theoretically may not such a lesion however minute be initiated by introducing an infection into the kidney or by a nephrostomy wound plus an infection, even though the renal wound heals and the infection later clears. Cases in which the kidney is already damaged by obstruction ideally speaking, should have surgical correction without drainage and the resulting temporary infection or a cortical injury by a nephrostomy. Such surgery demands careful and painstaking technique. Few authors indeed there are who advise the primary closure of a pelvic incision without drainage of the urinary tract. The risk of a bad result looms large to the uninitiated but the purpose demands exacting surgery which we must promote if we are to progress in renal surgery. Hypothetically the idea is sound and should be recommended and executed more often because we see patients who come without infection who are operated upon and are left with an infection which is never controlled.

JOHN A. LOFF, M.D.

# SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

## CONDITIONS OF THE BONES, JOINTS, MUSCLES TENDONS ETC

De Leo, F. A Contribution to the Pathogenesis of Volkmann's Ischemic Paralysis (Contributo alla patogenesi della malattia di Volkmann) *Chir org movim* 1946 30 90.

The author shows a series of microscopic sections of tissue specimens taken from muscles afflicted with Volkmann's ischemic paralysis. He shows the various grades of muscular changes from mild hyperplasia of the connective tissue, through the stages of collagenous infiltration about the muscle fibers to complete replacement of the muscular elements by fibrous tissues to a condition which he calls *cirrhosis muscularis*.

After a review of the literature and on the basis of his personal experiences, the author states that it is his opinion that the etiology of Volkmann's ischemic paralysis is pressure produced by hemorrhage and edema in the cubital area of the arm which becomes encased by the deep fascia of the arm until there is a definite ischemia of the nerves in the elbow region usually involving both the median and radial nerves.

For this reason the author believes that the only treatment for Volkmann's ischemic paralysis is a long sitting of the deep fascia of the arm with exposure of both the median and radial nerve roots in the cubital area. He believes that by this method only can the numerous trophic changes which occur in the hand be avoided and also only by this means can the marked destruction of the muscle tissue be prevented. He goes into considerable detail as to why he believes that the prime etiology is not, in itself due to vascular impairment but to direct pressure on the nerves with resulting trophic changes.

CARLO SCUDERI M D

Cabuzzac, M., and Jung, F.: Contusion of the Humeral Artery; Spasm of the Vessels; Volkmann's Syndrome (Contusion de l'artère humérale. Spasme vasculaire. Syndrome de Volkmann) *Rev orthop* Par 1946 32 241

A child of 10 years fell on her wrist while playing and fractured her right elbow. This was on September 4. There was great pain at the site of fracture and the arm was cold and dead below it.

The roentgen examination showed a supracondylar fracture of the elbow and physical examination revealed all the typical nervous and vascular complications. Because of repeated fainting spells operation was delayed until the next day.

An incision over the internal bicipital groove showed that the humeral artery and the median nerve were contused. When the artery was freed the circulation appeared to be restored to normal and the fracture was reduced. Recovery seemed to be pro-

ceeding normally until September 17 when the child complained of intense pain in the forearm and coldness and pallor of the hand. As a stellate ganglion injection could not be made on account of the child's intense fear a perihumeral injection of novocain was given above the cast. On October 6 the cast was removed. On December 4 the hand was cold and violet colored and on slight extension of the wrist, the fingers contracted spasmodically in a typical Volkmann's contracture. Active movements were very limited.

Therefore 3 months after operation for a supracondylar fracture with contusion of the humeral artery and median nerve there was a typical Volkmann's syndrome due to vessel spasm. Ten perihumeral infiltrations of novocain were given and the child gradually recovered.

This case shows all the typical results of arterial spasm and it also shows the efficacy of operations on the sympathetic nervous system in Volkmann's contracture. This syndrome begins slowly and surgery of the sympathetic nerves may cure or improve the condition for a long time after the accident. In this case the authors believe that the early operation with release of the constriction of the artery prevented the development of a much more serious picture. Probably a sympathectomy at the time of the initial operation would have prevented any contracture.

AUDREY G MORGAN M D

Morandi, G.: The Indications and Results of Surgical Reconstruction of the Thumb (Indicazioni e risultati della ricostruzione chirurgica del pollice) *Chir org movim* 1946 30 41

The author reports on 17 cases which came under his observation at the Putti amputation center at Bologna. Two cases involved the upper extremity after the thumb had been lost and 15 involved both upper extremities.

The operative procedure which he recommends is the surgical removal of the second and third metacarpal bones which leaves a sufficient amount of skin for the closure of the cleft resulting from prolongation of the depth of the web between the first and second metacarpals. In addition it gives a space that is sufficient for the production of grasping power; this power is limited if the second and third metacarpals are not removed.

There are 15 illustrations in this article showing the 'before and after findings in a number of cases.

There is no question that with the removal of the second and third metacarpals the hand is smaller but there is definitely a thumb that can be brought over to grasp something against the remaining fourth and fifth metacarpal bones.

In all 17 cases a very satisfactory result was obtained. The author stresses the point that this pro-

cedure is much less formidable and the period of disability of the patient is far shorter than in any other form of thumb reconstruction that has been recommended in the past, such as the transplantation of tibial grafts covered by skin or transplantation of the toes into the stump of the thumb.

CARLO SCUDERI, M.D.

Cabrea, G : Spondylolisthesis (Spondylolistesi) *CAI org mens* 946 30 57

The author gives a very fine résumé of the historical background of spondylolisthesis. He presents 10 cases of his own.

The author gives a very excellent review of the subject including a bibliography.

In concluding he states that spondylolisthesis should be treated by long immobilization in bed followed by local heat and massage and in some cases by the use of x rays. The patient is then permitted to be up and about, always wearing a plaster jacket that is light and very form fitting. Under this regimen the majority of the patients are relieved of pain in the area of the spondylolisthesis. Although the author discusses the different forms of spinal fusion in detail, he does not suggest it as treatment and in none of his cases was any spinal fusion performed.

CARLO SCUDERI, M.D.

Martin P : Pyogenic Osteomyelitis of the Spine. *Brit M J* 1946 688.

Pyogenic osteomyelitis of the spine is approximately three times more common in males than in females, and usually the age of onset is in the third decade that is after the vertebrae are fully formed thus differentiating it from osteomyelitis occurring in the long bones. There is no true epiphyseal growth in the vertebral bodies such as one finds in the long bones. This may account in part for the occurrence of the condition in the third decade or later.

These cases are often so acute and fulminating, and toxemia is so intense that an antemortem diagnosis is not made. The author believes that in many cases the condition labeled tuberculous of the spine, which responds so well to early firm bony fusion is in reality a pyogenic osteomyelitis.

The lumbar region is most frequently involved and the bodies of the vertebrae are generally affected. This is usually a metastatic phenomenon the primary focus being recognizable in about one-half of the cases as a topical infection such as a boil, whitlow, tooth infection, septic wound or another focus of osteomyelitis. The causative organism if it can be obtained directly or by blood culture or from the primary focus is a *Staphylococcus aureus* less commonly a *Staphylococcus albus* or rarely a streptococcus.

The treatment for pyogenic osteomyelitis is immobilization of the spine preferably in a plaster bed until the disease process has subsided and bony fusion is complete. Penicillin is advocated both locally and systemically. If abscesses form, evacua-

tion is recommended. A fusion operation is thought to be unnecessary.

A series of 4 cases is reported.

C. FRED GORRINGER, M.D.

Dellitala, F : Localization of Paget's Disease in a Single Vertebra (La localizzazione vertebrale isolata nel morbo di Paget) *Chir org mens* 1946 30 33

Several diseases have been named for Sir James Paget a distinguished English physician and student of surgical pathology. In this article the author discusses Paget's osteitis deformans. He collected 110 cases from the Rizzoli Institute, the Orthopedic Clinic of the University of Bologna. Twenty of these cases are described and illustrated with roentgenograms. In 10 of these cases the lesion was localized in a single vertebra while in the remaining 10 several vertebrae or other parts of the skeleton were involved.

The disease is probably of endocrine and sympathetic origin, although the chief factor is not known. Clinically there is loss of teeth, deafness, difficult nasal respiration, change in the form and size of the skull and bones of the limbs, rheumatoid pain, and a condition of asthenia. Differential diagnosis is impossible, however, without an accurate knowledge of the roentgen picture of the affected bones. In the case of disease of the vertebrae the affected vertebra shows a dense structure like that of marble (osteolytic type) or large trabeculae arranged irregularly and more transparent than normal (osteoprotic type) because they are made up of osteoid tissue. The vertebra is often enlarged and flattened out between the two adjoining ones. Sometimes the two forms are combined. In advanced stages of the disease the hypertrophy of bone is often extreme.

ARNOLD G. MORAN, M.D.

Dundon, C. G., Williams, H. A. and Lattiply T. C : Eosinophilic Granuloma of Bone. *Radiology* 946 47 433.

The authors analyze the literature on 48 cases of eosinophilic granuloma of bone and add 5 cases of their own.

The condition occurs more frequently in males, in the ratio of 5 to 1. The age of the patients ranges from 6 months to 58 years. Thirty-four of the patients were under 30 years and 10 were under 10 years. Nearly all of the bones proximal to the wrists and ankles were involved. Thirty-six patients had single lesions and in 36 per cent of these the skull was involved and in 16.6 per cent the ribs and femurs. Most patients had from mild to severe pain, swelling of the soft tissues, and tenderness to pressure. A few patients had mild systemic reactions, fever, anorexia, lassitude and weight loss.

Laboratory examinations showed essentially normal conditions except for slight leucocytosis and occasional eosinophilia of from 4 to 11 per cent. Roentgenographic examinations showed round, oval, or irregular areas of decreased density usually from

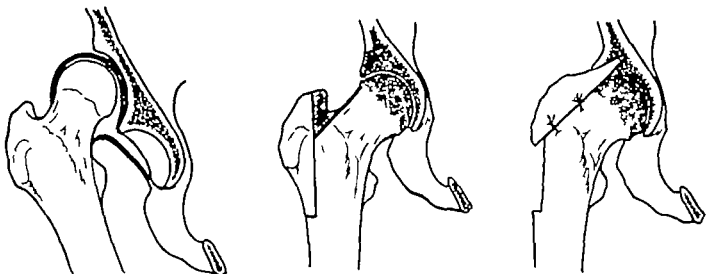


Fig. 1 (Delitala and Pals) Diagrammatic operative procedure for reduction and arthrodesis.

The operative approach which is recommended by the authors is a lateral incision extending from the crest of the ilium down along the line of cleavage between the tensor fascia femoris muscle and the gluteus medius muscle along the anterior aspect of the shaft of the femur for a distance of about 4 inches. Then by subperiosteal dissection the gluteus medius, minimus and maximus, are retracted posteriorly and the tensor fascia femoris is retracted anteriorly. The capsule is then exposed and cut by a T incision with the base along the intertrochanteric line. This permits a good exposure of the head and neck. The iliopsoas muscle is then cut at its attachment to the lesser trochanter. The cartilage from the head is removed and the acetabulum is drilled out so that all cartilage has been removed and the fresh bone of the head and acetabulum are brought in contact. Then by use of a motor saw the greater trochanter and a portion of the upper part of the shaft of the femur are cut and the Hibbs procedure is used for performing the arthrodesis of the hip by inserting the reversed end of the greater trochanter femoral shaft portion of bone into just above the superior lip of the acetabulum. The patient is then immobilized in a hip spica until such time as the x rays show a solid bony union of the arthrodesis.

The author states that it is imperative that the iliopsoas tendon be severed from the lesser trochanter otherwise it is most difficult to obtain a sufficient looseness of the hip articulation to produce a satisfactory reduction and replacement of the head in the acetabulum with sufficient abduction to maintain a good position of the arthrodesis of the hip. The authors also state that because of the fact that there is an actual lengthening of the leg from its previous position, it is necessary to keep the knee flexed at least to an angle of from 45 to 50 degrees at the time that the cast is applied so as not to produce vascular and nervous changes in the extremity. The knee is extended at the end of 2 months when the cast is changed and then another cast is applied which is maintained for a period of 3 to 5 months thereafter

until such time as x ray evidence of a solid bony union occurs.

The authors are reporting on their experience with 10 operative cases. The patients ranged from 14 to 30 years of age. One case was followed up for a period of 20 years.

CARLO SCUDERI, M.D.

**Pals, C.: Secondary Osteosynthesis in Operative Elongation of the Femur (Osteosintesi secondaria nell'allungamento operativo del femore) *Chir. org. movim.* 1946 30 159**

The author describes an improved method of lengthening the femur. After a certain period of traction an oblique osteotomy is performed and a stainless steel wire is run through the apposed surfaces of the fragments; a plaster cast is then applied. This method has proved very satisfactory in his hands. The danger of infection is no greater than in any operative procedure and the occurrence of infection is a reflection on the surgeon's skill and care rather than on the method.

Illustrations showing the exact technique of applying the wire and roentgenograms of the cases operated on, showing the exact degree of lengthening obtained are given in the original article. As compared with Pott's method the necessary period of immobilization is reduced by half—from 6 months to 3.

AUDREY G. MORGAN, M.D.

**Giuntini L.: Surgical Mobilization of Rigid Joints with Interposition of Absorbable Membranes (La mobilizzazione chirurgica delle rigidità articolari con interposizione di membrane assorbibili) *Chir. org. movim.* 1946 30 216**

Various living tissues, including muscle, aponeurosis, fat and tendons have been used in joint surgery to prevent recurrent ankylosis. The author has been experimenting with the use of gelatin for such interpositions. He has used it in experiments on rabbits and describes 2 clinical cases in which it was used one involving the elbow joint and the other the ankle. His work is illustrated.

1 to 4 cm. in diameter. The lesions produced expansion of the bone in 5 cases and perforation of the cortex in at least 5 cases. Periostitis was present in 14 cases, and 3 lesions had sclerotic margins.

At operation the early lesions contain soft, friable yellowish brown and red material. Microscopically, the characteristic cell is a large mononuclear cell with granular cytoplasm. There are a variety of other cells, including large numbers of eosinophils. Treatment by surgical excision, curettage or irradiation has given good results. No death has been attributed to the disease. VERNON C. TURNER, M.D.

### SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Renon, C. and Calvez, L. Screwing the Ruptured Tendon of the Long Portion of the Brachial Biceps into the Diaphysis of the Humerus (*Le suture diaphysaire dans les ruptures de la longue portion du biceps brachial*). *Rev. chir.* Par. 946, 3: 353.

Rupture of the tendon of the long head of the biceps may result from violence or it may occur in longstanding arthritis of the shoulder without any unusual effort. The authors describe a case in a man of 42 years who on lifting a sack weighing 75 kgm. felt intense pain and a tearing sensation in the left arm. Examination revealed rupture of this tendon.

The authors recommend screwing the end of the ruptured tendon into the humerus in the bicipital groove at the level of the muscle insertion to accomplish fixation of the fleshy body of the muscle in the normal position. The thing to be avoided is too low fixation of the ruptured tendon. It is simple and easy. The review of a case operated on in this way 18 years ago shows that there is no injury to the bone from the screw. A Lambotte screw 3 cm. long is passed through the tendon; needless to say the tendon must be sufficiently solid and intact so that the screw can be passed through it without tearing. An opening for the screw is made in the humerus with a perforator and the screw fixed in it. The arm is then kept in plaster for 3 weeks with the elbow at a right angle.

Blondin and Roy have recently recommended suture of the ruptured tendon to the anterior branch of the V-shaped insertion of the deltoid tendon. The authors do not advocate the complete replacement of this method by that of screwing. Both have their indications. AUDREY G. MORGAN, M.D.

Gherlinzoni, G.: Surgery of Spastic Deformity of the Wrist and Hand (*Contributo alla chirurgia delle deformità spastiche del polso e della mano*). *Chir. org. movim.* 946, 3: 176.

The results of surgery in spastic deformity of the wrist and hand have been so poor that many surgeons have given up all attempts at surgical management of this condition. Statistics from the Orthopedic Hospital in Los Angeles show that among 1000 cases

of spastic deformity in childhood, 542 operations were performed. Only 65 of these were on the upper limb, 21 on the wrist and 10 on the hand.

The author discusses 25 cases operated on at the Rizzoli Institute, the Orthopedic clinic of the University of Bologna, for spastic deformity of the wrist and hand resulting from the tetraplegic form of Little's disease and infantile cerebral hemiplegia. Some of these cases were caused by spasm of the muscles of the forearm and others by spasm of the muscles of the hand itself. The degree of flexion of the wrist varied from a very slight one to one so extreme that the palm of the hand rested against the forearm. The operations performed in these cases were plastic elongation of the flexors of the wrist, arthrodesis of the wrist, capsuloplasty of the radiocarpal joint with tendon fixation of the radial extensors and tendon transplantation at the wrist.

The latter operation was performed in 15 cases. In the great majority of the cases the tendons transplanted were two—those of the palmaris longus and of the anterior cubital muscles, the former being fixed to the extensor pollicis longus, the radialis, or the extensor communis, and the latter chiefly to the extensors ulnaris or radialis of the wrist. Cases are illustrated, showing just what tendon transplantations were made and the results of the operations.

Tendon transplantation is the preferred operation in these cases. The esthetic results were good in all, the deformity being permanently corrected. In 8 of the cases a certain degree of function was restored. Complete restoration of active motility is not to be expected.

Cases for operation must be carefully selected. Those in which brain function is too much affected or in which choreoathetoid manifestations or deformities of the bones and joints are present must be excluded. AUDREY G. MORGAN, M.D.

Dellitala, F., and Pais, C.: The Reduction and Arthrodesis of Old Unilateral Congenital Dislocations of the Hip (*La riduzione-artoidei nella lussazione congenita inveterata unilaterale dell'anca*). *Chir. org. movim.* 946, 3.

The authors definitely believe that old congenital dislocations of the hip which are unilateral in type should be fused once they begin to give manifestations of progressive pain, deformity, and poor walking habits. No other method do they think, gives as gratifying a result and as great a possibility of success as arthrodesis. The freedom from pain, the stability of the hip and the better walking habits of individuals with old dislocations of the hip certainly more than compensate for the loss of motion in this one articulation.

The authors believe that an arthrodesis is far preferable to the old Lorenz bifurcation operation or subtrochanteric osteotomies which are performed by some men. In a few selected cases they believe that the shelf operation is of value—when there is a fairly good acetabulum and not much evidence of subluxation or osteoarthritic changes associated with pain.

Murray G. End Results of Bone Grafting for Nonunion of the Carpal Navicular. *J Bone Surg* 1946, 28 749

The author presents the results in 100 cases in which bone grafts were used for nonunion and fractures of the carpal navicular bone. Excellent results with good function of the wrist were obtained in the majority of the cases.

The author suggests that certain principles must be followed to obtain the best results. The bone graft must be large and well placed so that both fractured fragments are well approximated. The drill hole must be made so that the surrounding articulations are not involved. The fractured fragments must be impacted and the graft so placed that it holds the fractured fragments in good apposition. The splint must include the wrist and all metacarpals, and the proximal phalanges so that the normal movements are completely prevented for a minimum of 10 weeks. Immobilization must be continued until there is x-ray evidence of union of the graft to both fragments. The bone grafts in this series were usually taken from the tibia.

A table is included showing the data on 100 cases of bone grafting for nonunion of the carpal navicular bone. There were 4 cases of nonunion after bone grafting.

The contraindications to bone grafting for nonunion of the navicular are: (1) recent fractures and (2) arthritis in the wrist. Considerable bone grafting of the navicular does not lessen the tendency toward arthritis in the wrist.

The functional end results in these cases were excellent.

RICHARD J. BENNETT JR. M.D.

Larrew, J.: Pathological Luxations of the Hip Following Osteoarthritis in Infants (Luxations pathologiques de la hanche consécutives à l'ostéoartrite du nourisson). *Rev orthop* Par 1946 32 213.

The hip is the joint most frequently involved in osteoarthritis in infants. The disease is generally seen in the first few days or the first few months of life. The author's 14 patients were seen later for the sequelae of the osteoarthritis, that is dislocation of the joint surfaces. The 14 cases are described and illustrated with roentgenograms.

Operation was performed in all cases as nonoperative reduction is practically impossible in these cases. The causative organism of the osteoarthritis is generally the streptococcus, although some cases have been known to be caused by the staphylococcus aureus. The beginning localization of the disease is in the bone on the metaphyseal side of the joint cartilage.

Ombredanne and Longuet say that there is luxation in almost all cases, but among the author's 14 cases there were only 2 of luxation and 12 of subluxation. The capsule is generally preserved which is important in reconstruction of the joint. The acetabulum is preserved and lined with cartilage and frequently contains membranous adhesions. The

head and a considerable part of the neck are destroyed.

The author's aim is to restore the reconstructed neck to the acetabulum and provide for its fixation at that point. The steps of the operation are illustrated. A transtrochanteric incision is made and the capsule is incised circularly near the base of the neck. When the joint is opened the adhesions are removed from the acetabulum. The difficult part is the preparation of the upper end of the femur. The chondrophytes which adhere to the stump of the neck are removed and the obliquity of the neck is restored by an incision like that of Whitman's operation. White wax is used for hemostasis of the bleeding surfaces. The segment of the neck is introduced into the acetabulum in marked abduction. The operation is terminated by careful fixation of the capsule to the base of the neck. The joint is kept in position for about 6 weeks with a plaster cast.

A secondary osteotomy of the neck is performed after about 3 months in cases of subluxation and after from 4 to 6 months in those of complete luxation. In the first case the osteotomy was performed at the time of the first operation but the neck was absorbed; therefore it is performed secondarily now. In some cases the limb had a marked tendency to assume a position of flexion-adduction. In such cases the patient should wear a leather apparatus to keep the hip in good position for about a year. The operation should be performed at an early age about 3 years.

AUBREY G. MORGAN M.D.

Turner C. G.: Stable Osteosynthesis. Personal Experience with Kuentscher's Method (La osteosintesis estable. Experiencia personal con el método de Kuentscher). *Rev espal cir* 1946 3 93.

Kuentscher introduced the so-called nailing of bone marrow which employs a steel nail containing 8 per cent of nickel and 18 per cent of chrome. Such a nail does not undergo any changes in the body and is resistant to corrosion. Unlike the nails made of other kinds of steel such a nail does not produce an electrolytic reaction. The transverse section of the nail is V shaped. Either straight or curved nails may be used according to the location of the fracture. The function of osteoblasts is not altered by the presence of the nail. Vitallium may also be suitable for such purposes although it is not as resistant as steel. On the other hand, tantalum, because of its physical properties cannot be used for bone marrow nailing. Plastic substances, which are derivatives of acrylic resins, are not sufficiently resistant and durable.

A straight nail is applicable when the transverse diameter of the medullary cavity is uniform in the entire bone. This is the case in the diaphysis of the femur. On the other hand the humerus has the conical shape of the medullary cavity with the narrow side pointing upward; therefore, a nail introduced in the region of the fossa of the olecranon can immobilize sufficiently only a fracture of the lower third of the humerus. In the lower portion of the tibia an hour

As gelatin is closely related physicochemically to synovial fluid and as it is easy to prepare and apply it would seem to be the best physiological agent for this purpose. The clinical cases in which the author used it presented absolute rigidity of the involved joint from an old fracture or another injury. The gelatin, which is an organic extract of bone and cartilage, is dissolved in 40 parts of water and boiled for from 45 to 60 minutes until the solvent is completely dissolved. It is then spread on sterile dishes to form a thin layer and after cooling and condensation this thin layer of gelatin is spread over the bleeding joint surface which has been produced by operation. The gelatin prevents the formation of connective tissue which would reproduce rigidity and the joint remains mobile.

In the author's cases this mobility has persisted for from 4 to 5 months after operation but it will require more time to tell whether the mobility will remain permanent. If it does, this method of interposition should prove useful in other operations, such as operative elongation of the femur and osteotomy of the neck of the femur for *coxa vara* or *valga*, in which it is necessary for the two bone fragments to move on each other. The author knows of no other substance so well adapted to prevent too early fusion as gelatin. AUDREY G. MORRAN, M.D.

### FRACTURES AND DISLOCATIONS

Patrick, J.: A Study of Supination and Pronation, with Especial Reference to the Treatment of Forearm Fractures. *J Bone Surg* 94b, 28 737

This study is based on 6,000 fractures of the forearm treated during the past 11 years. There are also included nontraumatic cases with limitation of rotation due to other causes. 1,245 cases presenting more than slight limitation of rotation were particularly investigated. Normally the range of rotation seems to decrease with age, there being a wide variation in the normal range of supination and pronation. Pronation shows the greater individual variation and in normal adults may be as little as 30 degrees. Supination is rarely less than 70 degrees. The interosseous border of the ulna can be regarded as corresponding to the line of the axis of rotation of the radius.

Six hundred and thirty-seven forearm fractures excluding those with imperfect reduction or malalignment were studied for the average combined limitation of supination and pronation for fractures of the radius and ulna, respectively at the different levels, with the exception of some fractures of the head of the radius. Fractures above the level of the interosseous membrane do not cause limitation of rotation after union has occurred. This is true also of fractures of the radial styloid. Cases of Colles fracture show limitation of rotation.

This problem was investigated by taking arthrograms of the joint space between the head of the ulna and the fibrocartilage. In the fractures with limitation of rotation some degree of obliteration of this joint space could be demonstrated. Measurements

showed that limitation of supination was usually twice as great as limitation of pronation. This degree of limitation is quite unpredictable. There appears to be no relation between the degree of the original displacement and the extent of loss of rotation. Nor does perfect reduction necessarily insure a full return of rotation. Most fractures of the head of the radius produce no limitation of rotation. Even careful excision of the head of the radius gives varying degrees of limitation of rotation.

In fractures of the radius and ulna at the level of attachment of the interosseous membrane there will be some loss of pronation. The restriction of rotation in isolated ulnar fractures is rarely permanent. Callus or fibrous tissue extending into the interosseous membrane from the radius cannot affect the range of rotation of the radius. It was found that the attachments of the articulating discs were torn and caused the disability. Isolated fractures of the shaft of the radius with displacement demand careful treatment. In fractures of the shafts of the radius and ulna above the level of the interosseous membrane there was no loss of supination or pronation after the fractures had united. During the past 5 years 32 cases of fracture of the head of the radius have been treated by excision with the result that there has been an almost complete return of rotation. Open operation of fracture of the ulna may result in an increase in callus and fibrous tissue around the fracture and, unless absolutely necessary, operation should be avoided. The author incorporates a calico bandage in the last layer of plaster just below the elbow joint and suspension is carried out from this level. With this method, there have been no cases of angulation occurring under plaster.

In cases in which cross union in the lower one-half of the forearm between the radius and ulna have occurred, the treatment consists in excision of 1 inch of the ulna at the site of fracture as well as of the mass of callus between the bones. A full range of supination and pronation is obtained. When cross union has occurred in the middle third of the forearm, treatment is difficult. Here it is necessary to excise 1½ inches of the ulna with callus. After 3 months, a whole thickness fibular graft may be inserted across the gap. When severe permanent limitation of rotation develops after Colles fracture, excision of the head and neck of the ulna is suggested as a reliable way to recover full rotation. Twenty of 24 patients undergoing such operations were finally discharged without any complaint of disability. Volkman's contracture can be improved by physical therapy.

When there is loss of rotation in paralytic and spastic states, a curvature of the shaft of the ulna may develop. Considerable improvement in the range of rotation can be obtained by performing an osteotomy on the upper third of the ulna and realigning the shaft so that the interosseous border conforms to the axis of rotation of the radius. This is best accomplished by forcing the forearm into full supination or pronation after osteotomy and fixing it in plaster. RICHARD J. BENNETT, JR. M.D.

## SURGERY OF THE BLOOD AND LYMPH SYSTEMS

## BLOOD VESSELS

Stowers, J M and Grossman M E.: Thrombosis of the Inferior Vena Cava *Lancet* Lond 1946 2 868

The principle of proximal ligation in the treatment of venous thrombosis whether it be for a spreading thrombophlebitis or a silent phlebothrombosis of the lower limbs is currently gaining favor. Appropriate ligation of the inferior vena cava for venous thrombosis of the pelvic veins has been recommended by DeBakey and others as a lifesaving procedure in some cases. It combats the chance of pulmonary embolism or possibly the sudden extension of the thrombus to occlude both renal veins.

Formerly thrombosis of the inferior vena cava was regarded usually as an incidental happening difficult to diagnose and in any case, of little more than academic interest. The authors believe however that thrombosis of the inferior vena cava may be more common than is realized and that great practical surgical importance may now rest upon a reliable method of diagnosis.

The authors describe in detail a technique of phlebography in which a radio-opaque substance diodone is injected into one of the tributaries of the sphenous vein near its junction with the femoral vein and roentgenograms are taken during and immediately after the injection. Sensitivity to diodone is carefully determined by either the intradermal method or the ocular method. As a final safeguard, 2 c.c. of diodone are injected intravenously and the patient is observed for untoward reactions.

A neat maneuver, used by the authors to enhance the radio-opacity of the phlebograms is the employment of a blood pressure cuff below the site of injection thereby decreasing the dilation of diodone with venous blood from the limb. About 30 c.c. of 70 per cent diodone is injected through an 18 gauge needle in about 20 seconds. Films are taken at 5, 15, 25 and 35 second intervals after initiating the injection.

Two case records are reported in which diodone successfully demonstrated the occlusion of the inferior vena cava. The question of the practical importance and technical performance of this method in the presence of a thrombosis of the inferior vena cava, when it occurs in association with iliac and femoral thrombosis was not discussed.

EDWARD F LEWISOM M.D

Elkin, D. C.: Exposure of Blood Vessels. *J Am M*  
*Ass* 1946 132 431

The author is desirous of emphasizing the importance of knowing the anatomical relationships of vascular trunks in order to perform operative procedures on the blood vessels intelligently and safely. Adequate exposure is essential but the placing of

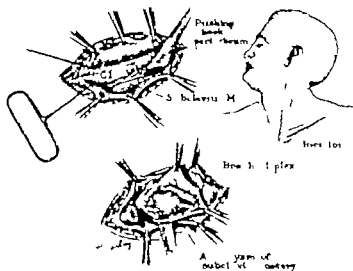


Fig. 1 (D. C. Elkin) Subperiosteal resection of the clavicle for exposure of vessels at the base of the neck.

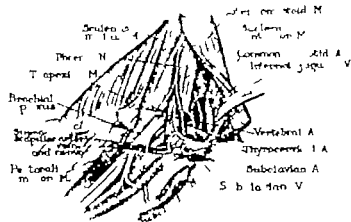


Fig. 2. Exposure of the vessels at the base of the neck. The medial half of the clavicle has been removed. Medial retraction of the carotid sheath exposes the vertebral and thyrocervical vessels at their origin. Further exposure is obtained by dividing the scalenus anterior muscle (after Henry)

the skin incision must conform to recognized surgical principles.

The methods of exposure of most of the major vascular trunks are described with superiosteal resection of a clavicular segment and of the fibular head to expose the vessels at the base of the neck and the proximal portions of the tibial and peroneal vessels respectively it is neither necessary nor advisable to replace these resected segments. The most difficult exposure described is that of the vertebral vessels because of the deep position in which they lie in the neck and because of the vital nature of the surrounding structures. The approach to the vessels lying within the thoracic cage is difficult because of the



glass constriction of the medullary cavity is usually found and this narrow space interferes with the introduction of the nail.

The V-shaped nail causes only a minimal irritation of the medulla. Usually eosinophilia, more pronounced in children than in adults, follows the introduction of the nail. The sedimentation rate is usually accelerated but no effect on the amount of hemoglobin or on the number, size, or shape of red or white blood corpuscles could be observed. Eosinophilia is attributable to the irritation of the red bone marrow of the epiphysis in the vicinity of the nail.

There is no unanimity of opinion as to whether the nail favors or inhibits regeneration of bone.

The introduction of the nail is not difficult for an experienced bone surgeon. A strict observance of technical rules laid down by Kuentscher is essential.

The author has never observed fat embolism which was attributable to the introduction of the nail into the bone marrow. Infection of the fracture is possible if strict asepsis is not observed. As a rule such infections are mild because the area is immobilized; the medulla possesses a strong bactericidal action, normal nutritional and circulatory conditions of the involved region are maintained and the metal apparently inhibits the progress of infection. Lane's technique is advisable and a local application of sulfathiazole is recommended by the author. Frequently a transient

stiffness of the articulation distal to the fracture is observed. Such stiffness as a rule disappears spontaneously within a few weeks. The stiffness may be accompanied by edema and may be interpreted as a reflex sympathetic dystrophy.

The indications for the introduction of the nail are as follows: (1) fractures in patients whose age or general condition make prolonged immobilization undesirable; (2) spontaneous fractures caused by nonmalignant processes; (3) transverse fractures of the diaphysis which frequently show a tendency to lateral displacement; (4) fractures which can be easily reduced but are difficult to maintain in good apposition; (5) fractures of a diaphysis with an annular fragment; (6) fracture dislocations of the neck of the humerus; (7) pseudarthrosis, fractures with delayed consolidation, and osteotomies; and (8) compound fractures of recent origin.

As to the use of the nail in spontaneous fractures caused by malignant tumors, there is a potential danger of propagation of the tumor due to pressure exerted by the nail on tumor cells.

The nailing favors excellent results in transverse fractures of the middle third of the femur.

The method is contraindicated in infected fractures and those of infancy and adolescence because of the danger of impairment of the functions of the hemopoietic system.

JOSEPH E. NARAT, M.D.

# SURGERY OF THE BLOOD AND LYMPH SYSTEMS

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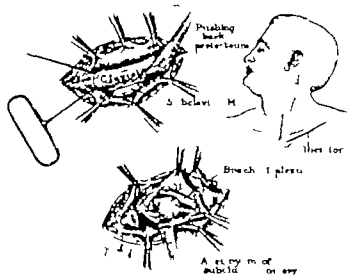


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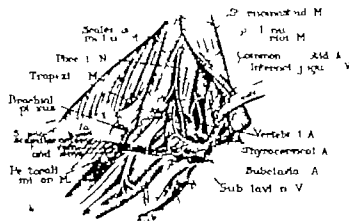


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Fig. 3 (D. C. Elkin) Exposure of innominate vessels in case of arteriovenous aneurysm. A portion of the clavicle, first and second ribs and sternum have been removed in A. B shows the false sac with the false aneurysm sac. C is a transverse section showing the false sac and communication between the artery and vein. D shows the vessels ligated and divided.

overlying structures and the difficulty is enormously increased in the presence of an aneurysm or arteriovenous fistula because of the danger of hemorrhage. The adequate exposure necessary here is gained only by resection of portions of the first and second ribs and of a segment of the sternum in addition to removal of part of the clavicle.

The methods of exposure of the larger vessels in the extremities are also described.

EDWARD H. CAMP, M.D.

Gordon, L. Z., and Thurber, D. C.: Temporal Arteritis; Report of a Case and a Comparison with Respect to Periarthritis Nodosa. *Arch. Path. & Clin.* 1946, 4, 4.

First described in 1932, temporal arteritis has been reported occasionally in the literature as a definite clinical and pathologic entity. A great diversity of symptoms has been described with this condition including fever, anorexia, malaise, anemia, weight loss, and pain along areas of the temporal arteries and over the scalp, and it has generally been found that the condition is associated with widespread involvement of the arterial tree, the aorta, and the carotid, subclavian, cerebral, and iliac, as well as temporal arteries.

A case of temporal arteritis is described and a pathologic comparison is made between this condition and periarthritis nodosa. The case was that of a 65-year-old white laborer whose chief complaint was severe headache and pain over both temporal regions.

He further stated that he had had severe pain in his thighs 2 months previously. Thickened, tender, and pulsating temporal vessels were seen. Other findings were negative except for thickened radial and pedal arteries. Temporal pain subsided abruptly on the second hospital day; the constitutional symptoms cleared, and 8 months later when the patient was seen he was asymptomatic. A biopsy of the temporal arteries on the fourth hospital day revealed that the walls were thickened and infiltrated with lymphoid cells; the internal elastic membrane was reduplicated, pigmented, and destroyed in places, and the media was edematous and infiltrated with lymphocytes and plasma cells with occasional small areas of necrosis. The specimen had the appearance of a granulomatous lesion. It was concluded that the patient had suffered from a generalized arteritis, with progressive involvement of different arteries.

The authors concluded from a review of the literature and their own findings that every histologic picture described in temporal arteritis so far can be found in periarthritis nodosa. It is impossible to differentiate the two conditions on the basis of cellular responses; both conditions go through destructive and reparative phases which are similar. The statement that there is specifically an axial spread in temporal arteritis and a local lesion in periarthritis nodosa has been controverted in many instances.

The differences between temporal arteritis and periarthritis nodosa are as follows: (1) periarthritis nodosa involves the visceral and only less commonly

a few of the medium sized and smaller peripheral arteries temporal arteritis has its predominant involvement in the aorta and in its larger branches (innominate carotid subclavian iliac as well as the temporal arteries) (2) temporal arteritis is observed twice as frequently in women as in men (3) temporal arteritis has never been reported in anyone under 55 years of age whereas periarteritis nodosa is most frequent in young adult males and (4) periarteritis nodosa is usually fatal whereas patients with temporal arteritis usually recover.

Periarteritis nodosa is called a misnomer by the authors, as occasionally the nodose character of the lesion is absent. Temporal arteritis is also incorrectly named as often the involvement is not limited to the temporal arteries and on occasion the temporal arteries may not be involved. It is suggested that periarteritis nodosa be called panarteritis predominately of the visceral arteries and that temporal arteritis be called panarteritis predominately of the aorta and its peripheral branches.

PHILIP B. CHASE, M D

### BLOOD TRANSFUSION

Leffebvre F. Transfusion and Autotransfusion of Oxygenated Blood in the Treatment of Asphyxia, Electrocution Drowning and Carbon Monoxide Poisoning. (La transfusion et l'autotransfusion oxygénée dans le traitement des asphyxies, électrocutions, noyades et intoxications par l'oxyde de carbone) *Presse méd.* 1946 54 833

In cases of asphyxia artificial respiration often fails for two reasons:

1 In many cases, especially in drowning the lower portion of the respiratory tract is obstructed because of the aspiration of water or other substances and the walls of the alveoli are adherent to each other like two sheets of wet blotting paper this prevents the oxygen from passing into the lung capillaries.

2 Even if the lower respiratory tract is free and oxygenation of the pulmonary blood by artificial respiration is possible this blood does not circulate in the systemic circulation when the heart has stopped beating as in electrocution or reflex collapse.

In these conditions it appears more rational to inject oxygenated blood directly into the heart, rather than to try artificial respiration. The author experimented on cats which were kept under water

for different periods up to 30 minutes. Then the thorax was opened for observation of the heart and a few cubic centimeters of oxygenated blood were injected intracardially. In all of the cases the heart started contracting again the cyanotic color of the muscle changed to bright red and systemic circulation could be observed. After the oxygen had been exhausted, the contractions stopped. This experiment can be repeated any number of times in the same individual.

On the basis of these experiences the author developed the following routine for the purpose of resuscitation.

Oxygenated blood is injected intracardially. One minute later, the cardiac muscle is stimulated electrically. This proceeding is repeated in the same order until contractions of the heart set in. After the beginning of heart pulsation, the injection of oxygenated blood is continued by the intravenous way. The blood is supplied either by heterotransfusion or autotransfusion. The latter method is preferable, except for cases of severe hemorrhage as the amount of available blood is not limited. The blood is drawn from the femoral vein and passed through the oxygenating apparatus before being reinjected either in the heart muscle or in the vein. The author considers this as the method of choice in all cases in which the cardiac muscle is in a condition of asphyxia without lesion of an organ (electrocution syncope during anesthesia).

The treatment of carbon monoxide poisoning by autotransfusion presents a special problem. Since the affinity of carbon monoxide to hemoglobin is 210 times greater than that of oxygen blood which had been exposed to carbon monoxide cannot be oxygenated in the usual oxygenation apparatus. To substitute the oxygen for the carbon dioxide, oxygen has to be brought in contact with the blood under high pressure. The development of this method is still in the experimental stage and has not been applied to clinical cases.

Altogether it seems that the work of the author has not gone beyond the stage of animal experiments since he does not mention any experiences with cases of asphyxia in man. He reports however that Vladimir Negovsky in Russia has developed a similar method which was applied successfully to wounded soldiers. Of 51 patients who were considered lost 12 were resuscitated by autotransfusion of oxygenated blood.

WERNER M. SOLMITZ M D

# SURGICAL TECHNIQUE

## OPERATIVE SURGERY AND TECHNIQUE POSTOPERATIVE TREATMENT

Baronofsky I. D., Treloar A. E. and Wangersteen O. H.: Blood Loss in Operations: A Statistical Comparison of Losses as Determined by the Gravimetric and Colorimetric Methods. *Surgery* 1946, 20, 76

Earlier methods for the determination of blood loss in operations involved colorimetric estimations by the acid hematin method of blood washings from sponges, linens, and instruments. The latter test could be done only after the completion of the operation. Further there was no direct correlation between the amount of blood lost and changes in hematocrit hemoglobin and plasma protein concentration.

In the present investigation the blood loss from various operations was determined by the gravimetric method by means of a small weighing scale used directly in the operating room. Only dry sponges were used. The average weight of a 4 by 8 centimeter Curry x ray sponge was 6 grams and that of the laparotomy ring sponge .38 grams.

The results from the gravimetric method were compared with those obtained by the colorimetric method. The average blood loss during appendectomy was 25.8 c.c. during hernia 82.0 c.c. during gall bladder operation 179.4 c.c. subtotal gastrectomy 456 to 500 c.c. thyroidectomy 406 c.c., and pneumonectomy 1,543 c.c. Comparison with the colorimetric method showed good agreement between the two tests.

BENJAMIN G. P. SHIFFRITZ M.D.

Abbott W. E.: Chemical Alterations Occurring in the Surgical Patient and Their Interpretations. *Surgery* 1946, 20, 770.

Methods for the correction of the chemical and physiologic disturbances in the sick and injured are not dependent on the accumulation of a large variety of laboratory data but rather on the proper clinical interpretation of the metabolic disturbance. Although there are accurate chemical methods for the estimation of hemoglobin cell volume specific gravity of the blood and plasma protein etc. such values may become misleading especially when they are not paralleled by estimations of the circulating blood volume. It has been demonstrated that normal hematocrit values in males may vary between 41.8 and 52%. Blood studies often yield normal values in spite of obvious clinical states of malnutrition or dehydration.

In a study of 6 cases of gastric obstruction hematocrit and plasma protein values were within normal limits but the plasma volume was subnormal and masked, by this dehydration, a reduced cell mass and a low total circulating protein. Postoperative edema, either the local or general type, is related to a variety of factors such as protein depletion particularly of the albumin fraction increased filtration pressure in

creased capillary permeability loss of tissue elasticity kidney or endocrine dysfunction lymphatic obstruction or postoperative salt intolerance. The administration of isotonic salt solution is often undesirable because a greater percentage of the ingested water is excreted thus creating a hypertonic extracellular phase of salt which in turn causes the withdrawal of water from the cell. Such salt intolerance may result in death due to pulmonary or cerebral edema. The administration of half strength isotonic solution may produce a hypotonic extracellular phase with a shift of water to the intracellular deposits.

Normal plasma chloride or sodium concentrations may be obtained both in the state of dehydration and in overhydrated patients. Proof was presented that the degree of hydration or deficiencies of sodium chloride could not be determined from a plasma chloride estimation. Edema may appear in patient with a normal plasma protein concentration yet it may fail to appear in others with a low plasma protein concentration showing that water and salt consumption are equally important in the process of edema formation. In intestinal obstruction, dehydration and plasma volume reduction follows as a consequence of a reduced intake of fluid plus the loss of fluid by vomiting, distention hemorrhage transudation and infection. The prerenal azotemia or elevated urea nitrogen of intestinal obstruction is due to the lack of fluid necessary for the excretion of nitrogenous end products. In such cases 4,000 to 5,000 c.c. of 10 per cent glucose in distilled water may be necessary to carry off the products of nitrogenous breakdown.

The author emphasizes that parenteral therapy should be dependent on the findings of a careful physical examination and the logical interpretation of a detailed history. In addition, blood chemistry an accurate record of intake and output, plus the determination of the specific gravity the chlorides and the nitrogen in a 24 hour sample of urine will serve to direct the kind and quantity of fluid the patient needs.

Dr. JAMES G. P. SHIFFRITZ M.D.

Gibson J. H. Jr. and Freeman L. W.: The Primary Closure of Decubitus Ulcers. *J Surg* 1946, 24, 48

The surgical problem presented by a large decubitus ulcer is similar in many respects to a third degree burn with a full thickness skin loss. The end results of spontaneous healing and skin grafting are unsatisfactory because they do not provide full thickness skin and subcutaneous tissue over bony prominences.

A method of operative closure of decubitus ulcers described. It involves (1) complete excision of the ulcer its margin and all pockets without contamination of the wound (2) the formation of skin flaps in the immediate vicinity with curved borders and broad bases (3) the rotation and advancement

of these flaps to cover the skin defect without ten sion and (4) the use of very fine cotton thread for suture material.

Sixty-five ulcers were operated upon by this method in 43 patients. Primary healing took place in 44, or 68 per cent, but the results could be regarded as satisfactory in 59 or 90 per cent.

The author believes that complete excision and immediate plastic closure is the best method of treating bedsores in young patients with paraplegia.

EMIL C. ROBINSON, M.D.

Fontaine, R., and Greiner-Oswald, A.: *Diagnosis of Pulmonary Embolism, and Its Treatment Except by the Method of Pulmonary Embolotomy* (Identification et traitement des embolies pulmonaires, l'embolotomie pulmonaire exceptée) *J. chir. Par.* 1946 62 249.

Extensive animal experiments are described which show that massive pulmonary embolism with obstruction of the trunk of the pulmonary artery as described by classical writers really exists and that it is found in approximately two-thirds of the cases terminating in sudden death. However in about a third of the cases with rapid death obliteration of the circulation had not occurred in enough of the lung surface to cause death in itself. The cause of death in massive pulmonary embolism is not entirely mechanical death is partly due to reflexes originating in the endothelium of the vessels and bringing about vasoconstriction and dilatation of the right side of the heart with stagnation of the blood in it.

The embolism may represent the whole of the venous thrombus. Such thrombi are brought about by slowing of the circulation, changes in the walls of the veins, and changes in the blood. Surgery tends to bring about such changes in the blood that it is not astonishing that postoperative embolism occurs but that it does not occur more frequently. Whether or not a thrombus breaks off and forms an embolism depends to a great degree on the rapidity of retraction of the clot; an excess of platelets favors retraction and therefore embolism. If the exact physico-chemical changes in the blood could be determined and prevented it would be possible to prevent embolism entirely.

There are four typical forms of clinical picture in acute embolism: the syncopeal form, the form accompanied by anguish, the form with cardiovascular collapse and the form with respiratory asphyxia. Diagnosis is not too difficult in these classical forms but there are atypical forms with hemiplegia or peritoneal syndromes in which diagnosis is very difficult. Most of the mistakes in diagnosis are made in these forms.

As to treatment, the author does not discuss the only really curative treatment, pulmonary embolotomy as this is to be discussed by Redon in another article. The prevention of venous thrombosis requires careful and delicate handling in surgical operations. Factors which tend to prevent venous stasis are early exercise in bed, massage and elevation of the foot of

the bed. Early rising activates the circulation in the lower limbs and in this way combats one of the factors of postoperative thrombosis. Preoperative surgical treatment of varices reduces stasis. Hypercoagulability of the blood may be treated with heparin and the derivatives of coumann. However none of these methods is absolutely effective. Once thrombosis has developed an effort may be made to prevent embolism by ligating the vein in front of the embolus by phlebectomy (excising the obliterated segment of the vein) or by thrombectomy. Villaret, Justin Besancon and Bardin use ephedrine for its action on the sympathetic system, neutral atropine sulphate as a vagolytic drug and bicarbonate of soda for alkalization.

When pulmonary embolism has developed analgetic drugs to quiet the patient's excitement, heart tonics excluding digitalis and papaverin as a peripheral vasodilator should be given to the patient. Minor surgical procedures may be used such as infiltration of the stellate ganglion and intravenous and intrapleural injections of novocain.

AUDREY G. MORGAN, M.D.

Redon, H.: *The Surgical Treatment of Pulmonary Embolism* (Traitement chirurgical de l'embolie pulmonaire) *J. chir. Par.* 1946 62 267.

The idea of opening the pulmonary artery and extracting an obstructing embolus was conceived first by Trendelenburg in 1907. Up to 1939 130 cases have been published, 12 of which were successful. Probably the true mortality rate is even higher since many unsuccessful operations may not have been published. In view of this high mortality many surgeons are pessimistic and hesitate to operate at all; however it should be possible to decrease the mortality rate under three conditions: precise indication, perfect organization and impeccable operative technique.

The time between the occurrence of a massive embolism of the pulmonary artery or one of its main branches and death is between 30 and 45 minutes on the average; however this time may frequently be prolonged to several hours. As some patients survive without operation the surgeon should be ready for operation at shortest notice but should wait at the bedside sometimes for hours and decide on operating only when the patient begins to die. Perfect organization means that a surgeon trained and experienced in embolotomy should be available on shortest notice, i.e. within 30 or 25 minutes and that the equipment should be complete and always ready for use.

The technique follows more or less the original concept of Trendelenburg.

A T-shaped incision is made along the left sternal margin and parallel to the second rib. The second and third costal cartilages are resected close to the sternum and the second and third ribs 6 or 8 cm. laterally. The left border of the sternum is resected to a width of 2 cm. to avoid opening of the pleural cavity. The pericardium is opened at the inferior angle

of the incision. The artery is visualized and opened by a longitudinal incision of 2 cm. and the embolus is extracted by forceps, both main branches of the artery being explored. It is vital to operate at high speed to avoid damage to the nervous centers. The artery should not be clamped for more than 45 seconds.

Two grave errors which have proved fatal in a number of cases must be avoided: one is the accidental opening of the left pleural cavity which may cause death by pleural shock, and the other is mistaking the aorta for the pulmonary artery which has been done even by outstanding surgeons.

The postoperative complications include suppurative pericarditis or mediastinitis and damage to the cerebral centers (amaurosis, aphasia). The danger of a second embolism after a longer or shorter interval is always present and should be prevented by ligation of the thrombosed vein. One case is on record in which embolectomy was done successfully twice in the same patient. WILKINSON M. SOLARTE, M.D.

Padgett E. C.: Indications for Determination of the Thickness for Split Skin Grafts. *Am J Surg* 946, 72 653

In skin grafting it is a truism that the advantageous properties of a skin graft are in proportion to the thickness of the graft provided a 'take' can be obtained. Conversely the disadvantageous properties are in proportion to the thinness of the graft except that a 'take' is more assured.

It is obvious then that a skin graft cut at a uniform thickness has positive advantages.

Padgett classifies these sheet skin grafts into four types:

1. Thiersch. (Thiersch's original description of his graft as containing only the epithelial layer probably never was nor can be cut; there is always some corium.) This graft is cut from a thickness of about 0.008 (0.2 mm.) to 0.10 of an inch (0.25 mm.)

2. Superficial and intermediate 'split skin' graft (Blair *et al*). This is from one-third to two-thirds of the skin depth in adults usually from 0.012 (0.3 mm.) to 0.016 of an inch (0.4 mm.)

3. The so-called 'three-quarter thickness' skin graft. This is cut from 75 to 90 per cent of the skin depth from 0.018 (0.5 mm.) to 0.022 of an inch (0.6 mm.)

4. The full thickness skin graft. This includes all skin layers and varies from about 0.030 (0.83 mm.) to 0.038 of an inch (1 mm.)

The following factor has to be considered when the type of skin graft to be used is selected: Is the base granulating or freshly denuded? In addition the location of the recipient area, the age of the patient, the donor area and recipient areas difficult to cover with skin are important considerations.

Lesions for which skin grafts are particularly applicable are the granulating (more or less superficial) relatively nonaseptic areas (whatever their cause may be) and the healed or nearly healed cicatricial contracted lesions due to various causes which

when excised or cross-cut provide an aseptic base. To resurface the former in an adult, a thin skin graft from 0.008 to 0.10 of an inch in thickness is used. To resurface and correct the latter a 'three-quarter thickness' skin graft with certain exceptions, is best.

The author reviews various lesions and states the type of graft best suited for each. These include the unhealed and the healed lesion following severe burns, birthmarks and cavities. He also discusses the making of an artificial vagina, urethra, and eyebrows, and the correction of webbed fingers.

STEPHEN A. ZIMMAY, M.D.

#### ANTISEPTIC SURGERY; TREATMENT OF WOUNDS AND INFECTIONS

Hindmarsh J., Steinn G., and Steinn, A. A.: Accidents in Childhood. *Acta chir scand* 946, 94-483

The authors present an analysis of 5,083 accidental injuries in childhood. The injuries occurred during the period from 1930 to 1940, and were treated in an urban and a rural hospital in Sweden.

The majority of the patients were boys, the number of girls being at times only one half or one-third that of the boys. The accidents had occurred with greater frequency during the first 3 years of life, and the majority of accidents took place during the warmer seasons.

The mortality was low: only 22 of the children died. The children who managed to overcome the first shock seemed to have a distinctly greater capacity for recovery than adults. In the fatal cases death was due to injuries of the cerebrum and abdomen, to burns and (in 1 case) to a fracture. A number of serious accidents in children never reach the hospital.

During early infancy accidents occur in most cases without the co-operation of the child. Examples of such accidents were falls from weighing machines and tables (14 cases) and dropping when moved (6 cases). Cranial injuries resulted in 15 of these 30 children. The remaining 5 children sustained fractures of one of the bones of the lower extremities.

During infancy and in children from 2 to 6 years, burns predominated (315 cases, or 6.2 per cent of the total number of accidents). The causes of burns were as follows: scalding with hot fluids (236 cases), contact with hot metal (33 cases), exposure to chemicals (19 cases), contact with fire (15 cases) and electrical contacts with high voltage current (8 cases).

During the transition to the age of playing, the child enters a period of pronounced curiosity with regard to its surroundings. In 195 cases objects became lodged in the respiratory or digestive tracts. Of the 186 known objects, 147 (79 per cent) were metallic—61 sharp (screws, nails, pins, needles, etc.) and 86 blunt (metal balls, closed safety pins, toy parts and coins). The 39 nonmetallic objects included pieces of glass, celluloid bits, fish bones, toy parts, glass balls, etc. The foreign body was stuck

in the mouth in 2 cases and in the pharynx in 12 cases in the former large objects and in the latter thin, sharp objects. Only in 1 case had the foreign body found its way into the respiratory organs. Generally, coins were impacted in the esophagus (16 cases). In 55 children objects were stuck into the nose and in 5 cases in the external auditory canal. Swallowing of corrosive fluids was observed in 19 cases. Nine of the children were 1 year of age and the remainder from 2 to 4 years. Acid was the cause once, while in the remaining 18 cases lye was the injurious agent. In the event of a substance containing lye powder the injuries were generally superficial, but extensive corrosion injuries appeared from strong solutions. There were 57 injuries of intoxication, from the consuming of too easily accessible medicines in 23 cases, chemical washing solutions in 17 cases, diluted noncorrosive acids or alkalis in 8 cases, water colors and colored chalks in 6 cases and cigarette ends in 3 cases.

Thirty three children sustained injuries from falling with a stick or similar object in the mouth.

Falls out of bed or perambulators are reported in 115 children, 56 of them infants. Fractures occurred in 55 of these. In 9 cases concussion of the brain was noted. The injuries usually occurred in the upper half of the body, 39 being localized to the upper trunk, 9 to the upper part of the lower extremity and 5 to the upper part of the trunk. Only 9 were noted in the lower extremity.

Falls from a window or balcony occurred in 49 children. Fractures often multiple, followed in 32 cases. Nine of the children were 10 to 12 years of age, the rest being 5 years or younger. Falls from a staircase occurred in 150 children. In 57 of these a fracture ensued frequently being a fracture of the clavicle. Concussion of the brain resulted in 28 children. The injuries were localized either to the hand or the leg, they were usually wounds and contusions, and occasionally fractures.

As the result of an adult pulling the arm of a falling child damage to the shoulder or elbow joints may result, represented either by a subluxation of the head of the radius or a distortion in the elbow joint. Seventy three children sustained injuries caused by playing in swings and climbing stands. Fractures resulted in 26 cases and concussions of the brain in 8 cases. The remaining children had wounds and contusions.

One hundred and thirty children had injuries from bites—69 insect bites and 39 dog bites. The former do not, in the majority of cases, cause any serious more serious kind invariably involving great risk of infection. The latter caused a prolonged and complicated course of healing and ugly scar formation. Dog bites of the head occurred in 16 children, most often in the face and dog bites of the upper extremity occurred in 13 cases, most frequently in the hand. Aider bites were reported in 15 children, 14 of whom received serum.

Thirty-one cases of self inflicted bites of the mouth after falls were noted, all of them uncomplicated.

When the child reaches school age gymnastics and sports entered into the cases of accidents. There were 52 accidents occurring during gymnastics, 16 during athletics and 33 during sports. Fractures resulted in 47 cases, contusions in 17 cases, and concussions of the brain in only 4 cases.

As a result of winter sports 177 children were injured the younger while sledding and the older while skiing or skating. At tobogganing 59 children were injured head and leg injuries predominating. Ten fractures of the femur and 15 fractures of the leg occurred. Fifty five children were injured while skating. In 22 of these the injuries were to the arm. Injuries of the leg were common and of the thigh rare. Accidents while skating are a most common cause of concussion of the brain, 15 cases having been noted. Injuries of the extremities often fractures occurred in 40 children as a result of skating accidents.

Traffic accidents account for an important group of childhood injuries. Among pedestrians of all ages who have been subjected to traffic accidents by day light those in the age group of 0 to 10 years suffer the maximum number of accidents, the age group from 10 to 12 years are shown to have the lowest number. Traffic accidents numbered 461 (9.1 per cent of the total number of accidents). After the small number of traffic accidents in infancy a noticeable rise was seen in the 2 year age group which became marked in children between the ages of 3 to 7 years in which group 48.4 per cent of the total number were found. Children in the 6 year age group were the principal sufferers of these accidents. Bicycle accidents were the cause of injury in 242 children followed by motor car accidents in 108 cases. The latter causing the more serious injuries. Of the 461 children in traffic accidents, 337 (73.1 per cent) had to be admitted to the hospital for treatment.

Narrow escapes from drowning are common in childhood, but the children do not usually get to a hospital. All but 3 of the children in this group were seriously affected.

In the material from the country hospital, 15.3 per cent of the children were injured in the performance of household duties.

The authors recommend antitetanus vaccination for children with lacerations in which there is danger of infection or better a combination of diphtheria and antitetanus vaccination of all children. In the present series there were 1,067 such cases.

Fractures occurred in 1,336 instances usually in the upper or lower extremities. Fractures of the skull were found in 118 of the 295 children in whom roentgenograms of the skull were made. Three of these children died. Only 7 of the children had fractures of the base of the skull. A depressed fracture of the roof was noted in 18 children, but only 6 of these children were operated upon. Patients with cranial fractures were treated by rest in bed for at least 1 month while those with simple concussion



were kept in the hospital for 1 week and at home for 1 week.

The mortality from burns was 4.7 per cent, all the deaths occurring in children under 5 years of age. The authors recommend the tannic acid treatment of burns and advise the earlier use of skin grafts.

Foreign bodies in the intestinal tract of children were passed 63 times in from 1 to 22 days. Surgical removal was undertaken in 16 children. Eight coins in the esophagus were removed by the esophagoscope. The remaining 8 objects (1 coin, 3 pins, 2 nails and 2 hair clasps) required removal by opening of the stomach or duodenum. The curves of the duodenum may present difficulties for the passage of foreign bodies.

Prophylactic measures against accidents in childhood are discussed viz. the prevention of burns the isolation of corrosive fluids, medications and poisons in homes, the control of inferior electrical equipment, the sensible choice of toys, the fixing of window catches, gratings and balconies, the supervision of play apparatus, the education of children to traffic, the withholding of bicycles until the age of 10 to 12 years and the institution of social reforms.

ERNEST E. ARNHEIM, M.D.

Pervez, J., Borge P. Parnet, H., and André, J.: Accidents following Prolonged Compression of the Muscles of the Limbs (*Accidents consécutifs à la compression prolongée des masses musculaires des membres*). *Rev. Méd. et Biol.* 946 73.

In July 1944 the inhabitants of a small French town ran into a tunnel to escape an air bombardment. After a little while the individuals at the back of the tunnel had difficulty in breathing and pushed toward the opening. They were crowded close together and could only move slowly in the darkness. Some of them fell and others stumbled and fell over them until there was a pile of bodies 3 meters high blocking the tunnel for 10 meters. The bodies were so entangled that it was hard to get them out. There were 80 dead and more than 100 wounded.

The authors had occasion to treat 14 of these patients. There were 5 with very severe conditions resulting in death, 1 with a moderately severe condition and 8 with mild conditions. Details of the cases are given. When the patients were brought out of the tunnel where they had been for from 3 to 5 hours their muscles especially those of the legs, were very much swollen and very hard. The skin was livid and cold, with dilated veins. Some of the patients were in a state of shock and most of them said they were in great pain. The urine was scant and very dark. There was evidently a relationship between the continuation of the muscles and the hemoglobinuria or hematuria.

The authors do not know at the time of this English work on the crush syndrome or Bywaters syndrome a title has been named from its first investigator. They concluded that the prolonged compression of the muscles caused capillary hemorrhage and edema. The increase in volume added to the

external violence, brought about complete disintegration of the muscles, which was followed by fibrosis. They believe that the hematemic nephritis and the degeneration of the liver seen in 2 cases were toxic in origin and that the shock also was largely due to intoxication. They do not attempt to explain the labial herpes which occurred in 5 of the cases. English authors advise the application of a tourniquet to the injured limbs and keeping them cold to prevent dissemination of the toxin. The authors gave adrenalinized serum intravenously for the shock and infiltrated the sympathetic nerve with novocain. Transfusion did not seem to be indicated. They used bicarbonated serum for the acidosis to prevent the precipitation of hematin. They used hypertonic glucose solution and insulin in preference to hypertonic salt solution. They performed decapsulation of the kidneys in 1 case, but it was too late; the intoxication was far too advanced. In future they will do early decapsulation.

In the discussion GOSSET said that he thought too much importance had been attributed to intoxication as the cause of these phenomena. They are like those produced when a tourniquet is applied to a limb and ischemia is produced. When the tourniquet is removed the blood rushes in and causes edema; this decreases the volume of circulating blood and explains the initial shock, which is not toxic but circulatory. PERVEZ replied that it was hard to believe that the total disintegration of muscle in these cases did not result in toxic products which were carried into the body particularly the kidneys and liver.

ANDRÉ G. MOROUX, M.D.

Graham, J. R., and Scott, T. McN.: Notes on the Treatment of Tetanus. *New England J. M.* 946, 35 846.

The incidence of tetanus among American forces during World War II was very low; only 1 case had been reported up to February 1, 1945 in troops of the European Theater. In the German Army active immunization with tetanus toxoid was given only to a selected few. Consequently tetanus was frequently encountered in German prisoner casualties treated in American Army hospitals. The authors report 10 cases of tetanus that developed in 350 sick and wounded German prisoners treated at an overseas station hospital during the period between September 1944 and March 1945.

Incubation periods ranged from 5 to 22 days, with an average of slightly more than 10 days. Of the 10 patients, 4 died all within less than 10 days of the onset of the disease, but 5 of the 6 survivors had incubation periods of 10, 8 and 5 days. None of the patients had had adequate prophylaxis, judging from available records. Tetanus toxoid does not benefit a patient who has not been previously immunized for the development of antibodies is too slow to prevent the disease. Fifteen hundred units (American) of antitoxin should be given on the day of wounding and repeated every 7 days, as the passive immunity lasts only from 7 to 14 days. The fact that 9 of the

10 patients had received large doses of chemotherapeutic agents (one patient had been given 1 000 000 units of penicillin and 30 grams of sulfadiazine) prior to the onset of symptoms suggests that these agents will not prevent the disease.

In outlining the signs and symptoms of classic generalized tetanus and of local tetanus the authors emphasize that the most important step in making the diagnosis is to think of the possibility of tetanus.

The treatment of the disease is a major undertaking. The patient should have his own room and special attendants at all times. Usually he will require redébriment of his wound. Radical wound excision eliminates the focus of further toxin formation. Subsequent to the operation all attentions to the patient should be arranged on a schedule at three hour intervals, to minimize the disturbance to his rest. These ministrations will include the giving of sedation and penicillin feeding back massage postural changes. Sufficient antitoxin should be given to neutralize the toxin already produced. In the authors' experience this was 120 000 to 180 000 units of which 20 000 to 40 000 units were given intravenously. Increased metabolic requirements may be met by using a stomach tube (left in place 5 to 6 days) to introduce a daily diet of 3 000 to 3 500 calories containing 120 to 130 grams of protein in 3 500 to 4 000 c.c. of fluid. Sedation must be balanced between the danger of spasms and convulsions resulting from inadequate sedation and the danger of pulmonary complications, the result of over sedation. The authors achieved this balance by using from 4 to 6 c.c. of paraldehyde or 0.2 gm. of sodium amytal orally every 3 hours. Either may be given intravenously for emergency sedation.

Sulfadiazine and penicillin are effective in preventing wound infection and pulmonary infection subsequent to atelectasis which was an almost universal complication in the authors' cases. Their treatment of atelectasis included voluntary coughing frequent changes of position postural drainage, carbon dioxide-oxygen inhalations, and slaps on the back to loosen mucus plugs. To avoid excretory complications they advocate the routine use of mineral oil as a prophylaxis against fecal impaction and the placing of indwelling catheters to prevent urinary retention secondary to sphincter spasm.

B F LOUNSBURY M D

DeLaverge V, Helluy J and Falvre, G: The Ineffectiveness of Local Surgical Treatment in Manifest Tetanus (De l'inefficacité du traitement chirurgical local dans le tétanos déclaré). *Presse méd* 1946, 54 602

Larrey first recommended amputation of the injured limb in manifest tetanus, and at the meeting of the Surgical Society in 1928 the physicians and surgeons present were almost unanimous in their opinion that surgery should be practiced. Small series of statistics were presented to prove this point, but it is well known that there are many sources of error in small series of statistics.

The statistics of the authors' own clinic show that the results are rather better in nonoperative than in operative cases and the difference is still more apparent in cases of postabortion tetanus. The argument for local operation was that the spores and bacilli were removed and this prevented the formation of toxin. However it has been shown that the bacilli do not remain localized at the portal of entry. They have been found on compresses placed on the operative wound which shows that they exist in tissues at a considerable distance from the portal of entry.

Surgery has never been recommended in diphtheria. It is true that antitoxin is more effective in diphtheria than in tetanus. This is because the angina of diphtheria develops while the toxin is still free and indicates merely the portal of entry while trismus in tetanus does not develop until the toxin has been fixed at a distance. There are no clinical symptoms in tetanus at a stage corresponding to the angina of diphtheria. In tetanus antitoxin should be given in addition to antitoxic serum for while the former does not destroy tetanus toxin it protects the patient from further injury by destroying the remaining spores and bacilli. AUDREY G MORGAN M D

Sulzmann M: Concerning the Mechanism of Infection in Chronic Recurrent Staphylococcal Diseases. A Special Clinical Bacteriological Investigation of Furunculosis and Its Complications (Ueber den Infektionsmechanismus bei chronisch rezidivierenden Staphylokokkenkrankheiten. Eine klinisch bakteriologische Untersuchung speziell ueber die Furunkulose und ihre Komplikationen). *Acta chir scand.*, 1946 94 291

Chronic staphylococcal skin infections have been more frequent in Finland during the war years. In order to gain a better understanding of these cases the mechanism of infection was investigated in its bacteriological and clinical aspects. Of especial interest to the author was the problem of pathogenicity of various strains of staphylococci. Likewise he was interested in determining whether recurrent infections in the same individual represented reinfection with the same bacterial strain or whether the recurrences represented new infection with other strains. The following criteria of pathogenicity were used: pigment formation, production of hemolysin, formation of plasma coagulase and destruction of mannitol.

One hundred healthy patients were studied. Sixty-six staphylococcal strains were recovered from the skin and 64 strains from the nasal secretions. Specimens were taken from pus in 150 acute infections. Twenty-one per cent of the skin strains were pathogenic according to 2 of 3 or 3 of 4 criteria. Similarly 46 per cent of those from the nasal secretions and 93 per cent from pus were pathogenic. None of the criteria of pathogenicity were found among 57 per cent of the skin organisms, 41 per cent of the nasal staphylococci and 4 per cent of the organisms taken from pus. The remainder were not definitely in either category.

Sixty patients with relapsing staphylococcal infections were studied: 47 were males and 13 females. Sixty per cent of the cases occurred in apparently healthy individuals and consisted of typical recurrent furunculosis. The other 40 per cent were associated with fairly obvious predisposing factors such as diabetes pseudodiabetes, malnutrition or local disturbances. These included such cases as multiple furunculosis, carbuncles, bullous or impetiginous staphylococcal and similar disorders with defective healing and a tendency to become chronic.

In vitro tests were performed in staphylococcal infections of long standing. The organisms isolated seemed to be somewhat more pathogenic than those taken from acute pyogenic infections. Cultures taken from several lesions at different times in multiple furunculosis showed only one strain in one and the same patient. In about half of the patients with furuncles the same organism was present in the nose and on healthy skin suggesting that the skin and mucous membrane were the sources of reinfection. Many patients with obvious low resistance were infected with strains which seemed relatively non-pathogenic in vitro.

In conclusion the author advises surgical incision of furuncles and radical excision of carbuncles except on the face. To cope with recurrences he suggests careful asepsis in handling, local applications of antiseptics to the skin and chemotherapy. He is uncertain about the value of polyvalent vaccine. Obvious causes of decreased general resistance such as diabetes or cachexia are corrected.

THEODORE B. MARRILL, M.D.

GOWAN, A. D. T.: An Account of the Pathology of Some Cases of Clostridium Welchii Infection. *J. Path. Bact. Lond.* 1946 58 4 3.

The first portion of the present article is concerned with a description of the local pathological changes in gas gangrene based on 120 muscle biopsies from service casualties. Immediately adjacent to the wound surface is a zone of necrosis involving all structural elements considered by the author to be due to the original injury. Peripheral to this zone is an area of marked edema in which the muscle fibers are widely separated from each other; there is beginning loss of muscle striation, and degenerative changes in the nuclei are moderately advanced. This zone merges into a more peripheral one in which the edema is accompanied by intense vascular congestion and the muscle shows fewer evidences of degenerative change. Extreme vasodilatation and extensive hemorrhage is present, and many vessels are thrombosed. The author stresses the significance of the thrombotic phenomenon in this zone as he believes that this is a primary cause for the characteristic necrotic changes of Clostridium welchii infection.

The second portion of the article deals with material drawn from post mortem examinations in 3 cases of severe Clostridium welchii infection. In all 3 of the cases diffuse fat emboli were found to form a significant part of the post mortem picture. Fat emboli

were prominent in the lungs and in the central nervous system. Fat emboli were demonstrated in the optic nerves of 1 patient in whom blindness had appeared before death.

Experimental work is quoted in which the injection of Clostridium welchii toxin into the thigh muscles of guinea pigs and rabbits invariably gave rise to extensive pulmonary fat emboli. The possible mechanisms to explain this phenomenon are discussed.

F. J. LEECH, M.D.

## ANESTHESIA

LEIGH, M. D. and BELTON, M. K.: Premedication in Infants and Children. *Anesthesiology* 1946, 7 611.

The advantages gained by premedication are important in infants and children as well as in adults. In addition a most important factor in children is the curbing of a rapid exhaustive respiratory rate. This increased respiratory rate, sometimes over 100 per minute, is found especially in the unpremedicated infant who receives ether without due attention having been given to the elimination of carbon dioxide.

The postoperative nausea and vomiting frequently seen following preoperative medication with opiates may be offset to a large extent by adding one of the barbiturates. They are also most effective because they allay apprehension and prevent early convulsions.

There is a tremendous advantage in preventing the secretions in the respiratory tract by the use of drugs of the belladonna group. Scopolamine is more effective than atropine in this respect and has a longer duration of action. Atropine, on the other hand, is thought to reduce the dangers from vagal reflexes on the heart. A table is given in the original article showing the dosages of morphine and scopolamine or atropine for patients of 2 months of age and upward. This table gauges the dosage not only by the age of the child but also by the weight which may cause the dosage to vary considerably.

A warning is given regarding the measurement of the small doses of drugs. They should be dissolved in several cubic centimeters of sterile distilled water and thoroughly mixed so that the calculated dose can be more accurately administered.

Since any injection with a needle is painful it is best to give attention to details such as not allowing the child to see the needle, using sharp needles without barbs, allowing the alcohol to dry on the skin before injection, and by firmly pinching a generous part of the skin and subcutaneous tissues.

Morphine and scopolamine are given about an hour before operation, morphine and atropine one-half hour and atropine alone one-half hour before operation. Barbiturates such as nembutal and secobarbital are given an hour before operation.

MARY KARP, M.D.

CLEMENT, F. W.: Nitrous Oxide-Oxygen Anesthesia. *Anesthesiology* 1946 7 66.

The familiar terms, anoxia, anoxemia, and asphyxia are often confused or loosely applied. The

occurrence of anoxia is not confined to the administration of nitrous oxide alone but may occur with any and all of the anesthetic agents. For many years the oxygen exclusion theory was accepted to explain the action of nitrous oxide in producing anesthesia. However every anesthetist of experience has encountered cases in which the oxygen percentage in the nitrous oxide-oxygen mixture could be increased considerably above 20 per cent (which is roughly the normal air content of oxygen) and still maintain adequate anesthesia. Today the commonly accepted theory is that nitrous oxide itself possesses weak anesthetic properties.

All anesthetists should be familiar with the possible dangers of nitrous oxide-oxygen anesthesia. Nevertheless such dangers arise not from the action of gas itself but from its maladministration. No anesthetic is safer than the one who gives it. The effects of anoxia have been evident after all types of anesthesia but the anoxia state may be more readily produced with nitrous oxide-oxygen anesthesia than with other anesthetic agents and the margin of safety is narrow.

Respiration is by far the most important sign during nitrous oxide-oxygen anesthesia. The patient is in no danger as long as he is breathing efficiently but should maintain about equal the rate somewhat faster than normal and continuous or uninterrupted with adequate volume. The greatest single hazard during nitrous oxide-oxygen anesthesia is the failure once increase in the oxygen percentage of the mixture. The need for oxygen is usually very apparent because of the muscular responses of the patient. However the weak anemic, or debilitated patient does not necessarily show muscle spasm during deep anesthesia in fact flaccidity may occur. In such cases the danger signals are largely respiratory.

Once the desired depth of anesthesia is attained the oxygen concentration should be increased 1 per cent at a time while the effect of each increase on the level of anesthesia is noted. Failure to increase the oxygen supply as anesthesia progresses may well lead to fatal or near fatal degrees of anoxia.

During nitrous oxide-oxygen anesthesia the application of a simple and accurate test will reveal whether or not anesthesia is being maintained at a depressing level. This test is based upon the fact that whenever a patient in need of oxygen is given an abrupt and abundant supply slowing of the respiratory rate or even temporary cessation of breathing occurs.

The duration of the apneic period is in direct ratio to the degree of oxygen deficiency. If at any time the anesthetist is in doubt regarding the depth of narcosis he should administer one or two breaths of 100 per cent oxygen and observe the effect (if any) on the respiration.

The use of oxygen is not mandatory in the Army Air Forces until above the 10,000 foot level (14.25 per cent oxygen). Surely a patient premedicated

asleep and quiet in anesthesia can tolerate a comparable decrease of oxygen reduction.

Induction with 100 per cent nitrous oxide is advised for normal risk patients. For subnormal risk patients and children a mixture of oxygen nitrous oxide is advocated in order to decrease the possibility of inadvertent rapid production of the profound plane. No other anesthetic agent equals it in speed of absorption and elimination from the body. Also it is free from the hazard of explosion.

MARY KARP M.D.  
D Errico G. Intratracheal Anesthesia in Man (La narcosi endotracheale nell uomo) *Giar ital chir* 1946 2 399

The following advantages of intratracheal anesthesia have been pointed out by several writers:

- 1 It is possible to induce anesthesia with barbiturate in persons in whom superficial veins cannot be located.

- 2 Repeated doses of anesthesia may be administered without the need of a special apparatus to keep the needle in place.

- 3 The needle remains in proper position in spite of agitation of the patient.

- 4 The same needle may be used for transfusions of blood or plasma or for the administration of saline or glucose solution.

- 5 The danger of a venous thrombosis is avoided.
- 6 The surgeon has the opportunity to supervise the anesthesia and even to administer it without accessible field.

Endotracheal anesthesia has been employed by the author in 19 cases. In 3 instances complications arose in 1 case a subcutaneous aseptic abscess developed in another peritonitis and osteoperitonitis of the sternum appeared following the anesthesia but subsided spontaneously within a few days and in the third a grave osteomyelitis of the sternum was attributable to the mode of administration of the anesthetic. The patient in the last case a 46 year old man with syphilis recovered after incision and drainage.

A 5 per cent solution of sodium pentothal was used for anesthesia. Preoperatively morphine and atropine were given. In all instances the manubrium sterni was used as the site of injection and the usual precautions with regard to the preparation of a sterile field were taken. As an average from 5 to 10 c.c. of the anesthetic solution were injected within 2 to 10 minutes additional amounts being given from time to time according to the condition of the patient.

An infection following sternal puncture for anesthetic purposes may be caused by the introduction of pathogenic micro-organisms from the outside or it may be attributable to bacteria from the inside or sternum from the blood stream.

The occurrence of 3 complications in a group of 19 patients induces the author to condemn the sternal administration of an anesthetic.

JOSEPH K. NARAT M.D.

Bishop H. F.: *Operating Room Deaths. Anesthesiology* 946 7 63

During the last few years the trend has been toward a full and impartial report on operating room deaths—a progressive step which is believed to be in keeping with the true scientific spirit.

In the line of progress, the operating room should be made a safer place for the patient to enter. Anesthesia societies have recently shown interest in the creation of anesthesia study commissions whose purpose it is to sift the facts impartially concerning operating room mortality.

In most instances death under anesthesia is the result of failure of circulation or respiration. Evidence bearing on the actual mechanism of death is frequently inconclusive. Goggio has attempted to distinguish between those cases in which the heart ceases to function because of asphyxia and those cases in which the heart stops in systole or ventricular fibrillation.

Anesthetic drugs have been involved in 20 per cent of the deaths (caused by drugs) which have been reported to the medical examiner in the Boston area. These deaths under anesthesia were classified into the following subgroups: (1) aspirated vomitus, (2) serious preexisting disease of an inflammatory or degenerative nature, (3) sudden deaths on a neurogenic basis, (4) delayed deaths, (5) deaths without known cause.

Pressure over the carotid sinus should be avoided during anesthesia. A fatality may result if pressure is applied in this region of the neck on individuals who have a hyperactive sinus reflex which has been sensitized by certain anesthetic drugs such as nitrous oxide and morphine. Coronary occlusion may account for as high as 20 per cent of the sudden deaths occurring in adults undergoing operation.

The author presents a report on 6 deaths which occurred in the operating rooms of two hospitals with which he has been associated during the past 4 years. A total of 20,021 anesthetics have been administered during that time.

Case 1: A patient with suspected brain tumor was given avertin for an exploratory craniotomy. Respirations ceased before operation was started and after 30 hours in a respirator heart action ceased. The following management is suggested in such cases: trephine openings are made through the skull the day before operation. A ventriculogram is made on the morning of operation. The patient receives scopolamine premedication only. Just before the induction

of anesthesia the surgeon is asked to insert a brain cannula into each ventricle to reduce any increased pressure that may be present. In this way anesthesia induction is not commenced with an existing elevated pressure.

Case 2: A baby 4 days of age died at the completion of an operation for congenital atresia of the esophagus. No anesthesia was used although oxygen was given during operation. It was believed that the amount of blood loss might have accounted for the shock and death of the infant. For babies, one should cut down on an ankle vein and tie an 18 gm intravenous cannula in place before operation.

Case 3: Death occurred suddenly and unexpectedly in a 27 year old asthmatic patient while undergoing therapeutic stellate ganglion block. Death in this case might be explained by the observation of Cromer and Ivy who following a series of experiments on dogs in 1933 reported that bilateral resection of the stellate ganglia sensitized the respiratory center to impulses rising in the vagus nerve and caused respiratory paralysis.

Case 4: The death of a 70 year old patient was attributed to fatal pulmonary embolism during manipulation of a hip fracture under anesthesia. Six similar deaths during manipulation have been reported to the author. It is difficult to understand how the type of anesthesia could have changed the outcome in these cases. On numerous occasions during manipulation for hip fractures (Leadbetter's nerve) the author has encountered sudden circulatory changes which were transient and were vaguely passed by as some type of reflex response.

Case 5: A 2½ year old child undergoing revision of a cleft palate under ether insufflation anesthesia died 30 minutes after the start of anesthesia. It was generally agreed that asphyxia was the cause of death. There has existed some opposition to the use of endotracheal tubes in infants and small children, but most writers are definitely in favor of them. It was believed that an endotracheal tube might have prevented this death.

Case 6: An 11 months old baby died during the repair of a harelip. It was considered that death resulted from asphyxia, caused by an error in the application of an endotracheal tube which was too long, and entered the right main bronchus.

Tragedies of this kind can serve some useful purpose if an exhaustive study is carried out on all operating room deaths.

MARY FRANCES FOR, M.D.

# PHYSICOCHEMICAL METHODS IN SURGERY

## ROENTGENOLOGY

Kooperstein, S. I. and Bass, H. E. A Pulmonary Reaction following Intrabronchial Instillation of Lipiodol in Bronchial Asthma *Am J Roentg* 1946, 56 569.

The authors report that in a study of 40 cases of bronchial asthma including bronchograms as a part of the clinical investigation 3 patients developed febrile illness with roentgen evidence of pulmonary infiltration. The lipiodol used in these cases was the commercial product consisting of iodized poppy seed oil (40 per cent) Butyn sulfate 2 per cent was introduced intranasally, and anesthesia of the bronchial tree was attained by the gravity method. Lipiodol was swallowed to visualize both lower lobes and the right middle lobe.

Two of the patients developed an acute episode characterized by a rise in temperature, cough, expectoration, and malaise at the end of 9 and 12 days respectively. The third developed an acute pulmonary episode characterized by chilly sensations, malaise, substernal pain, and cough. Roentgenograms of all 3 patients revealed bilateral basal densities which suggested the presence of pneumonia in the areas of the distribution of the lipiodol except for an additional shadow of increased density in the upper right lung field of one of the patients. All of the cases showed an increase in the total white blood count and polymorphonuclear neutrophils. Marked eosinophilia paralleled the course of the acute illness in 2 of the cases and was absent in the other. Two of the patients developed an urticarial eruption one at the onset of the illness and the other 2 days after the bronchogram was taken.

Sensitivity tests were done on the 3 patients and 10 control cases with lipiodol, diiodrast, poppy seed oil and butyn sulfate (2%) respectively. All of the controls failed to react. The 3 patients reacted in varying degrees to diiodrast and 2 of them reacted to scratch tests of lipiodol. None of the 3 reacted to the tests with poppy seed oil or butyn sulfate (2%).

The authors conclude that the 3 cases of bilateral pneumonia which followed lipiodol bronchograms offer evidence of having been caused by the lipiodol.

FRANK L. HUSKEY, M.D.

Schilling, J. A.: Perforation of a Duodenal Ulcer during Roentgen Examination. *Surgery* 1946 20 730.

Perforation of a duodenal ulcer during fluoroscopic examination is fortunately very unusual. Fifty-seven cases have been reported that occurred either during or immediately following a barium study. The author's case falls in the first group.

During the routine fluoroscopic examination of a 71 year old white male who had had two large tarry stools 3 days previously the barium suspension was



Fig 1 (Schilling) Flat abdominal x-ray film taken at time of perforation. Note barium concentrations in the right and left lower quadrants. No barium is present deep in the pelvis or in the right subphrenic space.

seen to escape from the duodenal bulb and flow both to the right and the left and promptly outline the right lower boundary of the peritoneal cavity.

Following laparotomy a 1.5 cm perforation was found on the anterior portion of the duodenum. A large amount of black watery fluid was present, but the extravasated barium was fixed in small clumps and flecks by a fibinous exudate. These flecks were distributed over all of the free peritoneal surface of the intestines and abdominal wall. Removal of the barium was impossible.

The patient's postoperative course was rather stormy. During the first 3 weeks there was considerable abdominal pain and diarrhea and a large tender pelvic mass developed which subsided slowly. During the second month an eosinophilia averaging 23.5 per cent with a white blood cell count of from 10,000 to 20,000 developed although the patient was essentially asymptomatic. A check-up examination after 6 months revealed essentially normal findings.

This case illustrates the route of spread of intra-peritoneal effusions from the right subhepatic space. On the right side the effusion passes first to the right

infracolic space then across the ascending colon and across to the right lumbar gutter or paracolic groove then to the right subphrenic space. On the left side the subphrenic space is involved directly from the infracolic space and to a lesser extent from the left paracolic groove and both right and left subhepatic spaces.

Figure 1 taken at the time of perforation illustrates both the avenues of peritoneal spread and the rapid and relative diffuse nature of the spread. Films taken 10 days later showed rather large amounts of barium in the right subphrenic space and in the deep pelvis. One hundred and thirty nine days after the perforation there had been relatively little change in the distribution of the opaque material.

The microscopic distribution of intraperitoneally injected barium sulfate was studied in 3 dogs. Films made following the injection revealed the same rapid and diffuse spread of the solution and relatively little change in the distribution after the first few hours. Postmortem examination revealed the barium to be distributed throughout the entire peritoneal cavity. There were dense adhesions at the sites of the barium deposits, especially between the bowel loops and the parietal peritoneum. The mesenteric nodes were enlarged and contained barium. The lymphatics of the omentum and mesentery in 1 instance were clearly outlined with streaks of barium. Some of the thoracic nodes near the internal mammary vessels contained large quantities of barium. These nodes were observed on the antemortem roentgenograms. Microscopically only moderate numbers of giant cells were present. There was round cell infiltration and fibrous encapsulation of small amounts of barium. In the omentum all of the barium was in either large single or multiple confluent macrophages.

R. B. Lewis, M.D.

Dann D. S., and Koritschoner R.: A Clinical Study of Normal and Pathologic Motor Activity of the Gall Bladder. Preliminary Report. *Radiology* 94:6 47 494.

The motor activity of the gall bladder was studied in 21 healthy apparently normal individuals.

Oral administration of sodium tetradiophthalein resulted in good visualization in 16 cases, fair visualization in 3 cases, medium visualization in 1 case, and an absence of shadow on repeated examinations in 2 cases. One woman presenting good visualization did not return for postcibal films. The remaining 18 individuals pursued their normal daily activities and maintained their customary dietary habits following the roentgen demonstration of the gall bladder. Films were made over the gall bladder region 1 hour after each meal until the shadow of the dye completely disappeared.

Although a wide range in emptying rate normal was observed during the first 24 hours, there was no difference in the rate of emptying in the cases with fair and medium visualization compared to that in the cases with good visualization. One gall bladder required 48 hours for complete emptying although the

meals were thought to be ample in fat, while another emptied completely after the first meal which contained practically no fat. In 2 cases there was no contraction following the first meal which was adequate in fat but the gall bladder responded satisfactorily after a second meal which was variable in its fat content.

Since the response of the gall bladder in these apparently normal individuals was so varied following meals of different fat content, the authors question the significance of the so-called poorly functioning gall bladder "i.e. the normally visualized gall bladder with delayed or slow contraction following a meal containing fat."

R. B. Lewis, M.D.

Pereira A.: Roentgen Diagnosis of Diseases of the Neck of the Bladder. *Am J Roentg* 94:6, 51-489.

The author presents a discussion of the anatomical conditions which cause the so-called disease of the bladder neck and their known syndrome.

The diagnosis of many of these conditions can be made by urethrocytography. Roentgenograms are made at the termination of filling of the urethra with a suspension of 15 to 20 c.c. of barium (base, barium sulfate), an empty bladder having been previously filled with 60 to 80 c.c. of this opaque material. Oblique and anteroposterior films are taken. Three of the roentgenological images obtained correspond to anatomical conditions.

1. Image of the plane neck without protruding borders in both the profile and anteroposterior roentgenograms. It represents a hypoplasia of the sphincter itself. It corresponds to both congenital and acquired atrophy and to sclerosis of the neck. The differentiation between them can only be made by clinical examination in association with some roentgen characteristics of the prostatic urethra.

(a) In congenital atrophy the prostatic urethra is short or slender and much elongated. Sometimes the colliculus seminalis is hypertrophied.

(b) In acquired atrophy the internal opening of the urethra is changed, but the prostatic urethra may keep its proportionate dimensions (constriction of the neck, partial or total resection). In the atrophy of senile involution with reduction of the size of the prostate, obviously the prostatic urethra is shortened.

(c) In sclerosis of the bladder neck, shortening generally occurs because of the inflammatory retraction of the prostate gland.

The image is identical in the profile and anteroposterior roentgenograms. It shows a punctate smooth neck in the fundus of the bladder which does not change under anesthesia (operative verification).

2. Fish-mouth image. This represents exaggerated growth of the borders into the bladder cavity and corresponds to an exaggerated tone of the sphincter. The image corresponds also to what is seen in the neck when the bladder is opened. But under local anesthesia more than under spinal or general anesthesia, the sphincter relaxes and the protrusion disappears. It is therefore a transitory image and exists only when there are attacks of hypertonia of the sphincter. In certain

causes of the medulla the hypertonia becomes permanent and in that case the image persists and is not changed by any kind of anesthesia.

3 Image of hypertrophy of the trigonal muscle. Here the tissue which corresponds to the trigonal muscle is increased and tends to invade the bladder and deviates the internal opening of the urethra so that it projects forward. As it is a progressive condition in the early stages, the prostatic urethra is not changed and the muscle protrusion is barely perceptible.

The roentgen image faithfully reproduces these appearances but only in the profile roentgenogram. The posterior border of the internal opening of the urethra grows forward and becomes superimposed on the anterior border even forming a sort of valvular tongue. In the anteroposterior roentgenogram taken in the advanced stages, the image may resemble that of adenoma of the median lobe in the beginning of its growth. When the hypertrophy of the median lobe coincides with hypertrophy of the trigonal muscle the image does not show anything characteristic, except the projection of the adenoma itself.

FRANK L. HURSEY M.D.

Seale, A. B., Jr.: Ossification of the Coracoclavicular Ligament following Dislocation of the Acromioclavicular Articulation. *Am J Roentg* 1946 56 607

Ossification of the coracoclavicular ligament following partial or complete avulsion of the ligament incidental to dislocation of the acromioclavicular articulation is apparently a common sequela of a relatively common type of injury.

In the series of 18 cases reported in this article, 14 of the patients with dislocation of the acromioclavicular joint in the coracoclavicular ligament.

Dislocations of this joint are described as incomplete or complete, the latter term being applied when the coracoclavicular ligament is severed. In all dislocations there is tearing of the articular capsule and union of the superior and inferior acromioclavicular ligaments, or both.

X-ray examinations of both shoulders in injuries to the acromioclavicular joints should be made with the patient in the upright position and a 20 pound weight in each of his hands. Widening of the injured joint and elevation of the acromial end of the clavicle is demonstrated in this way.

Ossification of the coracoclavicular ligament has been observed as early as 22 days following injury. It usually appears as a group of amorphous, cloudy areas of light density below the outer third of the clavicle, frequently near the conoid tubercle and usually closer to the clavicle than to the coracoid process. These areas increase rapidly in size and density and within several weeks take on definite characteristics of bone being laid down in strands and spicules corresponding more or less to the lines of the fibrous strands of the conoid and trapezoid fascicle. While

the bone frequently becomes attached firmly to the clavicle above, it approaches, but rarely becomes continuous with, the coracoid process below. The process of ossification appears to be progressive for a period of about 8 or 10 weeks and then shows no perceptible change on subsequent examinations.

If ossification had not appeared within 6 weeks following injury it was not noted subsequently. The production or absence of ossification appeared to have no relationship to motion in this series of cases because in nearly all of the cases the shoulders were immobilized very shortly after injury.

Post traumatic ossification of the coracoclavicular ligament is a common sequela of avulsion of the ligament associated with dislocation of the acromioclavicular articulation. The ossification appears between 3 and 6 weeks following the injury and becomes complete about 8 or 10 weeks following the injury. The ossification does not appear to contribute to the disability of the patients.

FRANK L. HURSEY M.D.

Young, B. R.: The Roentgen Treatment of Bursitis of the Shoulder. *Am J Roentg* 1946 56 626

During a 6 year period 87 patients with bursitis were treated by radiation therapy. Patients were divided into three categories according to the duration of their symptoms. Symptomatology of less than 1 week's duration was classified as acute. Pain and disability lasting between 1 and 8 weeks were classified as subacute. Symptoms enduring more than 2 months were considered chronic.

In all three groups females outnumbered the males by 2 to 1. In the acute stage the diagnosis was made on the basis of clinical findings of pain and limitation of motion as well as local signs of heat and swelling. The diagnosis was more difficult in the subacute and chronic stages. Roentgen examination was necessary to establish or rule out calcification of the soft tissue or any other demonstrable pathology. The presence of calcification in itself was not too important. The history of the disease and the clinical findings were much more important for the evaluation of the activity of the disease. Calcium deposits were present in 43.6 per cent of the patients.

Roentgen therapy in the acute stage consisted of three treatments of 150 r in air. Sometimes a fourth treatment was needed. Subacute cases were treated twice weekly for a total dose of 600 r. Therapy in the chronic cases varied. Twenty-nine were treated twice weekly for 2 weeks, 11 received weekly treatments for 8 weeks and 8 were treated on 3 consecutive days with an additional treatment a week later.

Results of roentgen therapy in the treatment of bursitis of the shoulder indicate that this treatment is valuable in the acute and subacute stages. All but a week or less. Two-thirds of the patients in the subacute stage reported relief from pain in 2 weeks or less. Only one third of the patients in the chronic stage reported relief from pain. A second series of radiation therapy was never given to the patients with recalcitrant chronic bursitis.

MAURICE D. SACCHI M.D.



## MISCELLANEOUS

Bochta, J. W.: Radioactive Isotopes. *West J Surg* 1946 54 467

The author briefly describes some of the basic physics of radioactive isotopes.

The atom of each element is composed of three fundamental particles: the electron, the proton, and the neutron. The electron is the smallest particle of negative electricity; its mass is about  $1/2000$  of that of the proton and neutron. The proton carries a positive charge equal in magnitude to that of the electron; the neutron has no electric charge. The mass of the proton is practically the same as that of the neutron.

The central core or nucleus of the atom contains definite numbers of protons and neutrons. Around the nucleus revolve electrons, their number always being equal to the number of protons in the nucleus. Thus the hydrogen, which is the simplest atom, has a nucleus containing a single proton and there is a single electron revolving around the nucleus. The helium has a nucleus composed of two protons and two neutrons and there are two orbital electrons. The iodine has a nucleus of 53 protons and 74 neutrons, and so forth.

The "atomic weight" of an element is approximately equal to the total number of protons and neutrons contained within the nucleus, whereas the total number of the electrons (and hence also of the protons) indicates the atomic number of the element. Thus hydrogen has an atomic weight of 1 and an atomic number of 1 (H); helium has an atomic weight of 4 and an atomic number of 2 ( $\text{He}_{2+}$ ); iodine has an atomic weight of 127 and an atomic number of 53 ( $\text{I}_{53}^{127}$ ). The chemical properties of the elements are determined by the atomic number; that is, by the number and orbital arrangement of the electrons revolving around the nucleus and are quite independent of the nuclear structure. Therefore, it is possible for an element to have varieties with the same atomic number but different atomic weights. These varieties are called isotopes. For example, the oxygen with 8 orbital electrons, or an atomic number of 8, may have a nucleus of 8 protons and 8 neutrons ( $\text{O}^{16}$ ), a nucleus of 8 protons and 9 neutrons ( $\text{O}^{17}$ ) or a nucleus of 8 protons and 10 neutrons

( $\text{O}^{18}$ ). Most of the elements have stable isotopes; tin has 10. Since the isotopes of a given element have identical chemical behavior, they can be separated only by some other method than ordinary chemical process as, for example, by diffusion or electrolysis.

Radioactivity involves disintegration of the nucleus which may occur naturally in some of the heavy elements or may be induced artificially by nuclear transformation in every element of the periodic table.

The rate of disintegration cannot be influenced. The half lives of the radioactive products vary from a fraction of a second to millions of years. The uranium has the longest half life of all and is most abundant.

The number of radioactive isotopes already exceeds 300. All the elements of the periodic table have at least one radioactive isotope, and some have more than one-half dozen.

During the disintegration process of a radioactive isotope, electrons or (rarely) positrons are emitted, not infrequently accompanied with gamma rays.

An extremely sensitive apparatus for the detection of radioactivity is the Geiger counter which registers every single ionizing particle in the form of a "click." The number of clicks per minute is an indicator within certain limits of the strength of the radioactivity. If one drinks radioactivated salt water the Geiger counter will detect the presence of radioactive sodium in the hand within a quarter of an hour. A similar procedure can be used for tracing a radioactive substance in any part of the body.

The many possibilities of tracer studies are immediately obvious. Reports have already been published on the usefulness of more than a dozen tracers in all types of biologic experiments.

Up to the present, radioactive isotopes have been produced in comparatively small quantities through bombardment with the cyclotron or with the aid of intensive sources of natural radioactive substances. Now the use of the uranium pile which yields enormous numbers of neutrons permitting a very efficient nuclear transmutation, has considerably increased the availability of nearly every radioactive isotope. Another valuable supply is obtained from the contamination fission products of the atomic bomb pile.

T. LEUCUTIA, M.D.

# MISCELLANEOUS

## CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

Andres W. A., and Browne, J. S. L.: Ascorbic Acid Metabolism after Trauma. *Canad. M. Ass. J.* 1946 55 435

The authors summarize briefly what has been known about ascorbic acid wound healing and callus formation and then report their own studies which were done on patients with a normal vitamin C intake and not, as most previous studies, on patients with vitamin C deficiency.

They find that patients after trauma (fractures, burns) require considerably more ascorbic acid in order to become saturated with it than do normal persons. Their needs resemble those of patients with experimentally induced scurvy. However, while in the scorbutic individuals such increased vitamin C intake is necessary to promote wound healing, no significant clinical effect of saturation doses of ascorbic acid is found in traumatized patients with an initially approximately normal vitamin C status.

HEINRICH LAMM, M.D.

Hoet, P. and Hugulier, J.: The Probable Role of Reflex Capillary Stasis in General Pathology (Le rôle probable de la stase capillaire réflexe en pathologie générale). *J. chir., Par.* 1946 63 184

The authors contend that all trauma provokes reactions which are generally admitted to be of a reflex nature and that local reflex reaction is the constant means by which the organism reacts to aggression of any sort at any site.

Following trauma a local reflex capillary stasis occurs, with increased arterial pulsations proximal to the site of trauma comparable to those which occur proximal to any arterial obstruction. Capillary stasis rapidly induces serous exudation which is manifested by edema, blisters, and joint effusion. If the stasis is intense local diapedesis and even hemorrhage may occur. Sympathectomy by producing active hyperemia, relieves the local capillary stasis.

Assuming that diffusion of reflexes is a common phenomenon the authors suggest that the general reactions to trauma such as shock may represent in effect a diffusion or spread of the local reflexes to produce a peripheral vasomotor stasis.

EDWARD W. GIBBS, M.D.

Holabec, H.: An Improved Intravenous Treatment of Intestinal Occlusion. An Experimental Study (Úprava vnitřního prostrředí a účinné neprůchodnosti. Experimentální studie.) *Lah. listy* 1946, 1 106.

The rapid infusion of large quantities of physiologic saline solution has been observed to result in degeneration of the cardiac muscle and kidney par-

enchyma eventuating at times in circulatory failure and even in anuria. Likewise Ringer's solution leads at times to edema.

The author in studying the method of injecting plasma with the physiologic saline solution as recommended by Gendel and Fine (*Ann. Surg.* 1940 111 248) employs the exact technique of the American authors. However a closer study of blood conditions during the experiment convinces him that the early losses in water and electrolytes, and the later loss of plasma from the blood in experimental in sufflation distention of an isolated segment of small bowel, together with reduction in the albumin globulin ratio denotes a change in the colloidal conditions in the blood plasma, rather than the previous explanations on the basis of humoral changes in the blood.

The coincidental injection of plasma and physiologic saline solution permits of the use of smaller quantities of the latter and is thus regarded as a definite improvement in the treatment of ileus.

JOHN W. BRENNAN, M.D.

McKiltrick, L. S.: Recent Advances in the Care of Surgical Complications of Diabetes Mellitus. *N. England J. M.*, 1946 235 929

The general safety of all patients undergoing surgical procedures has been increased immeasurably during the past few years, and although diabetic patients necessitate special attention to their local and general surgical conditions as well as their diabetes mellitus recent experience has shown that their metabolic disorder is no contraindication to any surgical procedure. Surgical emergencies should be avoided as much as possible in order to insure the safest possible convalescence. This discussion of diabetic surgery deals with problems involved in operations accounting for about two-thirds of the surgery performed on diabetics at the New England Deaconess Hospital. These operations were necessary for infections of the skin and subcutaneous tissues, especially carbuncles, and for gangrene and infection of the lower extremities.

Among 95 patients operated on for carbuncles between 1928 and 1941 there were 7 deaths. This, however, gives little concept of the seriousness of this condition to the diabetic. The recently instituted treatment of carbuncles with penicillin (from 100,000 to 300,000 units daily for from 7 to 10 days) has been most gratifying. This results in the disappearance of large early carbuncles or the change of advanced infections to small painless fluctuant areas which heal promptly after local incision. Penicillin has reduced materially the morbidity, mortality and the period of hospitalization in these cases.

Diabetic patients with carbuncles should be treated as emergency cases hospitalized immediately have careful management of their diabetes and receive daily injections of penicillin. When the carbuncle is so

advanced that penicillin fails to cause complete disappearance and leaves a small central area of necrosis, it may be treated by a small incision followed by packing with gauze for 1 or 2 days. Small carbuncles that fail to resolve completely are best treated by complete excision and early skin grafting. Extensive operations such as were previously done for carbuncles are necessary only in the badly neglected cases. Parenteral administration of penicillin is superior to local or oral use.

The mortality of major and minor leg amputations in diabetic patients between 1923 and 1942 before the use of sulfonamides or penicillin was 9.7 per cent (1,036 cases) as compared to 2.6 per cent (229 cases) since the use of antibiotic and chemical therapy. This remarkable improvement is attributed solely to the increasing ability to eliminate infection.

The supracondylar type of amputation is the safest and easiest; the lower leg type and the Gritti-Stokes operations being reserved for selected cases. Gullotine amputation is indicated for patients in poor condition or those with extensively spreading infection but it is now rarely required.

When infection can be controlled in the diabetic patient a more conservative operation can be done. The transmetatarsal amputation is now used, but formerly it was not feasible because of the danger of invasive local infection and septicemia. Seventy-five metatarsal amputations have been done in the past 2 years, in 11 cases they failed and in 1 case the patient died of coronary disease. Indications for this type of operative procedure are not yet clear. Occasionally a small area of necrosis occurs on the dorsal flap. The importance of penicillin is recognized when one realizes that in 75 routine cultures from this group the *Staphylococcus aureus* was present in pure cultures in 11 cases and in combination with other organisms, usually streptococci, in 41 instances. Experience has shown that amputation at the metatarsal level is practical and safe with the use of penicillin and gives a better functional result than when done at a higher level in the leg. The author estimates that from 10 to 15 per cent of this group would have required amputation at a higher level prior to the use of penicillin.

A further advantage in technique is the suture of the operative site leaving only a small part open for drain

age following removal of one or several toes when the foot is split longitudinally. This results in a smaller scar and decreases the healing time.

Proximal spinal anesthesia is best, and no justification is found for the use of refrigeration anesthesia. Preoperative sedation is not given to these patients since it is believed unnecessary and at times dangerous.

C. FREDERICK KITTLE, M.D.

Gordler, G. and Demirhan, J.: The Use of Animal Plasma or Serum in Man. *Universaal Detoxified Plasma or Serum* (L'utilisation du plasma ou sérum animal chez l'homme. Plasma ou sérum universel detoxiqué). *Presse méd.*, 946, 54, 833.

During the last war the supply of human plasma or serum for transfusion presented a difficult problem for the French Army fighting in Tunis as the Mohammedan soldiers refused to donate blood. Based on an article by Donald Edwards in the *British Medical Journal* the author developed a method of using animal plasma for transfusion purposes. Bovine plasma was used as it has the greatest similarity to human plasma in its protein content. The blood was drawn from living cattle which were at the slaughter house.

In order to detoxify the plasma, the globulins have to be removed from the blood as the antibodies attached to the globulins seem to be the cause of untoward accidents in transfusion. The citrated blood is kept for 3 days at room temperature in the dark, then centrifuged for 15 minutes. The plasma is then filtered through cotton and muslin, 0.2 per cent formalin and 0.34 per cent ammonia are added, and the serum is kept in a water bath at 74 C. for 30 minutes.

The author's experiences are still rather limited (about 100 cases) but the results were most encouraging. In only 3 cases were reactions observed with chills and hyperpyrexia. The amount of transfused plasma averaged 400 c.c. although some patients received as much as 1,000 c.c. without any reaction. In several cases the transfusion was repeated after 10 to 15 days without any signs of anaphylaxis. It is important to make the transfusion very slowly.

WERNER M. SOLOVITZ, M.D.

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